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The CEPS Journal is an open-access, peer-reviewed journal devoted to publishing research papers in different fields of education, including scientific.

Aims & Scope

The CEPS Journal is an international peer-reviewed journal with an international board. It publishes original empirical and theoretical studies from a wide variety of academic disciplines related to the field of Teacher Education and Educational Sciences; in particular, it will support comparative studies in the field. Regional context is stressed but the journal remains open to researchers and contributors across all European countries and worldwide. There are four issues per year. Issues are focused on specific areas but there is also space for non-focused articles and book reviews.

About the Publisher

The University of Ljubljana is one of the largest universities in the region (see www.uni-lj.si) and its Faculty of Education (see www.pef.uni-lj.si), established in 1947, has the leading role in teacher education and education sciences in Slovenia. It is well positioned in regional and European cooperation programmes in teaching and research. A publishing unit oversees the dissemination of research results and informs the interested public about new trends in the broad area of teacher education and education sciences; to date, numerous monographs and publications have been published, not just in Slovenian but also in English.

In 2001, the Centre for Educational Policy Studies (CEPS; see http://ceps.pef.uni-lj.si) was established within the Faculty of Education to build upon experience acquired in the broad reform of the national educational system during the period of social transition in the 1990s, to upgrade expertise and to strengthen international cooperation. CEPS has established a number of fruitful contacts, both in the region – particularly with similar institutions in the countries of the Western Balkans – and with interested partners in EU member states and worldwide.

Revija Centra za študij edukacijskih strategij je mednarodno recenzirana revija z mednarodnim uredniškim odborom in s prostim dostopom. Namenjena je objavljanju člankov s področja izobraževanja učiteljev in edukacijskih ved.

Cilji in namen

Revija je namenjena obravnavanju naslednjih področij: poučevanje, učenje, vzgoja in izobraževanje, socialna pedagogika, specialna in rehabilitacijska pedagogika, predšolska pedagogika, edukacijske politike, supervizija, poučevanje slovenskega jezika in književnosti, poučevanje matematike, računalništva, naravoslovja in tehnike, poučevanje družboslovja in humanistike, poučevanje na področju umetnosti, visokošolsko izobraževanje in izobraževanje odraslih. Poseben poudarek bo namenjen izobraževanju učiteljev in spodbujanju njihovega profesionalnega razvoja.

V reviji so objavljeni znanstveni prispevki, in sicer teoretični prispevki in prispevki, v katerih so predstavljeni rezultati kvantitativnih in kvalitativnih empiričnih raziskav. Še posebej poudarjen je pomen komparativnih raziskav.

Revija izide štirikrat letno. Številke so tematsko opredeljene, v njih pa je prostor tudi za netematske prispevke in predstavitve ter recenzije novih publikacij.

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Izdajanje revije v letih 2025 in 2026 sofinancira Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije v okviru Javnega razpisa za sofinanciranje izdajanja domačih periodičnih znanstvenih publikacij.

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Contemporary Issues and Challenges in Computer Science Education

In recent years, as computer science (CS) has increasingly become part of compulsory education curricula worldwide, computer science education research (CER) has shifted its focus towards nuanced investigations of how, by whom and under what conditions CS – also referred to as informatics in many educational contexts – and computational thinking (CT) are meaningfully taught and learned (Fincher & Robins, 2019). Recent studies emphasise that the successful integration of CS in education depends not only on curricular reform but also, and crucially, on teachers' conceptual understanding, pedagogical beliefs and assessment practices, as well as on the cultural contexts in which learning takes place (Denning & Tedre, 2021; Yadav et al., 2017).

Drawing on earlier work in computational and constructionist approaches to learning, particularly Papert's constructionist tradition, CT was articulated and brought into broader educational discourse by Wing (2006) as a fundamental competence for everyone, initially being framed primarily in terms of general problem-solving skills. In contemporary CER, however, CT is increasingly conceptualised as a discipline-sensitive, context-dependent competence that emerges through engagement with the specific practices, representations and epistemic norms of computer science (Denning & Tedre, 2021; Weintrop et al., 2016). From this perspective, CT cannot be reduced to a checklist of isolated skills such as abstraction, decomposition, algorithmic thinking or pattern recognition, but is better understood as a constellation of interrelated practices that are enacted differently across learning contexts. Brennan and Resnick's (2012) influential framework captures this shift by distinguishing between computational concepts, computational practices and computational perspectives, while placing particular emphasis on practices as central to understanding how learners think, act and reflect computationally. Importantly, these practices take different forms depending on whether CT is developed through block-based or text-based programming, unplugged activities, game-based learning or cross-curricular integration, each offering distinct pedagogical affordances for the development of computational fluency and understanding.

Against this background, the call for papers for this focus issue emphasised several interrelated challenges: (i) the preparation and professional identity of CS teachers, (ii) pedagogical approaches to teaching CS and CT, (iii) assessment of CT, (iv) learning resources and alternative learning environments, and (v) early and cross-curricular CS education. The contributions in this issue address these themes explicitly, while collectively reflecting current directions and open questions in CER.

A first thematic cluster concerns teacher education, motivation and professional readiness, a topic identified in CER as a critical bottleneck for the sustainability of CS education reforms (Yadav et al., 2017).

Václav Dobiáš, Václav Šimandl and Martin Kouřimský analyse the decision-making processes of pre-service CS teachers in the first paper of the focus section of this issue, entitled *The Factors Influencing the Process of Deciding Whether to Become a Computer Science Teacher*, shedding light on how external labour-market factors intersect with intrinsic motivations and beliefs about teaching. Their findings resonate with the international CER literature showing that CS teacher recruitment and retention are shaped by tensions between disciplinary identity and pedagogical commitment.

Teacher preparation is further addressed by Alenka Žerovnik in her paper *Developing Digital Literacy in Pre-Service Primary School Teachers Through a Massive Open Online Course and Project-Based Learning*. The author investigates the development of digital literacy through a combination of a massive open online course and project-based learning. This contribution responds to the call for papers' focus on teacher training and learning resources, demonstrating how integrated pedagogical approaches can effectively support the development of digital competences in pre-service teachers.

A second cluster of articles engages with teachers' attitudes, competencies and assessment practices in primary education, reflecting the growing CER interest in early CS education.

In the third paper of this section, entitled *Primary Programming: Teachers' Attitudes and Skills in the Light of Computing Reform*, Jiří Vaníček and Jan Pršala examine primary teachers' attitudes towards programming in the context of curricular reform, confirming earlier research that positive attitudes alone are insufficient without sustained professional support and experience.

Complementing this perspective in the paper entitled *Assessing Computational Thinking Practices and Engagement: Primary Teachers' Reflections on an Unplugged Activity*, authors Jakob Škrobar, Andrej Flogie, Alenka Lipovec and Nika Golob focus on how teachers observe and assess CT practices during an unplugged activity based on Bebras Challenge tasks. Their process-oriented approach aligns with recent CER calls for assessment models that capture how learners think, not merely what they produce, while drawing on the well-established Bebras framework for concept-based learning of informatics and CT (Dagienė & Stupurienė, 2016).

A third thematic cluster addresses the development of CT across diverse learning contexts, reflecting CER's growing recognition that CT emerges through varied forms of engagement. In the fifth focus paper of this issue, entitled *Video Games and the Development of Computational Thinking*, Mária Čujdíková and Ivan Kalaš analysecommercial video games as informal environments for the development of CT-related cognitive processes, reinforcing CER findings that game-based contexts can foster algorithmic thinking, abstraction and evaluation when accompanied by reflection and dialogue.

Focusing on pedagogical approaches to programming education, Matej Zapušek and Irena Nančovska Šerbec examine programming patterns as a pedagogical tool for developing conceptual programming knowledge in future CS teachers, in their submission entitled *Developing Conceptual Programming Knowledge in Pre-Service Computer Science Teachers: The Role of Programming Patterns*. Their study contributes to ongoing CER debates about what constitutes robust programming knowledge for teaching, particularly the relationship between code implementation, conceptual understanding and pedagogical competence.

The focus section concludes with a study by Stavroula Prantsoudi, Georgios Fesakis and Hüseyin Özçınar on culturally responsive, unplugged integration of CT in language, literature and arts lessons, which the authors explore in their paper entitled *Culturally Responsive Unplugged Integration of Computational Thinking Skills in Language/Literature and Arts Lessons: A Case Study in Greece*. This contribution directly addresses the call for papers' emphasis on cross-curricular learning and responds to recent CER arguments that CT should be embedded in culturally meaningful practices rather than treated as a context-free skill set (Weintrop et al., 2016).

The varia section brings together contributions that address broader educational questions beyond the field of CER.

In her paper *The Importance of the School Magazine as an Extra-Curricular Activity in Facilitating Students' Cross-Curricular Skills and Competences*, the author Melita Lemut Bajec examines the role of the school magazine as an extracurricular activity that supports the development of students' cross-curricular skills, including literacy, collaboration and critical engagement with social issues.

Complementing this perspective, José Carlos Bronze, Carlinda Leite and Angélica Monteiro provide a critical review of Erasmus+ mobility research in their paper *Emancipation or Instrumentalisation in Erasmus+ Mobility: A Literature Review*, highlighting tensions between emancipatory and instrumental approaches to internationalisation in education.

In the third paper of the varia section, entitled *Environmental Content as a Part of Science-Oriented Sustainable Development Goals in Grades 6 and 7 of Slovenian Primary School: An Analysis of Science Textbooks*, the authors Matej

Vošnjak, Neva Rebolj and Iztok Devetak contribute an analysis of environmental content in Slovenian science textbooks, examining the extent to which sustainability-oriented learning goals are reflected in curricular materials.

In the next varia paper, *Perceptions of the Teaching Profession and Motivation to Teach Among Slovenian University Students*, authors Melita Puklek Levpušček and Katja Depolli Steiner explore Slovenian university students' perceptions of the teaching profession and their motivation to teach, offering insights into factors shaping career choices in education and raising questions relevant to ongoing teacher shortages in many education systems.

A second varia strand foregrounds artistic expression, creativity and embodied learning in education.

In their paper *The Frequency of Music Improvisation Activities in the Fourth and Fifth Grade of Primary School*, Alja Krevel and Jerneja Žnidaršič investigate the frequency and forms of music improvisation activities in primary school music education, documenting current classroom practices and identifying constraints related to time, teacher confidence and curricular frameworks.

The issue concludes with a review by Alenka Žerovnik of the book entitled *Teaching with AI: A Practical Guide to a New Era of Human Learning* by Bowen and Watson (2024), which critically examines the pedagogical, ethical and practical implications of integrating artificial intelligence into educational practice.

Together, these contributions underscore the importance of creativity, reflection and human-centred approaches in contemporary education, even as digital and AI-based technologies increasingly shape learning environments.

The articles in this focus issue illustrate how contemporary CER is increasingly characterised by methodological diversity, attention to educational context and a shift from purely technical concerns towards pedagogical, cultural and epistemic questions. They collectively underscore the fact that advancing CER requires not only curricular change but also theoretically grounded teacher education, robust assessment practices and learning designs that acknowledge the embodied, social and cultural dimensions of CT. As generative AI increasingly transforms what and how we teach and learn (Prather et al., 2023), these foundational commitments become ever more critical.

Irena Nančovska Šerbec

References

Bowen, J. A., & Watson, C. E. (2024). *Teaching with AI : A practical guide to a new era of human learning*. Johns Hopkins University Press.

Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking. In A. Ball, & C. Tyson (Eds.), *Proceedings of the 2012 Annual Meeting of the American Educational Research Association* (pp. 1–25). AERA. https://scratched.gse.harvard.edu/ct/files/AERA2012.pdf

Dagienė, V., & Stupurienė, G. (2016). Bebras – a sustainable community building model for the concept based learning of informatics and computational Thinking. *Informatics in Education, 15*(1), 25–44. https://doi.org/10.15388/infedu.2016.02

Denning, P. J., & Tedre, M. (2021). Computational thinking: A disciplinary perspective. *Informatics in Education, 20*(3), 361–390. https://doi.org/10.15388/infedu.2021.21

Fincher, S., & Robins, A. (2019). *The Cambridge handbook of computing education research*. Cambridge University Press.

Prather, J., Denny, P., Leinonen, J., Becker, B. A., Albluwi, I., Craig, M., Keuning, H., Kiesler, N., Kohn, T., Luxton-Reilly, A., MacNeil, S., Petersen, A., Pettit, R., Reeves, B. N., & Savelka, J. (2023). The robots are here: Navigating the generative AI revolution in computing education. In M.-J. Laakso, M. Monga, Simon, & J. Sheard (Eds.), *Proceedings of the 2023 Working Group Reports on Innovation and Technology in Computer Science Education* (pp. 108–159). Association for Computing Machinery. https://doi.org/10.1145/3623762.3633499

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology, 25*(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Yadav, A., Gretter, S., Good, J., & McLean, T. (2017). Computational thinking in teacher education. In P. J. Rich, & C. B. Hodges (Eds.), *Emerging research, practice, and policy on computational thinking* (pp. 205–220). Springer. https://doi.org/10.1007/978-3-319-52691-1_13

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The Factors Influencing the Process of Deciding Whether to Become a Computer Science Teacher

Václav Dobiáš*[1], Václav Šimandl[2] and Martin Kouřimský[3]

Choosing a future profession is an important step in life, and the decision to become a teacher is widely discussed in the literature. However, pre-service computer science teachers hold a unique position, as they are highly employable in the information technology job market, and this may have an impact on the decision to choose teaching as a career. The present research aims to clarify the decision-making process of becoming a computer science teacher and the factors that influence it. The qualitative research inspired by the constructivist grounded theory involved semi-structured interviews with 18 first-year pre-service computer science teachers. Through a questionnaire developed for this sample, the findings from the qualitative research were quantitatively verified on 69 respondents. The key choice is whether to become a teacher. Pre-service teachers are motivated by external factors (length of holidays, job stability, flexibility and salary) and the desire to work with children. In contrast, they are demotivated by the negatives of being a teacher, particularly by concerns about pupils (especially their behaviour) and parents. After deciding to study teaching, pre-service teachers need to make a decision about their specialisation. This is influenced by the high school they attended, their relationship to computer science, their former teachers, strategic reasons (believing this specialisation to be an easy way of getting the degree or a job after graduation), gender stereotypes (especially among women), and their expectations about teacher education in computer science.

Keywords: computer science teacher, pre-service teacher, deciding on a teaching career, computer science education

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Dejavniki, ki vplivajo na odločitev za poklic učitelja računalništva

Václav Dobiáš, Václav Šimandl in Martin Kouřimský

Izbira poklica za svojo prihodnost je pomemben korak v življenju vsakega posameznika, odločitev za poklic učitelja pa je v literaturi široko obravnavana. Bodoči učitelji računalništva imajo pri tem edinstven položaj, saj so na trgu dela v informacijski tehnologiji visokozaposljivi, kar lahko vpliva na odločitev za poklic učitelja. Namen te raziskave je pojasniti proces odločanja za poklic učitelja računalništva in dejavnike, ki vplivajo nanj. Kvalitativna raziskava, ki je temeljila na konstruktivistični utemeljeni teoriji, je vključevala polstrukturirane intervjuje z 18 bodočimi učitelji računalništva v prvem letniku študija. Z vprašalnikom, razvitim za to skupino udeležencev, so bili izsledki kvalitativne raziskave kvantitativno potrjeni na 69 udeležencih. Ključna odločitev je, ali postati učitelj. Bodoče učitelje motivirajo zunanji dejavniki (dolžina počitnic, stabilnost zaposlitve, fleksibilnost in plača) in želja po delu z otroki. Nasprotno pa jih demotivirajo negativne strani učiteljskega poklica, zlasti skrbi v povezavi z učenci (predvsem njihovim vedenjem) in s starši. Ko izberejo izobraževalno smer študija, morajo sprejeti še odločitev o specializaciji, tj. predmetu, ki ga bodo poučevali. Na to vplivajo: srednja šola, ki so jo obiskovali, njihov odnos do računalništva, njihovi nekdanji učitelji, strateški razlogi (prepričanje, da je ta specializacija lahek način za pridobitev diplome ali zaposlitve po diplomi), spolni stereotipi (zlasti med ženskami) in njihova pričakovanja glede izobraževanja učiteljev računalništva.

Ključne besede: učitelj računalništva, bodoči učitelj, odločitev za poklic učitelja, računalniško izobraževanje

Introduction

As claimed by Moses et al. (2017, p. 444), "understanding student-teachers' decisions to enter and stay in the teaching profession after graduation could help teacher educators to find appropriate procedures to enhance commitment to teaching". The decision to become a teacher has been described in general terms by many authors; See et al. (2022) have identified 517 papers on this topic. The motivators that influence this decision-making process can be divided into personal and extrinsic. Personal motivators include perceptions of the profession (Butler, 2021; Nur Fitria, 2023; Watt & Richardson, 2008), altruism (Wang & Wang, 2022; Yong, 1995) and personal fulfilment (Knell & Castro, 2014). Extrinsic motivators include social norms and expectations of the teaching profession (See et al., 2022), teacher role models (Daud, 2021), benefits of the teaching profession, such as job stability and income (Everson & Ko, 2022; See et al., 2022), and the amount of free time (Richardson & Watt, 2005). These motives may be further influenced by teacher education (Bruinsma & Jansen, 2010; Teng, 2017). However, some novice teachers enter the profession without a commitment to stay (Plunkett & Dyson, 2011), which may further exacerbate the teacher shortage (Fokkens-Bruinsma & Canrinus, 2012a).

According to Bergmark et al. (2018), there are four motives that lead to enrolment in teacher education: (re)creating the caring school, fostering the upright human being, creating a desirable (professional) life, and forming valuable knowledge. Other authors attempt to describe the diversity of factors motivating people to become teachers. Watt and Richardson (2008) have developed a multidimensional model called FIT-Choice. Motivators in this model include the perception of the teaching profession, specifically the job requirements (e.g., a high level of expertise) and the job benefits (e.g., relatively good salary or social status) (Watt & Richardson, 2008; Watt et al., 2012). Other researchers have investigated the significance of factors within the FIT-Choice model (Fokkens-Bruinsma & Canrinus, 2014). Based on the FIT-Choice model, diagnostic and research tools have been developed in some countries to measure motivation for choosing the teaching profession (Fokkens-Bruinsma & Canrinus 2012b; Hennessy & Lynch, 2016; Kılınç et al., 2012; Tomšík, 2019).

Gender is an important factor in choosing a teaching career. Different motivators to become a teacher prevail for each gender (See et al., 2022). According to Keck Frei et al. (2017), the main motivator for men is a good match between their interests, skills and future profession. Most men who choose to become teachers have family members who are teachers, and thus are supported in their choice (Keck Frei et al., 2017). As claimed by See et al. (2022, p. 1), "men are reported to be more strongly influenced by social norms and expectations and were less likely to choose primary and early years teaching. Women are also more likely to experience higher levels of career satisfaction and less social dissuasion than men".

Saqipi and Vogrinc (2021, p. 5) claim that "the importance of studying teachers' personal and professional identities has gained significant attention in recent decades, given the need to understand better the rationale behind teachers' behaviour in their tasks". Teachers' identities are deeply embedded in their personal biographies (Bukor, 2015). As stated by Bukor (2011, p. iii), "it is essential to explore teachers' personal life experiences in order to gain a holistic understanding of the dominant influences on the development of teacher identity". Teacher identity is considered an important aspect of becoming a teacher (Butler, 2021), and future teacher identity is likely to be formed in the process of deciding whether to enter teaching. This identity is further shaped by the study of teacher education (Butler, 2021; Pappa & Moate, 2021) and practice (Torres-Cladera et al., 2021).

Many computer science teachers leave the education sector after graduation (Průcha, 2023; Yadav et al. 2022). This is one of the factors contributing to the shortage of computer science teachers. Let us illustrate this with reference to the situation in the Czech Republic. In lower secondary schools, computer science is taught by 6,200 teachers (Ministry of Education, Youth and Sports of the Czech Republic, 2025). In 59% of lower secondary schools, computer science lessons are taught by teachers who do not have the education to teach this subject (Czech School Inspectorate, 2024), and 8% of computer science teachers in primary and lower secondary schools do not have a university degree (Ministry of Education, Youth and Sports of the Czech Republic, 2025). In the upcoming school year, 730 computer science teachers will be needed (Ministry of Education, Youth and Sports of the Czech Republic, 2025). Although 14 faculties at 9 universities offer teacher education in computer science (Průcha, 2023), the number of graduates in computer science teaching is insufficient.

The context of the Czech education system

The school system in the Czech Republic is divided into three levels: primary school (grades 1–5 for pupils aged 6–10), lower secondary school (grades 6–9 for pupils aged 11–14), and high school (grades 10–13 for pupils aged 15–18). In primary school, one teacher teaches (nearly) all of the subjects in his or her class. In lower secondary school and high school, the teacher specialises in teaching one or two subjects. One usually becomes a teacher after graduating from the faculty of education, where one can enrol in teacher education for primary school or teacher education for lower secondary school, with two specialisations (e.g., mathematics and computer science). Another common option is to enrol in teacher education for high schools at applied faculties.

Research problem

Although the general factors and motives that influence the decision to become a teacher are well described in the literature, the specific motivators that lead to teaching particular disciplines vary by discipline (Everson & Ko, 2022). Pre-service computer science teachers for lower secondary schools or high schools are in a unique position. Their studies have equipped them with skills that make them highly employable in the information technology job market (Průcha et al., 2019), which may have an impact on the decision to choose a teaching career. If we better understand why high school students decide whether or not to study teacher education in computer science, it will enable us to address the individual factors and increase both the quality and quantity of pre-service teachers and later teachers of this subject.

The present research aims to clarify the decision-making process of becoming a computer science teacher and the factors that influence it. Based on this, we created the following research question: What is the process of deciding whether to become a computer science teacher? Within this research question, we formulated the following sub-question: What factors influence this process?

Methods

The research was based on a mixed-method approach. While the qualitative part was intended to describe the decision-making process and the factors, the quantitative part was used to verify the qualitative findings. The research was conducted with Czech pre-service teachers.

Participants

The chosen research question led us to carry out qualitative research on pre-service computer science teachers for lower secondary schools. The research participants were in their first year of study and approximately 19 years of age. We decided on this age category because they had gone through the decision-making process of which profession to practice shortly before the research. Moreover, their perception of the teaching profession was still minimally influenced by their university studies. A total of 18 students of the Faculty of Education at the University of South Bohemia and the Faculty of Education at the University of West Bohemia took part in the qualitative part of the research: 13 male students and 5 females students. At the beginning of the research, the simple random sampling method was used to select the participants. Later, participants who had the potential to help us to explain unexplored areas of the research were chosen.

A total of 69 participants took part in the quantitative part of the research, 23 of whom were women. The questionnaire was distributed to all first- and second-year pre-service computer science teachers at the Faculty of Education, University of South Bohemia. As we addressed 105 students, the return rate of the questionnaire was 66%.

Instruments

In order to be able to collect data in the qualitative part of the research, a basic outline of interviews was prepared (Birks & Mills, 2011; Švaříček & Šeďová, 2007). The outline contained 24 questions reflecting the research aim. The questions covered topics such as previous experience of working with children, relationship to computer science, description of the process of choosing whether to become a computer science teacher, expectations of the teacher education and teaching profession, and opinions on whether they will want to teach after graduation.

The quantitative part of the research involved a questionnaire survey including seven closed-ended questions, three open-ended questions and three questions containing together nine Likert scales. The questionnaire was created electronically using Google Forms and distributed to respondents by email. It is available in Czech from the corresponding author.

Research design

The qualitative part was inspired by the grounded theory approach. Since grounded theory is intended to describe a process, we believe that it is an appropriate way to address our research questions. Charmaz's approach was adopted for the implementation of the research (Charmaz, 2014; Mills et al., 2006; Šimandl & Dobiáš, 2021). Qualitative data collection involved interviewing the participants. At the start of each meeting, the researcher and the research project were introduced, anonymity was assured, and participants were asked for consent to participate and to have the interview recorded on a Dictaphone. The interviews followed the outline (see above), but follow-up questions could be created and asked as needed during the interview in order to add depth (Charmaz, 2014). The average length of the interviews was 13 minutes. Quantitative data collection involved a questionnaire survey based on the prepared questionnaire (see above).

In the qualitative part of the research, the data analysis was based on the initial coding method. In order to ensure the validity of the research, it included the principle of constant comparison according to Charmaz (2014). The analysed text was divided into units that were assigned an appropriate code (Charmaz, 2014). The created codes were grouped into categories according to their internal similarity (Strauss & Corbin, 1990; Corbin & Strauss, 2008), and the emerging categories were arranged into a structure. Based on this structure, the final text was constructed, which forms the basis of the Results section below. To enhance credibility, the final text is documented by authentic citations of the participants, presented in italics with quotation marks.

Let us present an example of the data analysis. One of the participants claimed: *"What is good is the security of a stable income. You don't have to worry about being redundant somewhere"*. During the initial coding, the code *"Job stability"* was assigned to this text. The same code was also assigned to other texts with a similar meaning. In this way, seven positive motivational factors in the data were identified and grouped into the category *"Positives of being a teacher"*.

The data obtained from the questionnaire survey were processed to find the frequencies of responses. Contingency tables were used for this purpose. In the case of the open-ended questions, open coding was performed at the beginning of the analysis. The contingency tables are available from the corresponding author.

Results

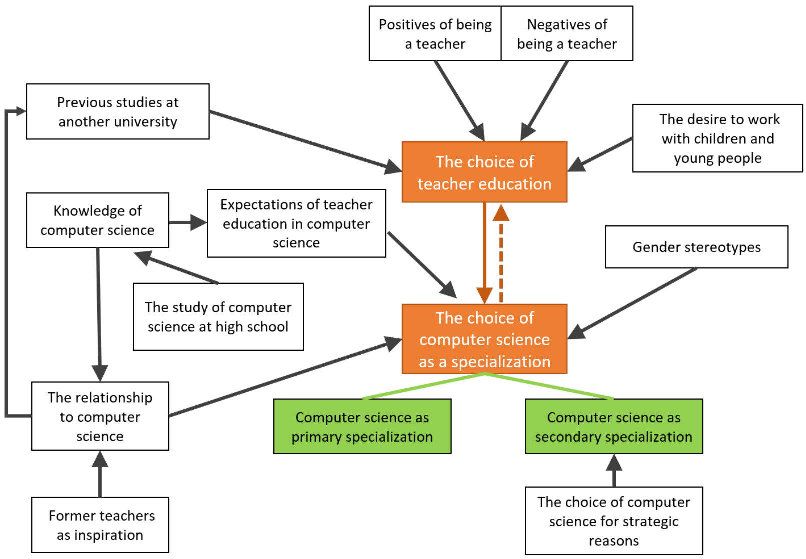
During their high school studies, students face the decision of which profession to practice, choosing a university and field of study accordingly. Thus, prospective pre-service teachers face two key decisions:

1. Whether to choose teacher education or to study another field.
2. Which two specialisations they want to teach if they decide to study teacher education for lower secondary schools.

Each of these key decisions is treated separately below. In this text, we describe the factors that influence participants to study teacher education in computer science for lower secondary schools, as summarised in Figure 1. The factors are in white boxes and the key decisions are in orange boxes. Figure 1 was created on the basis of the structure that emerged during the qualitative part of the research.

Figure 1

Factors influencing high school leavers to study computer science teacher education for lower secondary schools



Unless otherwise stated, the results in this section are based on the qualitative part of the research, i.e., the interviews with 18 participants. The results of the quantitative part of the research (i.e., the questionnaire survey with 69 respondents) are always marked and are usually used to indicate the proportion of respondents expressing a certain opinion or experience.

The choice of teacher education

We first discuss the general choice of teacher education from the perspective of pre-service computer science teachers. The specificity of this group is shown by the results of the questionnaire survey: 46% of the respondents are considering a job outside education after graduation, 30% are not sure, and 23% are not considering such a job.

During the decision-making process, students take into account the supposed positives and negatives of the teaching profession, along with their intrinsic motives, such as their desire to work with children and youth.

Expected positive and negative aspects of the teaching profession

One of the key influences shaping decisions about a future profession is the perception of the profession. This perception contains the perceived strengths and weaknesses of the profession, as well as some factors that are perceived ambivalently.

Positives of being a teacher: As the qualitative research shows, the expected benefits of being a teacher include length of holidays, job security and job stability. A welcome positive is longer holidays compared to other professions. Participants especially appreciate the summer holidays: *"I really like knowing when I will have time off. I like to travel (...)"* (Participant H).

Job stability and job security are mentioned by several participants. They are convinced that it will be easy for them to get and keep a job after graduation: *"What is good is the security of a stable income. You don't have to worry about being redundant somewhere*" (Participant G).

Ambivalently perceived factors: The participants in the qualitative research differ on some aspects of being a teacher, including the public's view of the teaching profession, the time demands of the profession and the salary. While some participants feel these are welcome benefits, others mention them more as factors that discourage them from becoming a teacher.

In relation to the public's view of the teaching profession, one participant expresses that the teaching profession is highly prestigious and is viewed with respect: "*When you say teacher, it is 'The teacher', he is SOMEONE*" (Participant D). Many other participants perceive the teaching profession differently. An example of this is their fear of parents and pupils (see below) related to a perceived lack of respect for the profession.

Another ambivalent aspect is the time demands of the teaching profession. Some participants believe that teachers do not have much free time. According to them, they spend a lot of time at school or take their work home: *"Teachers have almost no personal life because they are either at the school or checking something*" (Participant O). Other participants perceive the time demands of the profession in terms of the number of hours they teach per week and the relatively short time teachers have to spend at the school. Some of them infer from this the possibility of having another job alongside teaching: *"The important thing is that I would like to do two jobs. To be a trainer, and to be a teacher (...)"* (Participant B).

The participants also have different views on the salary. Some of them place the salary in the context of holidays and the number of hours taught: *"You* *don't have to work 40 hours a week. The job isn't poorly paid, considering what you do"* (Participant E). Other participants have a positive view of the frequent increases in teachers' salaries: *"They keep increasing their salaries, which is great"* (Participant I). However, somewhat negative views on teachers' salaries prevail, with the salaries seeming low to most of the participants: *"I would say they could increase the salary, for how much stress they have with pupils"* (Participant O).

The questionnaire survey focused on the importance of the aforementioned motivators. In the questionnaire, the respondents could choose from the option *It motivates me a lot* (score 4) to *It does not motivate me at all* (score 0). The results show that the amount of free time is an important motivating factor. Moderate motivators are job security, job stability and flexibility, and the opportunity to work with children. The prestige of the profession and the salary are perceived ambivalently. For details see Table 1.

Table 1

Scores of selected motivators for becoming a teacher

Motivator	Free time	Flexibility	Job security	Job stability	Work with children	Prestige	Salary
Score	3.1	2.6	2.8	2.8	2.5	1.8	2.1

Negatives of being a teacher: Among the participants of the qualitative research, the most frequently mentioned negative factor is the pupils. The greatest concern relates to the behaviour of pupils: *"Children are getting more and more spoiled; they have no respect for the teachers"* (Participant I). Some participants expressed concern about whether they would be able to behave professionally when pupils misbehaved: *"I'm afraid that if I were a teacher, they would treat me like that (...), I don't know if I would be able to deal with it professionally"* (Participant I). Another participant mentions concerns about pupils' behaviour in the context of a lack of power to manage it: *"Teachers have terribly few rights to say or do anything so that they don't suffer any consequences"* (Participant M). Another negative factor is concerns related to parents. Participants are of the opinion that many parents do not cooperate with the teacher, and instead stand in opposition to him/her: *"If the child doesn't learn, it's the child's fault, not the teacher's. It's just that the parents go to the teacher, shout him down, and the teacher can't do anything"* (Participant D).

The above factors are related to concerns about the quality of school management. One participant states: *"(I'm a little worried) about having good management because I think that's one of the most important things. If you have* *bad management, it can make you quite uncomfortable*" (Participant E).

Some participants mention problems in the education system, particularly the excessive amount of paperwork that teachers have to deal with: "*Because of the thousands of papers, teachers don't want to go on excursions*" (Participant H).

The questionnaire survey examined concerns related to the teaching profession. This open-ended question was answered by 69 respondents. Each respondent could indicate multiple areas of concern. The most frequently mentioned issues involved parents and communication with them (15 responses), pupils (13 responses), class leadership (7 responses) and public speaking (6 responses), which is consistent with the qualitative research.

The desire to work with children and young people

The qualitative research indicates a desire among the participants to work with children and youth. Sometimes it is an ambition to develop knowledge and skills in the pupils: "*I'd rather be around people, around children, and give them some knowledge, so that they don't turn out to be dummies*" (Participant L). The motivation of some participants is not only to educate pupils but also to foster their development and encourage moral values in them: "*I can be some kind of role model for these kids, so that they don't become bad guys*" (Participant O).

The desire to become a teacher is often related to previous experience of tutoring and working with children. A number of the participants have such experience. The range of their activities varies considerably; while some have previously helped peers with homework, others have regularly tutored family members, helped classmates to understand more difficult content, or have experience of leading summer camps. Some participants explicitly state that they have enjoyed such activities: "*I tutored a girl who really worked hard, and I enjoyed it with her*" (Participant I).

In the questionnaire survey, 46% of the respondents state that the reason they chose teacher education is that they want to become teachers, while 59% state that they already have experience of working with children.

The choice of computer science as a specialisation

In the Czech education system, when enrolling in teacher education for lower secondary schools, applicants choose two teaching specialisations that they will study and then teach in the future. Given the applicants' preferences, it is common that one teaching specialisation is the "obvious choice", known as the primary specialisation, while the other specialisation is called the secondary specialisation. In our research, we were interested in whether computer science is perceived as a primary or secondary specialisation. The questionnaire survey found that one third of the respondents (35%) see computer science as their primary specialisation, one third (33%) as a secondary specialisation, and one third (32%) cannot decide.

Choosing computer science for strategic reasons

For many of the participants in the qualitative research, the choice of computer science as a secondary specialisation is influenced by strategic reasons. Some participants are motivated by the idea of getting a job more easily due to the shortage of computer science teachers: *"I know that schools in my area don't have enough of these teachers. Many computer science teachers are retired (...) There are some who don't even have a degree"* (Participant P). The same participant sees computer science as a complement to his primary specialisation: *"I was thinking of computer science (as a complement) to maths. What is most suited to it (...)"* (Participant P). In the questionnaire survey, 24% of the respondents who consider computer science as a secondary specialisation indicate that they chose computer science for strategic reasons.

Some participants select computer science because they believe it will be an easy degree, often choosing this specialisation as an easy way to become students of their favoured primary specialisation. Participant O chose computer science as a secondary specialisation because: *"It is one of the easiest ways, we come across computer science all the time, everyone is always using the computer and maybe playing some games"*.

The study of computer science at high school

The questionnaire survey shows that 23% of the respondents attended high schools specialising in computer science (CS high schools). These respondents are more likely than others to consider computer science as their primary specialisation (56% of leavers of CS high schools versus 28% of leavers of other schools). However, these respondents are more likely than others to consider not entering the teaching profession after graduation (63% of leavers of CS high schools versus 42% of leavers of other schools).

The qualitative part of the research shows that leavers of CS high schools have a good knowledge of computer science; for example, in the area of programming. On the other hand, leavers of the other schools report that their computer science lessons at high school dealt mostly with the basics of office software: *"At lower-secondary school, we basically did the same things as we did at high school. Word, PowerPoint, Excel, and that kind of classic stuff"*

(Participant Q). Thus, their knowledge of computer science varies considerably, which in turn affects their expectations of studying teacher education in computer science.

The relationship to computer science

A positive attitude towards computer science seems to be an important factor in the choice of specialisation. This is evident among participants of the qualitative research who chose computer science as their primary specialisation: "*We had optional classes of programming, so I was more attracted to it afterwards*" (Participant F). However, some participants may have a distorted view of what computer science involves: "*Mainly I was always around computers and games*" (Participant M).

Some participants first chose the specialisation they wanted to pursue, and only later decided to study teacher education. This can be seen among participants who previously studied at a technical university specialising in computer science. However, as they were not successful in their studies, they returned to the process of choosing a field of study. For these participants, there is a reconciliation with not having mastered the more difficult studies of the applied field and being satisfied with the easier alternative in the form of teacher education in the same field: "*My first university studies didn't work out well. I studied computer science at the Czech Technical University in Prague, but it was too difficult for me*" (Participant A).

Former teachers as inspiration

Good teachers do not necessarily directly motivate their students to become teachers; however, they can contribute to fostering interest in the subject they teach. Later, when choosing a university and a field of study, students may focus on the field related to that subject. In the case of computer science, it is usually a degree in applied computer science, but it can also be teacher education in computer science: "*I said to myself: yeah, if I taught computer science this way, I would know that the lessons would be fun for everyone and that it would encourage others to go on to do computer science*" (Participant F). On the other hand, some teachers may discourage students from the subject they teach: "*As for physics, I was frustrated with one teacher: she was strict and I didn't learn anything*" (Participant N).

Expectations of teacher education in computer science

When choosing a specialisation, potential pre-service teachers are influenced by their expectations of teacher education in computer science. Nearly one half of the qualitative research participants expect to gain a deeper insight into programming: *"I wanted to learn a lot of programming languages (…) I like learning Python, that's great, but I would also like to learn something more difficult"* (Participant G). Other participants expect to gain skills for teaching computer science. For these participants, teacher education is their first experience of university study, and all of them want to enter the teaching profession after graduation. One participant states: *"I enrolled with the idea of learning how to teach the kids"* (Participant D). The participants expect to learn either applied computer science (including programming) or the didactics of computer science; no one mentions both at the same time.

Several participants are influenced by their lower secondary school experiences. As they learned only easy and uninteresting content in lower secondary school, they assume that teacher education in computer science cannot include any challenging courses: *"There will only be some basics in computer science, because when I saw it in our school, they really didn't learn anything"* (Participant K). Other participants expect to take computer science courses such as graphics, web development or computer networking, while still others are not sure which courses they might take. Some participants were discouraged from choosing this specialisation due to the fear of having to have knowledge of other disciplines, typically mathematics: *"When I went to computer science, I was so scared of maths because it seems to belong to computer science"* (Participant I).

For several of the participants who consider this to be their secondary specialisation, the reason for choosing it was to replace their original secondary specialisation. They believe that computer science is a similar field to their previous specialisation. An example is a participant who chose mathematics as a secondary specialisation in his previous unsuccessful teacher education: *"So I took computer science because I had mathematics before that. In computer science, I thought that the maths might not be so difficult, and it might be about something else"* (Participant M). For these participants, computer science education may represent an 'escape' to an easier specialisation, as described in section 3.2.1.

Gender stereotypes

Although women outnumber men in most teacher education specialisations, men outnumber women in computer science. According to the female participants in the qualitative research, the reason may lie in the inclination of women towards non-technical fields (and, in the case of teacher education, towards non-technical specialisations): *"It is true that there are not many girls in the classroom. Most of them choose some humanistic subjects. But why shouldn't a girl go into computer science?"* (Participant I). According to another female participant, this is due to the fact that women are not as technically oriented as men.

Three female participants were included in our qualitative research: one of them had been interested in computer science since childhood and thus it can be argued that she chose teacher education in computer science because of her interest in this field. Another originally intended to apply to a private film school, but due to the tuition fees she decided to become a teacher. It is possible that she considers computer science to be a similar field of study to her original choice. The third participant was recommended computer science as the easiest secondary specialisation.

The female participants perceive computer science and some other specialisations (and consequently teaching subjects) as being more the domain of men, while other specialisations are more the domain of women. One female participant states: *"I think computer science is a field for girls as well, but girls are not as tech-savvy. They are not as good at some of those subjects, so they prefer to teach music or art and subjects like that"* (Participant K).

As shown in the questionnaire survey, compared to male respondents, female respondents are less likely to choose computer science as their primary specialisation (26% of women versus 39% of men), show a less positive attitude towards computer science (on a five-point scale the difference in the scores was 0.35 points), and are more likely to choose computer science for strategic reasons (25% of women versus 9% of men who do not consider computer science to be their primary specialisation). Women are less likely than men to consider a job outside education (22% of women versus 59% of men).

Discussion

In line with other studies that have focused on computer science teachers (Everson & Ko, 2022; Průcha et al., 2019; Yeni et al., 2020), we identified similar demotivating factors inherent in teaching and working with children. Compared to these studies, our respondents also emphasise concerns about interacting with parents, but less frequently emphasise the insufficiency of salaries.

The pre-service teachers' opinions, expectations or ideas of the teaching profession identified in the present research may be naive or hypercritical. Although it would be possible to disprove them, we do not consider it useful to do so. The participants, and high school students in general, are influenced by these opinions and should be listened to. At the same time, pre-service teachers need to be prepared for the reality of school during their studies. In this way, their fears about whether they can cope with the role of a teacher can be overcome. This may reverse their earlier decision not to enter the teaching profession. According to Yeni et al. (2020), 75% of pre-service computer science teachers consider not entering the teaching profession. Our research suggests that 46% of pre-service teachers consider this at the beginning of their studies.

In order to educate future computer science teachers so that they will work in education, preparation in applied computer science courses should focus on the development of the skills needed by teachers rather than on producing experts in applied computer science. An example of this is programming lessons: instead of creating complex software, attention must be paid to skills such as the ability to discuss the accuracy of a solution, the ability to explain the functionality of the created program to another person, etc. By learning in this way, pre-service teachers can naturally develop their teaching skills beyond pedagogical and didactic courses. This in line with Juškevičienė et al. (2024, p. 1), who suggests prioritising "practical, classroom-oriented professional development and fostering a culture of collaboration in educational institution".

There is also a need to reduce over-optimistic expectations of students and prepare them for the reality of school. In this way, it is possible to avoid the reality shock that often leads to dropping out of the teaching profession. Different studies report varying dropout rates, ranging from 1% to 50% (Hanušová et al., 2017). In the Czech Republic, the drop-out rate for computer science teachers is 7% (for comparison, it is 5% for mathematics teachers) (Píšová & Hanušová, 2016).

If we want to avoid teachers dropping out of the teaching profession, it is necessary to provide pre-service teachers with sufficient connections to schools. In particular, quality teaching practice during their studies seems to be important in order to reduce their anxiety about managing interaction with pupils. This teaching practice should run throughout teacher education and gradually increase in intensity (first observation, then teaching part of a lesson, later teaching a whole lesson, and finally regular teaching of several lessons during the school year). Novice teachers should also receive quality support, such as having a mentor and psychological support.

The results of the present study suggest that teacher education in computer science is subject to gender stereotypes, as the female participants perceive this specialisation as a male domain. This is consistent with findings that far fewer women than men study and then work in computer science (Zhang et al., 2021). If we want to change this trend, we need to make computer science more attractive to women. This can be achieved during education at school, especially at primary and lower secondary levels. It is necessary to choose appropriate teaching methods and select appropriate tasks that are attractive to women

(Hubwieser et al., 2016). This should also be followed in the education of pre-service teachers of computer science. Although female pre-service teachers of computer science show a less positive attitude towards computer science than men, they are less likely than men to consider a job outside education. There is therefore a need to provide assistance in their education.

Novice pre-service teachers differ in their expectations of teacher education in computer science: while some expect to learn specialised computer science topics, others expect a didactical focus. If we want to prevent dropouts due to considerable differences between expectations and real education, it is necessary to differentiate the lessons and offer a suitable range of optional courses. These should meet the needs of different groups of pre-service teachers and reflect the main objective of the study, i.e., to educate future computer science teachers. Approaches that support computer science skills while incorporating pedagogical aspects (e.g., the development of software to support learning and/or teaching) also seem to be appropriate.

Conclusion

The decision to become a computer science teacher is made at the end of high school and typically has two phases: deciding whether to study teacher education, and deciding whether to pursue computer science. In most cases, students first consider teacher education. This choice is influenced by the expected positive and negative aspects of the teaching profession as well as the desire to work with children and young people. Subsequently, they decide whether to choose computer science as a specialisation. Their relationship to computer science and their expectations of teacher education in computer science play an important role in this decision. Both are influenced by their knowledge of computer science, which is formed during their high school education. Other factors are their former teachers, strategic reasons and gender stereotypes.

Female pre-service teachers of computer science show a less positive attitude towards computer science than men. On the other hand, they plan to become teachers after graduation more often than men. Supporting them in their studies is therefore meaningful not only in terms of increasing the number of computer science teachers, but also in terms of breaking the stereotype that computer science is only for men.

The present research found that pre-service computer science teachers are motivated to become teachers by external factors (length of leave, job security and stability, and partly job flexibility and salary). Although these motivators may be important, it is also necessary to strengthen internal motivation for becoming a teacher, especially in psychology-oriented courses. Pre-service teachers are demotivated by concerns about pupils (especially their behaviour) and parents. As a result, many pre-service teachers decide not to enter the teaching profession after graduation. To avoid this, it is necessary to provide pre-service teachers with sufficient connections to schools and to offer them quality support.

One limitation of the present research is the small sample size. For this reason, we had to refrain from statistical testing of quantitative data, and such results are difficult to generalise. The research was conducted with Czech pre-service teachers; caution is needed when applying the results to other countries, as teachers in these countries may have a different social status and teacher education may also differ. The research participants were students who had already decided to study teacher education in computer science. It is not clear how students who considered these studies but who finally decided not to choose them would have responded.

The topic of students who are considering teacher education in computer science could be the focus of further research. This would help us to understand how to motivate them to study teacher education. There is also a need to investigate the factors that lead novice teachers of computer science to leave the profession. It is possible that, in addition to the general reasons, there is an imbalance in their workload. At least in the Czech Republic, schools are supposed to employ a network administrator and a methodology specialist in information technologies; however, these positions are often held by computer science teachers and it is questionable whether the scope really suits them.

The contribution of the research lies in the description of the decision-making process regarding whether to become a computer science teacher and the identification of the factors that influence this process. The findings will enable educational institutions (e.g., faculties of education) to adjust their marketing and educational strategies to produce more, and better, computer science teachers who will stay in education and be satisfied in their jobs.

Ethical statement

Data collection and data processing were performed in compliance with the relevant laws and institutional guidelines. Before the research began, the participants were informed of the purpose and the course of the research, and of the voluntary nature of their participation. The participants' informed consent was then obtained.

The privacy rights of the participants were observed. The interviews were recorded, but all of the data were anonymised before analysis to prevent the participants being identified. The same was done with the completed questionnaires.

The research study was approved by the Ethical Committee of the Faculty of Education, University of South Bohemia, Czech Republic.

Disclosure statement

The authors have no conflict of interest to declare.

References

Bergmark, U., Lundström, S., Manderstedt, L., & Palo, A. (2018). Why become a teacher? Student teachers' perceptions of the teaching profession and motives for career choice. *European Journal of Teacher Education*, *41*(3), 266–281. https://doi.org/10.1080/02619768.2018.1448784

Birks, M., & Mills, J. (2011). *Grounded theory: A practical guide*. Sage Publications.

Bruinsma, M., & Jansen, E. P. W. A. (2010). Is the motivation to become a teacher related to pre-service teachers' intentions to remain in the profession? *European Journal of Teacher Education*, *33*(2), 185–200. https://doi.org/10.1080/02619760903512927

Bukor, E. (2011). *Exploring teacher identity: Teachers' transformative experiences of re-constructing and re-connecting personal and professional selves* [Doctoral dissertation, Ontario Institute for Studies in Education, University of Toronto]. TSpace. https://utoronto.scholaris.ca/server/api/core/bitstreams/3df42f15-0e94-4fc5-a13e-b3bb0ad3bed4/content

Bukor, E. (2015). Exploring teacher identity from a holistic perspective: Reconstructing and reconnecting personal and professional selves. *Teachers and Teaching*, *21*(3), 305–327. https://doi.org/10.1080/13540602.2014.953818

Butler, A. S. (2021). The impact of external contextual factors on teaching candidates. *Center for Educational Policy Studies Journal*, 11(3), 55–74. https://doi.org/10.26529/cepsj.1072

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). Sage Publications.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Sage.

Czech School Inspectorate. (2024). *Kvalita vzdělávání v České republice ve školním roce 2023/2024: Výroční zpráva České školní inspekce* [Quality of education in the Czech Republic in the 2023/2024 school year: Annual report of the Czech School Inspectorate]. https://www.csicr.cz/cz/Dokumenty/Vyrocni-zpravy/Kvalita-vzdelavani-ve-skolnim-roce-2023-2024-%E2%80%93-vyr

Daud, A. (2021). Becoming an English teacher: An autobiographical narrative inquiry. *AL- ISHLAH: Jurnal Pendidikan*, *13*(1), 90–98. https://doi.org/10.35445/alishlah.v13i1.405

Everson, J., & Ko, A. J. (2022). "I would be afraid to be a bad CS teacher": Factors influencing participation in pre-service secondary CS teacher education. In J. Vahrenhold, K. Fisler, M. Hauswirth, & D. Franklin (Eds.), *Proceedings of the 2022 ACM Conference on International Computing Education Research – Volume 1* (pp. 237–246). ACM. https://doi.org/10.1145/3501385.3543966

Fokkens-Bruinsma, M., & Canrinus, E. T. (2012a). Adaptive and maladaptive motives for becoming a teacher. *Journal of Education for Teaching*, *38*(1), 3–19. https://doi.org/10.1080/02607476.2012.643652

Fokkens-Bruinsma, M., & Canrinus, E. T. (2012b). The Factors Influencing Teaching (FIT)- Choice scale in a Dutch teacher education program. *Asia-Pacific Journal of Teacher Education, 40*(3), 249–269. https://doi.org/10.1080/1359866X.2012.700043

Fokkens-Bruinsma, M., & Canrinus, E. T. (2014). Motivation for becoming a teacher and engagement with the profession: Evidence from different contexts. *International Journal of Educational Research*, *65*, 65–74. https://doi.org/10.1016/j.ijer.2013.09.012

Hanušová, S., Píšová, M., Kohoutek, T., Minaříková, E., Janík, M., Janík, T., Mareš, J., Uličná, K., & Ježek, S. (2017). *Chtějí zůstat nebo odejít?: Začínající učitelé v českých základních školách* [Do they want to stay or leave? Novice teachers at Czech primary and lower secondary schools]. Masaryk University. https://doi.org/10.5817/CZ.MUNI.M210-8922-2017

Hennessy, J., & Lynch, R. (2016). "I chose to become a teacher because." Exploring the factors influencing teaching choice amongst pre-service teachers in Ireland. *Asia-Pacific Journal of Teacher Education*, *45*(2), 106–125. https://doi.org/10.1080/1359866X.2016.1183188

Hubwieser, P., Hubwieser, E., & Graswald, D. (2016). How to attract the girls: Gender-specific performance and motivation in the Bebras Challenge. In A. Brodnik, & F. Tort (Eds.), *Informatics in schools: Improvement of informatics knowledge and perception. ISSEP 2016* (pp. 40–52). Springer. https://doi.org/10.1007/978-3-319-46747-4_4

Juškevičienė, A., Jevsikova, T., Stupurienė, G., & Vinikienė, L. (2024). STEM teachers' motivation and engagement in teacher professional development and career advancement: A case study of Lithuania. *Education Sciences*, *14*(7), 780. https://doi.org/10.3390/educsci14070780

Keck Frei, A., Berweger, S., & Bieri Buschor, C. (2017). Men considering (and choosing) teaching as a career: What accounts for their decision to become a teacher? *European Journal of Teacher Education*, *40*(4), 535–549. https://doi.org/10.1080/02619768.2017.1315397

Kılınç, A., Watt, H. M. G., & Richardson, P. W. (2012). Factors influencing teaching choice in Turkey. *Asia-Pacific Journal of Teacher Education*, *40*(3), 199–226. https://doi.org/10.1080/1359866X.2012.700048

Knell, P. F., & Castro, A. J. (2014). Why people choose to teach in urban schools: The case for a push-pull factor analysis. *The Educational Forum*, *78*(2), 150–163. https://doi.org/10.1080/00131725.2013.878775

Mills, J., Bonner, A., & Francis, K. (2006). The development of constructivist grounded theory. *International Journal of Qualitative Methods*, *5*(1), 25–35. https://doi.org/10.1177/160940690600500103

Ministry of Education, Youth and Sports of the Czech Republic. (2025). *Základní výstupy z mimořádného šetření: ke stavu zajištění výuky učiteli v MŠ, ZŠ, SŠ a VOŠ* [Key findings from the extraordinary survey: On the status of teaching provision by teachers in kindergartens, primary schools, secondary schools, and higher colleges]. https://edu.gov.cz/wp-content/uploads/2025/07/Mimoradne-setreni_ucitele_2025.pdf

Moses, I., Berry, A., Saab, N., & Admiraal, W. (2017). Who wants to become a teacher? Typology of student-teachers' commitment to teaching. *Journal of Education for Teaching*, *43*(4), 444–457. https://doi.org/10.1080/02607476.2017.1296562

Nur Fitria, T. (2023). Factors influencing education department students in choosing a teacher's career. *Epigram*, *20*(1), 43–56. https://jurnal.pnj.ac.id/index.php/epigram/article/view/5570

Pappa, S., & Moate, J. (2021). Teacher educators' professional identity in English-medium instruction at a Finnish university. *Center for Educational Policy Studies Journal*, *11*(3), 9–33. https://doi.org/10.26529/cepsj.1053

Píšová, M., & Hanušová, S. (2016). Začínající učitelé a drop-out [Novice teachers and drop-out]. *Pedagogika*, *66*(4), 386–407. https://doi.org/10.14712/23362189.2016.353

Plunkett, M., & Dyson, M. (2011). Becoming a teacher and staying one: Examining the complex ecologies associated with educating and retaining new teachers in rural Australia? *Australian Journal of Teacher Education*, *36*(1), 32–47. https://doi.org/10.14221/ajte.2011v36n1.3

Průcha, T. (2023). *Příprava učitelů informatiky v mezinárodním kontextu: Srovnávací studie* [Computer science teacher education in an international context: A comparative study] [Doctoral dissertation, University of West Bohemia in Pilsen]. Theses.cz.

Průcha, T., Filipi, Z., & Rohlíková, L. (2019). Problémy v přípravě učitelů informatiky: Případová studie [Problems in computer science teacher preparation: A case study]. In D. Horváthová, A. Michalíková, J. Škrinárová, & P. Voštinár (Eds.), *Proceedings of conference DidInfo 2019* (pp. 115–118). Matej Bel University in Banská Bystrica, Technical University of Liberec. https://www.fpv.umb.sk/app/cmsSiteBoxAttachment.php?ID=4558&cmsDataID=0

Richardson, P. W., & Watt, H. M. G. (2005). 'I've decided to become a teacher': Influences on career change. *Teaching and Teacher Education*, *21*(5), 475–489. https://doi.org/10.1016/j.tate.2005.03.007

Saqipi, B., & Vogrinc, J. (2021). The contexts and processes of shaping teacher identity. *Center for Educational Policy Studies Journal, 11*(3), 5–7. https://doi.org/10.26529/cepsj.1274

See, B. H., Munthe, E., Ross, S. A., Hitt, L., & El Soufi, N. (2022). Who becomes a teacher and why? *Review of Education*, *10*(3), Article e3377. https://doi.org/10.1002/rev3.3377

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* Sage Publications.

Šimandl, V., & Dobiáš, V. (2021). Analýza dat při tvorbě zakotvené teorie pomocí software atlas.ti [Using atlas.ti software for data analysis through the construction of grounded theory]. *Paidagogos*, *2021*(1), 131–156. https://paidagogos.net/issues/2021/1/article.php?id=8

Švaříček, R., & Šeďová, K. (2007). *Kvalitativní výzkum v pedagogických vědách* [Qualitative research in education sciences]. Portál.

Teng, F. (2017). Emotional development and construction of teacher identity: Narrative interactions about the pre-service teachers' practicum experiences. *Australian Journal of Teacher Education*, *42*(11), 117–134. https://doi.org/10.14221/ajte.2017v42n11.8

Tomšik, R. (2019). Choosing teaching as a profession: Validation of an SMVUP-4-S assessment tool. *Problems of Education in the 21st Century, 77*(4), 545–559. https://doi.org/10.33225/pec/19.77.545

Torres-Cladera, G., Simó-Gil, N., Domingo-Peñafiel, L., & Amat-Castells, V. (2021). Building professional identity during pre-service teacher education. *Center for Educational Policy Studies Journal*, *11*(3), 35–54. https://doi.org/10.26529/cepsj.1070

Wang, W., & Wang, Z. (2022). Why choose a career in teaching? Exploring motivational factors that influence the decision to teach. *British Journal of Guidance & Counselling*, *51*(1), 46–57. https://doi.org/10.1080/03069885.2022.2040003

Watt, H. M. G., & Richardson, P. W. (2008). Motivations, perceptions, and aspirations concerning teaching as a career for different types of beginning teachers. *Learning and Instruction, 18*(5), 408–428. https://doi.org/10.1016/j.learninstruc.2008.06.002

Watt, H. M. G., Richardson, P. W., Klusmann, U., Kunter, M., Beyer, B., Trautwein, U., & Baumert, J. (2012). Motivations for choosing teaching as a career: An international comparison using the FIT-Choice scale. *Teaching and Teacher Education, 28*(6), 791–805. https://doi.org/10.1016/j.tate.2012.03.003

Yadav, A., Connolly, C., Berges, M., Chytas, C., Franklin, C., Hijón-Neira, R., Leftwich, A., Marguliex, L., Macann, V., & Warner, J. R. (2022). Models for computer science teacher preparation: Developing teacher knowledge. In B. A. Becker, K. Quille, M.-J. Laakso, E. Barendsen, & S. (Eds.), *Proceedings of the 27th ACM Conference on on Innovation and Technology in Computer Science Education Vol. 2* (pp. 568–569). ACM. https://doi.org/10.1145/3502717.3532166

Yeni, S., Aivaloglou, E., & Hermans, F. (2020). To be or not to be a teacher? Exploring CS students' perceptions of a teaching career. In N. Falkner, & O. Seppala (Eds.), *Koli Calling '20: Proceedings of the 20th Koli Calling International Conference on Computing Education Research* (pp. 1–11). https://doi.org/10.1145/3428029.3428036

Yong, B. C. S. (1995). Teacher trainees' motives for entering into a teaching career in Brunei Darussalam. *Teaching and Teacher Education*, *11*(3), 275–280. https://doi.org/10.1016/0742-051X(94)00023-Y

Zhang, Y., Gros, T., & Mao, E. (2021). Gender disparity in students' choices of information technology majors. *Business Systems Research Journal, 12*(1), 80–95. https://doi.org/10.2478/bsrj-2021-0006

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Developing Digital Literacy in Pre-Service Primary School Teachers Through a Massive Open Online Course and Project-Based Learning

Alenka Žerovnik[1]

The present paper examines the implementation of a massive open online course and project-based learning to develop the digital competences of pre-service teachers. The course design was based on the Digital Competence Framework for Citizens. The study evaluates the effectiveness of the implemented massive open online course and project-based learning in developing digital competences and assesses student satisfaction with these methods. A total of 166 students participated in the study during two academic years. The massive open online course and project assignments are compulsory components of the ICT in Education course. Students completed the massive open online course in an online classroom and demonstrated basic knowledge and understanding by achieving a passing grade. Through project-based learning, they developed digital competences at higher cognitive levels. At the end of the academic year, anonymised student feedback was collected on satisfaction with the lessons delivered, the support received from the mentors, the feedback received, and assessment through the massive open online course and project-based learning. The results indicate significant progress in digital skills, especially in digital educational content creation. The study also revealed high levels of student satisfaction with the lessons delivery, mentor support and feedback. The students rated the assessment through project-based learning positively, indicating the effectiveness of this method. Recommendations are made for improving training and promoting digital competences of students. The study contributes to understanding the importance of integrating digital literacy into educational programmes and provides guidelines for developing effective approaches to promote digital literacy, which is essential for preparing students for future professional challenges and active citizenship in a technologically advanced world.

Keywords: digital literacy development, massive open online course implementation, project-based learning, pre-service teachers, student results and satisfaction

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Razvijanje digitalne pismenosti bodočih učiteljev razrednega pouka z masovnim odprtim spletnim tečajem in s projektno zasnovanim učenjem

Alenka Žerovnik

Prispevek obravnava implementacijo masovnega odprtega spletnega tečaja in projektno zasnovanega učenja kot pristopov za razvijanje digitalnih kompetenc bodočih učiteljev. Zasnova tečaja je temeljila na Evropskem okviru digitalnih kompetenc za državljane (DigComp). Raziskava vrednoti učinkovitost izvedenega masovnega odprtega spletnega tečaja in projektno zasnovanega učenja pri razvijanju digitalnih kompetenc ter analizira zadovoljstvo študentov z obema izobraževalnima oblikama. V raziskavi je v dveh študijskih letih sodelovalo 166 študentov. Opravljen masovni odprti spletni tečaj in projektne naloge so obvezni elementi predmeta IKT v izobraževanju. Študentje so tečaj opravili v spletni učilnici ter s pridobitvijo pozitivne ocene izkazali osnovno raven znanja in razumevanja. S projektno zasnovanim učenjem so razvijali digitalne kompetence na višjih kognitivnih ravneh. Ob koncu študijskega leta so bili zbrani anonimizirani odzivi o zadovoljstvu študentov z izvedbo učnih enot, s podporo mentorjev, prejetimi povratnimi informacijami ter z ocenjevanjem v okviru masovnega odprtega spletnega tečaja in projektnega dela. Izsledki kažejo na pomemben napredek v digitalnih spretnostih, zlasti na področju ustvarjanja digitalnih izobraževalnih vsebin. Raziskava prav tako poudarja visoko zadovoljstvo študentov z izvedbo pouka, mentorsko podporo in s povratnimi informacijami. Študentje so pozitivno ocenili tudi ocenjevanje v okviru projektno zasnovanega učenja, kar potrjuje učinkovitost tega pristopa. V zaključku so podana priporočila za izboljšanje izobraževalne prakse in spodbujanje razvoja digitalnih kompetenc študentov. Raziskava prispeva k razumevanju pomena vključevanja digitalne pismenosti v izobraževalne programe in ponuja usmeritve za oblikovanje učinkovitih pristopov za krepitev digitalne pismenosti, ki je ključna za pripravo študentov na prihodnje profesionalne izzive in aktivno državljanstvo v tehnološko napredni družbi.

Ključne besede: razvoj digitalne pismenosti, implementacija masovnega odprtega spletnega tečaja, projektno zasnovano učenje, bodoči učitelji, rezultati in zadovoljstvo študentov

Introduction

Digital literacy has become an increasingly important competence for educators in the twenty-first century, transforming from an optional skill to a professional necessity (Falloon, 2020; Redecker, 2017). As primary education increasingly integrates digital technologies into pedagogical practices, teachers must develop not only technical proficiency but also the ability to leverage these tools for effective teaching and learning (Admiraal et al., 2016). This educational landscape demands that teacher preparation programmes adapt to equip future educators with comprehensive digital competences that encompass both technical skills and pedagogical application (Chilla et al., 2025; Instefjord & Munthe, 2017; Tondeur et al., 2019). By fostering these competencies, teacher preparation programmes can ensure that educators are not only proficient in using technology but also adept at integrating it meaningfully into their curricula to support all learners effectively.

Digital competence extends beyond technical skills to include critical dimensions such as information evaluation, ethical communication, creative content development and privacy awareness (Vuorikari et al., 2022). The rapid digital transformation of education, accelerated by the COVID-19 pandemic, has emphasised the importance of digital literacy among educators (Sánchez-Cruzado et al., 2021). This global shift has revealed significant disparities in teachers' preparedness to navigate digital environments and implement technology-enhanced learning, with many pre-service and in-service teachers reporting feelings of inadequacy and uncertainty (Falloon, 2020; Gudmundsdottir & Hatlevik, 2017).

Many teacher preparation programmes, however, still emphasise basic technical skills without sufficiently linking them to pedagogy. This approach often fails to prepare pre-service teachers to apply technology meaningfully in real classroom scenarios (Falloon, 2020; McGarr & McDonagh, 2020). Empirical evidence indicates that while pre-service teachers comfortably learn to use new tools, they frequently lack the pedagogical knowledge required to apply these tools effectively in classroom contexts (Røkenes & Krumsvik, 2016; Tondeur et al., 2019). As a result, new teachers may feel adept with tools yet uncertain how to leverage them for deeper learning outcomes.

The European Digital Competence Framework for Citizens (DigComp) provides a structured approach to conceptualising and developing digital literacy across five key areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Vuorikari et al., 2022). This framework guides digital literacy initiatives across educational contexts, offering a comprehensive taxonomy of skills required for effective technology integration. Aligning teacher education with such frameworks is increasingly seen as vital for developing not just technical skills but also a well-rounded digital pedagogy (Redecker, 2017; Vuorikari et al., 2022). Since its initial development, DigComp has evolved to address emerging technological and social challenges, with the latest iteration (DigComp 2.2) expanding to include competences related to artificial intelligence, emerging data technologies and misinformation (Vuorikari et al., 2022). This evolution reflects the dynamic nature of digital literacy, which continues to transform as technological landscapes shift. For teacher education, these developments necessitate adaptive approaches that can respond to emerging digital challenges while maintaining a focus on pedagogical application (McGarr & McDonagh, 2021). For pre-service teachers specifically, the complementary DigCompEdu framework addresses educators' professional needs (Redecker, 2017). Developing competence across these domains proves crucial for both personal proficiency and the ability to foster digital literacy among their future students (Foulger et al., 2017; Røkenes & Krumsvik, 2016).

In response, innovative instructional strategies are being explored to more holistically build teachers' digital competence. Two approaches have gained particular attention: massive open online courses (MOOCs) and project-based learning (PBL). MOOCs offer structured, self-paced learning at scale and have been used in teacher education to deliver foundational content aligned with competency frameworks. They excel at imparting declarative knowledge and basic concepts to large cohorts. However, conventional MOOCs largely rely on video lectures and quizzes, which limits opportunities for active learning and contextual skill application. Studies have pointed out that while MOOCs efficiently transmit knowledge, their low interactivity and one-size-fits-all design make it difficult for learners to develop higher-order thinking or situational judgment (Margaryan et al., 2015).

In contrast, PBL is a constructivist, learner-centred method that engages students in complex, authentic tasks over extended periods (Guerra et al., 2017; Maros et al., 2021; Ribeiro et al., 2023). By working on real-world projects, learners practise collaboration, creative problem-solving and critical thinking, all of which are essential for mastering higher-order digital competences. Empirical evidence shows that PBL not only reinforces content mastery but also enhances motivation and the ability to transfer knowledge to new contexts (Al-Busaidi & Al-Seyabi, 2021; Granado-Alcón et al., 2020; Guo et al., 2020). Technological tools that support collaborative project work, such as digital platforms designed for teamwork, have been shown to further increase student participation and motivation, as well as the overall quality of the learning process (Salas-Rueda et al., 2022). In teacher education, this means pre-service teachers get hands-on experience designing and implementing tech-supported learning activities, thereby strengthening their technological-pedagogical integration skills (Kokotsaki et al., 2016; Zhang & Ma, 2023). The drawback is that PBL can be resource-intensive and difficult to scale in large programmes, often requiring extensive mentoring and iterative feedback. Thus, each approach addresses different needs: MOOCs provide breadth and scalability for foundational knowledge, whereas PBL offers depth and authenticity for applied skills.

The research gap and the research problem

Combining these complementary approaches presents a novel strategy to develop digital competence across multiple cognitive levels. A hybrid instructional design that integrates MOOC-based content delivery with PBL application could allow pre-service teachers to first acquire core knowledge and then immediately apply it in authentic settings. This promises a more complete learning experience, scaffolding from lower-order learning (understanding concepts) to higher-order performance (creating and implementing digital solutions). Despite this intuitive appeal, such hybrids remain underexplored in teacher education research. Few studies have systematically examined integrating an MOOC with PBL in a pre-service teacher programme, and empirical evidence on its effectiveness is limited (Admiraal et al., 2019; Chanpet et al., 2020; Tondeur et al., 2019). Moreover, there is a lack of insight into how teacher candidates experience these blended environments. Questions remain about how mentorship and feedback function in a scaled course, and how students perceive the value of PBL as a learning method. Addressing this gap is important, as understanding student perspectives can inform better design and support mechanisms for future implementations.

The present study investigates a hybrid xMOOC–PBL model in a compulsory ICT in Education course for pre-service primary school teachers at the University of Ljubljana. We focus primarily on how knowledge and skills acquired through the xMOOC transfer to project-based tasks and contribute to students' digital competence development. Detailed information on the participants, the course structure and the tasks is provided in the Method section.

Research questions

The aim of the study is to answer the following research questions:

RQ1: How does success in xMOOCs and performance in project-based assignments relate to the development of comprehensive digital literacy?

RQ2: To what extent are students satisfied with the lab work and seminars in the ICT in Education course, and how do they perceive the relevance and usefulness of the acquired knowledge for their future professional roles?

RQ3: How do students evaluate the quality and effectiveness of the teacher's mentoring support during PBL, and what factors influence their satisfaction with the mentoring process?

RQ4: How do students assess the feedback they received on their assignments in terms of content quality, thoroughness, clarity and alignment with assignment requirements?

RQ5: How do students perceive PBL as a method of assessment in the ICT in Education course?

These research questions aim to provide a holistic understanding of how structured digital learning and applied project work interact in fostering meaningful digital literacy. The study not only evaluates measurable outcomes but also foregrounds student experiences as essential for improving instructional design in teacher education.

Method

This study was conducted in the compulsory ICT in Education course at the Faculty of Education, University of Ljubljana. The course combines an xMOOC for foundational digital competence acquisition and project-based learning (PBL) for higher-order skills. The course design aligns with the DigComp framework. In line with Rodriguez (2013), the online course was implemented as an xMOOC – a closed, self-paced course for enrolled students – rather than an open-enrolment MOOC.

Participants

The study involved 166 students (151 female, 15 male) enrolled in the ICT in Education course at the University of Ljubljana across two academic years (2022/23: 76; 2023/24: 90). All of the participants completed the mandatory xMOOC and project-based assignments. At the end of each semester, 75 students (33 from 2022/23 and 42 from 2023/24) voluntarily completed an anonymous online survey.

Instruments

The survey combined Likert-scale and open-ended items. Satisfaction with lab work, seminars and mentor support was rated on a 5-point scale. Perceived knowledge usefulness used a 6-point scale. Mentor feedback was assessed on a 3-point scale across four aspects: content quality, clarity, thoroughness, and alignment with assignment goals. The students rated the PBL method on a 4-point scale. The choice of different scales was deliberate: 5-point scales for seminar/lab satisfaction allow a neutral midpoint; a 6-point scale for perceived usefulness removes neutrality to elicit a clearer stance; a concise 3-point scale for mentor feedback emphasises clear distinctions (insufficient–adequate–excellent); and a 4-point scale for evaluating PBL similarly avoids neutrality and promotes decision-making.

The internal reliability of the survey subscales was assessed using Cronbach's alpha. The four mentor feedback items demonstrated acceptable internal consistency (α = .745). In contrast, the subscale comprising lab work satisfaction, seminar satisfaction, knowledge gained and usefulness of knowledge showed lower internal consistency (α = .589), likely due to conceptual variation across cognitive and affective items. All of the items were nonetheless retained due to their theoretical and contextual relevance.

In addition to the survey, two performance-based measures were collected: scores from the xMOOC and project assignments. The xMOOC was structured around four DigComp competence areas. Each area included self-paced tasks with embedded automatic feedback, similar to other higher education online courses that integrate interactive elements such as quizzes and collaborative assignments to promote engagement and skill development (Dagarin Fojkar & Berčnik, 2023). Students earned a badge for each area and a final badge upon full completion. xMOOC performance was expressed as a percentage based on total points earned. The project component consisted of four individual assignments, each evaluated using a rubric covering pedagogical and technical criteria. The total project score was also recorded as a percentage. These two performance indicators provided objective measures of the students' digital competence at both foundational and higher-order levels. The xMOOC was delivered via the Arnes Moodle LMS. Open Badges were issued upon successful completion of each module and a final badge for course completion; the badges reflected pass/fail based on meeting a 50% points threshold (no graded badge levels).

Research design

The study used a mixed-methods approach, combining quantitative and qualitative data. Quantitative sources included xMOOC scores, PBL scores and student survey responses. Descriptive statistics (means, medians, modes, standard deviations) were computed for all variables. Due to non-normal data distribution (Shapiro-Wilk $p < .001$), non-parametric tests were applied.

In order to analyse the relationship between foundational and higher-order digital competences, a simple linear regression was conducted using xMOOC scores to predict project performance. Due to the anonymous nature of the survey, regression analyses were limited to non-survey variables. In addition, a Wilcoxon signed-rank test and Spearman's correlation were used to assess score differences and associations between the two assessment formats. Survey-based variables were analysed independently using descriptive and thematic methods.

Course performance was assessed using xMOOC completion scores and individual project assignments. The xMOOC consisted of auto-graded tasks covering four DigComp areas. Student performance was expressed as a percentage score based on the total number of points achieved. A minimum threshold of 50% was required to pass. The same criterion applied to the project-based learning, which was completed individually and consisted of four assignments.

xMOOC scores were automatically generated based on task completion and accuracy. Project scores were assigned by instructors using a rubric that evaluated both pedagogical and technical criteria. The xMOOC was designed to support knowledge acquisition at the first three cognitive levels of Bloom's taxonomy (remember, understand, apply), while project assignments required students to demonstrate the same digital competencies at higher levels (analyse, evaluate, create). Survey responses captured the students' satisfaction with course components, perceived knowledge gained and its usefulness, support received from the mentor, and quality of feedback. The questionnaire included four 6-point Likert-scale items measuring satisfaction and perceived usefulness, four 3-point items assessing mentor feedback quality, and one 4-point item evaluating the perceived value of project-based learning as a learning method.

The first project assignment involved creating a post in a collaborative e-portfolio environment, targeting competencies in information literacy, digital communication and collaboration, copyright and data protection. The second assignment focused on creating digital images for educational purposes. In the third task, the students designed an infographic on an educational topic. The final assignment required the creation of an educational video, with attention to principles of video pedagogy. Each project was evaluated by the instructors according to predefined rubric criteria, and the total project score was expressed as a percentage.

Qualitative data from the open-ended survey responses were analysed using reflexive thematic analysis (Braun & Clarke, 2020). Coding was performed separately for lab work, seminar sessions, mentoring support and PBL. Frequency counts were used to support theme prominence and identify dominant patterns.

The study adhered to ethical guidelines for research involving human participants. Informed consent was obtained from all of the participants to ensure that they were aware of the study's purpose and their right to withdraw at any time. Data were collected in an anonymised form to protect the participants' privacy.

Results

Analysis and comparison of xMOOC and project assignment scores in the ICT in Education course

Figure 1 presents individual student scores on xMOOC assessments and project assignments. The students are sorted by increasing project scores. The purple line represents xMOOC scores, the green line represents project scores, and the black dotted line shows the logarithmic trend of xMOOC scores.

Figure 1
xMOOC and project assignment scores with a black-dotted line indicating the xMOOC score trend

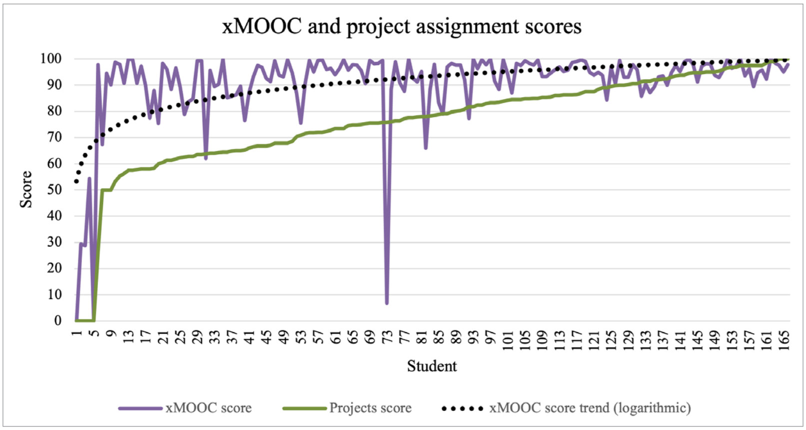

Figure 1 shows a positive association between xMOOC and project scores. Students with lower xMOOC scores tend to also have lower project scores. This is particularly visible at the lower end of the distribution. The logarithmic trend line of xMOOC scores confirms this relationship, indicating that lower-performing students in the xMOOC also performed worse in the projects.

In order to better explore this relationship, a Wilcoxon signed-rank test was conducted due to non-normal data distribution (Shapiro-Wilk $p < .001$ for both variables). The results revealed a statistically significant difference between the two sets of scores ($Z = -9.796$, $p < .001$), with project scores being lower than xMOOC scores in most cases (138 out of 164). This aligns with the nature of the assessments: the xMOOC focused on foundational knowledge and understanding, while the project assignments required higher-order skills such as application, analysis and creation, reflecting the upper levels of Bloom's revised taxonomy. It was therefore expected that the students would find the projects more cognitively demanding.

The positive association seen in Figure 1 suggests that students with weaker performance in foundational tasks also struggled with more complex assignments. Although this may appear intuitive, establishing this empirically is essential for instructional design, as it highlights the importance of scaffolding between lower- and higher-order digital competencies.

Spearman's rank-order correlation was used to quantify the strength of this association, revealing a weak but statistically significant positive correlation between xMOOC and project scores ($\rho = .231$, $p = .003$, $N = 164$). While students who scored higher in the xMOOC generally achieved higher project scores, the modest correlation indicates that the two assessment formats measured distinct dimensions of digital competence. The xMOOC primarily evaluated lower-order skills (remember, understand, apply), whereas the projects required the synthesis and creative application of knowledge in realistic educational contexts.

In order to further assess the predictive value of foundational knowledge, a simple linear regression was conducted with xMOOC score as the predictor and project score as the outcome variable. The regression model was statistically significant, $F(1, 162) = 51.993$, $p < .001$, explaining 24.3% of the variance in project performance ($R^2 = .243$). xMOOC performance significantly predicted project outcomes ($B = .692$, $\beta = .493$, $p < .001$), indicating that for every one-point increase in xMOOC score, the project score increased by approximately 0.69 points on average. These findings confirm that foundational digital competence acquired through structured online learning contributes meaningfully to performance in more complex, open-ended project tasks.

Analysis of student satisfaction with course implementation and perceived usefulness of the knowledge gained in the ICT in Education course

Table 1 presents the descriptive statistics for student responses regarding satisfaction with lab work, satisfaction with seminars, knowledge gained, and perceived usefulness of the knowledge.

Table 1

Descriptive statistics of student responses regarding satisfaction with course implementation and perceived usefulness of the knowledge gained (N = 75)

	Satisfaction with lab work	Satisfaction with seminars	Knowledge gained	Usefulness of the knowledge
M	4.57	4.48	5.27	5.36
Me	5.00	5.00	5.00	5.00
Mo	5	5	5	5
SD	.597	.665	.644	.671
Min	3	3	4	3
Max	5	5	6	6

Note. *M* = mean; *Me* = median; *Mo* = mode; *SD* = standard deviation; *Min* = minimum; *Max* = maximum.

The students reported a high level of satisfaction and perceived value across course components, with mean scores ranging from 4.48 to 5.36 on a 6-point scale. The highest mean score (M = 5.36) reflected the perceived usefulness of the knowledge gained, indicating that the students found the content highly relevant to both their studies and their future roles as teachers. Median and mode values were consistently 5, and low standard deviations indicated limited variability in responses (Table 1).

Lab work received a mean rating of 4.57 (SD = .597), with 62% of the students "Very satisfied" and 32% "Satisfied". Seminar sessions followed closely (M = 4.48, SD = .665), with 57% "Very satisfied" and 33% "Satisfied". For perceived knowledge gain, 89.3% of the students gave a score of 5 or 6 (M = 5.27), while 91.4% rated the usefulness of the knowledge as 5 or 6 (M = 5.36), confirming a strong alignment between course content and professional relevance.

In order to better understand these ratings, thematic analysis was conducted on 129 open-ended responses. A total of 68 responses related to lab work and 61 to seminars. For lab work, five dominant themes emerged: *Overall satisfaction* (*n* = 22), *Teaching quality* (*n* = 19), *Assignments and tasks* (*n* = 16), *Instructor support* (*n* = 7) and *Course materials and feedback* (*n* = 4). The students appreciated the structured design, clarity of instruction, logical task progression and responsive support. A few students raised concerns about workload volume and suggested improvements such as better pacing and resolving technical issues.

In the seminars, six main themes appeared: *Instructor quality* (*n* = 22), *Overall satisfaction* (*n* = 22), *Content relevance* (*n* = 21), *Engagement* (*n* = 16), *Connection to practice* (*n* = 16) and *Course materials* (*n* = 15). The students consistently praised the clarity, enthusiasm and practical orientation of the instruction. Interactive elements and real-world applicability were frequently mentioned as strengths. Moderate satisfaction ratings were typically linked to content redundancy, session length or irregular attendance.

These findings suggest that the combination of seminars and lab work created a coherent and supportive learning environment. The students valued the progression from theory to practice, clear explanations, individualised support, and strong alignment with professional contexts, all of which contributed to meaningful learning experiences.

Analysis of student satisfaction with the support received from the mentor

Table 2 presents the descriptive statistics for student responses regarding satisfaction with the support from the mentor. Six students indicated that they did not seek mentoring support.

Table 2
Descriptive statistics of student responses regarding satisfaction with mentoring support (N = 69)

	Satisfaction with the support from the mentor
M	4.84
Me	5.00
Mo	5
SD	.369
Min	4
Max	5

Note. *M* = mean; *Me* = median; *Mo* = mode; *SD* = standard deviation; *Min* = minimum; *Max* = maximum.

The students expressed high satisfaction with mentor support during PBL, with a mean score of 4.84 on a 5-point scale. Both median and mode were 5, and ratings ranged only from 4 to 5 (SD = .369), indicating consistent and overwhelmingly positive evaluations (Table 2). Most of the respondents rated the mentoring as “Excellent” (76%) or “Very good” (14%), while 8% reported not seeking support.

Thematic analysis of 62 open-ended responses identified eight key themes. *Usefulness* (n = 18) and *Support level* (n = 14) highlighted the mentor’s practical impact on task execution and project quality. The students described the support as comprehensive, responsive and tailored to individual needs. *Clarity of communication* (n = 11) and *Availability* (n = 8) were praised, with students noting the mentor’s detailed explanations, precise guidance and timely responses via multiple channels.

Additional themes included *Timely feedback* and *Improvement suggestions*, with students valuing constructive advice that helped refine their work. *Mentor attitude* was also noted, with students describing the mentor as patient, encouraging and supportive throughout the project process. Among those who did not seek help, one student acknowledged preferring independence but still recognised the potential benefit of mentoring.

The students viewed mentoring as a critical element of the PBL experience. The mentor’s clarity, accessibility and personalised guidance played a key role in supporting the students through complex tasks and contributed significantly to their learning outcomes.

Analysis of student satisfaction with the feedback received from the mentor

Table 3 presents the descriptive statistics for student responses regarding satisfaction with the feedback received from the mentor.

Table 3

Descriptive statistics of student responses regarding satisfaction with the feedback received from the mentor (N = 75)

	Satisfaction with feedback in terms of content quality	Satisfaction with the thoroughness of the feedback in relation to the assignment	Satisfaction with the consistency of the feedback with assignment requirements	Satisfaction with the clarity of the feedback
M	2.88	2.88	2.88	2.84
Me	3.00	3.00	3.00	3.00
Mo	3	3	3	3
SD	.327	.327	.327	.369
Min	2	2	2	2
Max	3	3	3	3

Note. *M* = mean; *Me* = median; *Mo* = mode; *SD* = standard deviation; *Min* = minimum; *Max* = maximum.

The students rated four aspects of feedback: content quality, thoroughness, consistency with assignment requirements, and clarity. Mean scores were nearly identical across all aspects, ranging from 2.84 to 2.88 on a 3-point scale, indicating a moderate level of satisfaction. Median and mode values were consistently 3, suggesting that most of the students selected the highest possible score. The standard deviation was low across all items (*SD* = .327 to .369), indicating little variability in responses. Minimum and maximum values remained constant (2 and 3), showing a narrow distribution (Table 3). These results suggest a generally positive, though not maximal, perception of feedback quality and clarity.

Analysis of student responses regarding assessment through PBL

Table 4 presents the descriptive statistics for student ratings of PBL as a method of teaching.

Table 4

Descriptive statistics for student ratings of PBL as a method used (N = 75)

	Student ratings of project-based learning as a method used in the ICT in Education course
M	3.61
Me	4.00
Mo	4
SD	.543
Min	2
Max	4

Note. *M* = mean; *Me* = median; *Mo* = mode; *SD* = standard deviation; *Min* = minimum; *Max* = maximum.

The students rated PBL on a 4-point scale (1 = meaningless, 4 = the only meaningful approach), with a mean of 3.61 and both the median and mode at 4 (Table 4). Most of the students considered PBL highly meaningful: 63% selected the highest rating, 33% rated it as good, and only 3% viewed it as less meaningful. None of the students rated it as meaningless, indicating strong support for PBL as an effective and relevant teaching method.

Thematic analysis of 62 open-ended responses identified eight themes. *Overall value* (n = 25) reflected strong appreciation of PBL's relevance and depth. The students emphasised its alignment with course goals and its role in promoting deep, meaningful learning. *Practical application* (n = 13) and *Knowledge retention* (n = 11) highlighted how applying theory in real-world tasks helped solidify understanding and improve memory. *Creativity and innovation* (n = 7) revealed that the students valued the opportunity to design original solutions and take ownership of their learning process.

Workload (n = 14) emerged as both a motivator and a challenge. While many of the students appreciated the engagement that came with complex tasks, some expressed concerns about time demands and performance pressure. Other themes included *Engagement and motivation*, *Collaboration* and *Assessment approach*, which were mentioned less frequently but reinforced the overall positive perception of PBL.

A co-occurrence analysis showed that the students who rated PBL most highly (4/4) were more likely to mention *Practical application* (27.5%) and *Knowledge retention* (22.5%), while those who rated it lower (≤3) more often cited *Engagement* issues and *Workload* burdens (both 28.6%).

The findings from this section suggest that the students perceived PBL as a highly effective and meaningful learning strategy that fosters applied skills, creativity and long-term learning. In order to maximise its benefits, however, educators should provide clear scaffolding and manage cognitive load through thoughtful task design.

Discussion

The findings of this study demonstrate the effectiveness of a hybrid instructional model that combines an xMOOC and project-based learning (PBL) to develop digital competence in pre-service primary school teachers. By integrating structured foundational learning with authentic, higher-order application, the course addressed both cognitive and pedagogical dimensions of digital literacy, aligning with the DigComp framework (Redecker, 2017; Vuorikari et al., 2022).

The positive, though modest, correlation between xMOOC and PBL scores (ρ = .231, p = .003) suggests that foundational digital knowledge contributes to (but does not fully determine) students' ability to perform complex, authentic tasks. The regression model further supports this by showing that xMOOC performance accounted for 24.3% of the variance in project outcomes. These findings support Sánchez-Cruzado et al. (2021), who argue that digital competence requires a combination of declarative knowledge and authentic practice. They also reinforce Tondeur et al.'s (2019) call for scaffolded learning approaches that bridge theoretical understanding with practical application. The gap between xMOOC and PBL scores aligns with Bloom's taxonomy, as PBL tasks required more cognitively demanding skills such as creation, evaluation and synthesis, skills that are not fully developed through passive content delivery.

The student feedback highlighted high levels of satisfaction with both the xMOOC and PBL components, particularly with the perceived usefulness of knowledge for future teaching roles. These results are in line with the findings of Svoboda and Mynaříková (2021) and Instefjord and Munthe (2017), who highlight the importance of aligning digital training with professional practice. The students appreciated the course structure, instructional clarity and real-world relevance of the assignments, which are key attributes identified by Røkenes and Krumsvik (2016) as essential for impactful digital competence development. At the same time, concerns about workload emerged, particularly in relation to the demands of PBL work. These concerns align with the findings of Janssen et al. (2019), who note that applied digital tasks often increase cognitive load and require careful instructional support to remain sustainable and effective.

Mentor support was a crucial factor in the course's success. The students consistently valued the mentor's availability, clear communication and targeted support, qualities also identified by Eller et al. (2014). These results also support Admiraal et al. (2019), who argue that mentoring in technology integration should combine pedagogical guidance with technical expertise. In the present study, the students appreciated multi-channel communication and described the feedback they received as clear, constructive and well aligned with assignment goals. Such alignment reflects the principles of constructive alignment in assessment design (Biggs, 2014) and supports Deng et al.'s (2019) view that timely, relevant feedback is essential in digital learning contexts, where students often feel uncertain about their progress.

The positive student response to PBL as a learning and assessment method strengthens the argument for its inclusion in digital literacy education. Most of the students surveyed viewed PBL as the most meaningful approach for demonstrating competence, citing its practical application, support for knowledge retention and opportunities for creativity. These outcomes reflect the established benefits of PBL in teacher education (Guo et al., 2020; Jopp, 2019; Sokhanvar et al., 2021) and validate the model's authenticity and transferability to real-world teaching contexts. While some of the students noted the workload as a challenge, this aligns with Foulger et al. (2017), who found that deep learning through authentic projects requires substantial time and cognitive effort from both learners and instructors. Nonetheless, the students generally perceived this effort as a worthwhile investment in their professional development.

The integration of MOOCs and PBL within a DigComp-aligned teacher education course offers a viable strategy for developing comprehensive digital competence. This hybrid model balances scalability with personalisation, combining the reach of online learning with the depth of authentic assessment. The findings highlight the importance of structured progression from foundational to applied learning, the value of responsive mentoring, and the potential of PBL to cultivate meaningful digital skills. As digital competence continues to evolve, such integrated approaches will be essential for preparing future educators to navigate and lead technology-rich learning environments.

The relationship between xMOOC performance and PBL outcomes

Our first research question (RQ1) examined how success in xMOOCs and performance in PBL assignments relate to digital literacy development. The results revealed a positive association between xMOOC and PBL scores, with a significant correlation and regression analysis indicating that xMOOC performance predicted 24.3% of the variance in project outcomes. Foundational knowledge acquisition through structured online learning contributes to performance in more complex tasks. However, the modest correlation also suggests that these assessment formats measure distinct dimensions of digital competence, supporting Sánchez-Cruzado et al.'s (2021) assertion that digital competence development requires multiple complementary approaches.

The significantly lower PBL scores compared to xMOOC scores reflects the increased cognitive demands of the PBL tasks, which required the students to operate at higher levels of Bloom's taxonomy. This pattern supports Redecker's (2017) DigComp framework conceptualisation, which posits digital competence as a multi-dimensional construct requiring both knowledge acquisition and applied practice. Moreover, it confirms Falloon's (2020) findings that while MOOCs effectively develop foundational digital skills, more complex competences require opportunities for authentic application and creation.

The regression model highlights the fact that foundational knowledge, although necessary, is insufficient on its own. These findings reinforce Tondeur et al.'s (2019) call for integrated teacher education approaches that blend theory and practice. Our results empirically support the need to scaffold digital literacy instruction from lower- to higher-order competencies.

Conclusions

The present study provides empirical support for an integrated approach to digital literacy development in pre-service primary teachers, combining an xMOOC based on the DigComp framework with project-based learning. The findings show a significant, although modest, link between foundational knowledge and higher-order application, confirming that structured online learning and PBL effectively scaffold digital competence in line with Bloom's taxonomy and Redecker's (2017) multi-dimensional model.

High student satisfaction and perceived relevance indicate strong alignment between course design and professional preparation. The value placed on PBL reinforces the importance of authentic, creative tasks in developing transferable skills. Key success factors included clear instructional design, progression between components, responsive mentoring and constructive feedback. This hybrid model offers a scalable yet personalised strategy adaptable across teacher education contexts, addressing the need for comprehensive, integrated digital competence development (Tondeur et al., 2019).

Theoretical and practical implications

Our findings support the view of digital competence as a multi-dimensional construct requiring both foundational knowledge and applied practice (Redecker, 2017). The correlation between xMOOC and PBL scores indicates that these dimensions are related but distinct, highlighting the need for complementary pedagogical strategies. A hybrid model that combines structured xMOOCs with PBL addresses Falloon's (2020) concern that digital literacy initiatives often overemphasise either theory or technical skills at the expense of authentic application. Sequencing foundational content before applied tasks creates effective scaffolding from lower- to higher-order competencies. These results align with Tondeur et al. (2019), who emphasise the importance of integrating technical and pedagogical skills in authentic educational settings.

From a practical standpoint, the study supports a scalable and personalised approach to teacher education: self-paced xMOOCs for foundational learning followed by mentored PBL for skill application. The students' high satisfaction with mentoring highlights the importance of human guidance in navigating complex digital tasks, supporting Admiraal et al. (2019). The strong preference for PBL over traditional assessments suggests the value of authentic, creative assignments for evaluating digital competence. While our course-level intervention proved effective, comprehensive digital literacy development depends on broader programme integration (Røkenes & Krumsvik, 2016) and continued support into early career stages (Gudmundsdottir & Hatlevik, 2017). Future research should explore how targeted interventions like this contribute to sustained competence development within teacher education programmes.

Limitations of the study

Although the present study was comprehensive, several limitations must be acknowledged. The study was limited to a single institution with a predominantly female sample (91%), which may affect generalisability. Although this reflects typical enrolment in primary teacher education, future research should include more balanced samples to explore gender differences in digital competence development. The study also relied partly on self-reported satisfaction and usefulness, which may introduce social desirability bias. While anonymity likely reduced this risk, future work should include objective measures, such as standardised assessments or external application tasks.

The modest correlation between xMOOC and project scores suggests that factors beyond foundational knowledge influence project outcomes. The study did not control for prior digital experience, academic ability or time investment. Future research using multivariate analyses could better isolate the impact of each learning component. Despite these limitations, the study offers strong empirical support for integrating xMOOCs and PBL to build comprehensive digital literacy in teacher education.

Practical recommendations and future research

Based on the findings of this study, several recommendations can be made to improve digital competence development in pre-service teacher education. Teacher education programmes should adopt a sequential structure that scaffolds foundational knowledge through xMOOCs into higher-order application via project-based learning. This model offers a scalable yet personalised approach adaptable across contexts. Mentoring should prioritise accessibility, clarity and comprehensive support, as students highly value human guidance alongside digital content (Admiraal et al., 2019). Instructors should maintain multiple communication channels and provide both technical and pedagogical feedback. Teaching practices should focus on authentic, creative tasks that reflect real-world classroom challenges. Given students' preference for PBL, traditional assessment methods may fall short in fostering and evaluating digital competence. At the same time, educators must carefully manage workload and cognitive demands through appropriate scaffolding.

Future research should examine how pre-service teachers transfer digital competences to professional practice through longitudinal studies. Comparative research on hybrid models would help optimise the structure between xMOOCs and PBL. Studies exploring peer collaboration could uncover new strategies for enhancing digital literacy through social learning. Additionally, investigating the use of adaptive learning technologies may reveal how to better personalise foundational training, especially given the varying digital skill levels among pre-service teachers (Tondeur et al., 2020).

Ethical statement

Ethical approval for the study was given by the Ethics Commission of the Faculty of Education of the University of Ljubljana, Slovenia.

Disclosure statement

The author has no conflict of interest to declare.

References

Admiraal, W., Schenke, W., De Jong, L., Emmelot, Y., & Sligte, H. (2019). Schools as professional learning communities: What can schools do to support professional development of their teachers? *Professional Development in Education, 47(*4), 684–698. https://doi.org/10.1080/19415257.2019.1665573

Admiraal, W., van Vugt, F., Kranenburg, F., Koster, B., Smit, B., Weijers, S., & Lockhorst, D. (2016). Preparing pre-service teachers to integrate technology into K–12 instruction: Evaluation of a technology-infused approach. *Technology, Pedagogy and Education, 26*(1), 105–120. https://doi.org/10.1080/1475939X.2016.1163283

Al-Busaidi, S., & Al-Seyabi, F. (2021). Project-based learning as a tool for student-teachers' professional development: A study in an Omani EFL teacher education program. *International Journal of Learning, Teaching and Educational Research*, *20*(4), 116–136. https://doi.org/10.26803/ijlter.20.4.7

Biggs, J. (2014). Constructive alignment in university teaching. *HERDSA Review of Higher Education, 1*, 5–22. https://www.tru.ca/__shared/assets/Constructive_Alignment36087.pdf

Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, *18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

Chanpet, P., Chomsuwan, K., & Murphy, E. (2020). Online project-based learning and formative assessment. *Technology, Knowledge and Learning*, *25*, 685–705. https://doi.org/10.1007/s10758-018-9363-2

Chilla, S., Doetjes, G., Vogt, K., Abed Ibrahim, L., & Tsagari, D. (2025). Digital-inclusive transformation and teacher preparedness for foreign language education – A bilateral German-Norwegian perspective. *Center for Educational Policy Studies Journal*, *15*(1), 83–124. https://doi.org/10.26529/cepsj.1690

Dagarin Fojkar, M., & Berčnik, S. (2023). Academic writing in teaching research integrity. *Center for Educational Policy Studies Journal*, *13*(3), 129–154. https://doi.org/10.26529/cepsj.1602

Deng, R., Benckendorff, P., & Gannaway, D. (2019). Progress and new directions for teaching and learning in MOOCs. *Computers & Education, 129*, 48–60. https://doi.org/10.1016/j.compedu.2018.10.019

Eller, L. S., Lev, E. L., & Feurer, A. (2014). Key components of an effective mentoring relationship: A qualitative study. *Nurse Education Today*, *34*(5), 815–820. https://doi.org/10.1016/j.nedt.2013.07.020

Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development, 68*(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Foulger, T. S., Graziano, K. J., Schmidt-Crawford, D., & Slykhuis, D. A. (2017). Teacher educator technology competencies. *Journal of Technology and Teacher Education, 25*(4), 413–448. https://www.researchgate.net/publication/322129355_Teacher_Educator_Technology_Competencies

Granado-Alcón, M. d. C., Gómez-Baya, D., Herrera-Gutiérrez, E., Vélez-Toral, M., Alonso-Martín, P., & Martínez-Frutos, M. T. (2020). Project-based learning and the acquisition of competencies and knowledge transfer in higher education. *Sustainability*, *12*(23), Article 10062. https://doi.org/10.3390/su122310062

Gudmundsdottir, G. B., & Hatlevik, O. E. (2017). Newly qualified teachers' professional digital competence: Implications for teacher education. *European Journal of Teacher Education, 41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Guerra, A., Ulseth, R., & Kolmos, A. (Eds.). (2017). *PBL in engineering education: International perspectives on curriculum change*. Sense Publishers. https://doi.org/10.1007/978-94-6300-905-8

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, *102*(1), Article 101586. https://doi.org/10.1016/j.ijer.2020.101586

Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education, 67*, 37–45. https://doi.org/10.1016/j.tate.2017.05.016

Janssen, N., Knoef, M., & Lazonder, A. W. (2019). Technological and pedagogical support for pre-service teachers' lesson planning. *Technology, Pedagogy and Education, 28*(1), 115–128. https://doi.org/10.1080/1475939X.2019.1569554

Jopp, R. (2019). A case study of a technology enhanced learning initiative that supports authentic assessment. *Teaching in Higher Education*, *25*(8), 942–958. https://doi.org/10.1080/13562517.2019.1613637.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Margaryan, A., Bianco, M., & Littlejohn, A. (2015). Instructional quality of massive open online courses (MOOCs). *Computers & Education, 80*, 77–83. https://doi.org/10.1016/j.compedu.2014.08.005

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2021). Project-based learning and its effectiveness: Evidence from Slovakia. *Interactive Learning Environments*, *31*(7), 1–9. https://doi.org/10.1080/10494820.2021.1954036

McGarr, O., & McDonagh, A. (2020). Exploring the digital competence of pre-service teachers on entry onto an initial teacher education programme in Ireland. *Irish Educational Studies, 40*(1), 115–128. https://doi.org/10.1080/03323315.2020.1800501

Redecker, C. (2017). *European framework for the digital competence of educators: DigCompEdu*. Publications Office of the European Union. https://doi.org/10.2760/159770

Ribeiro, S., Tavares, C., Lopes, C., & Chorão, G. (2023). Competence development strategies after COVID-19: Using PBL in translation courses. *Education Sciences*, *13*(3), 283–283. https://doi.org/10.3390/educsci13030283

Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs (massive open online courses). *Open Praxis, 5*(1), 67–73. http://dx.doi.org/10.5944/openpraxis.5.1.42

Røkenes, F. M., & Krumsvik, R. J. (2016). Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education. *Computers & Education, 97*, 1–20. https://doi.org/10.1016/j.compedu.2016.02.014

Salas-Rueda, R.-A., De-La-Cruz-Martínez, G., Alvarado-Zamorano, C., & Prieto-Larios, E. (2022). The collaborative wall: A technological means to improving the teaching-learning process about physics. *Center for Educational Policy Studies Journal*, *12*(4), 205–231. https://doi.org/10.26529/cepsj.1167

Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher digital literacy: The indisputable challenge after COVID-19. *Sustainability, 13*(4), Article 1858. https://doi.org/10.3390/su13041858

Sokhanvar, Z., Salehi, K., & Sokhanvar, F. (2021). Advantages of authentic assessment for improving the learning experience and employability skills of higher education students: A systematic literature review. *Studies in Educational Evaluation*, *70*, Article 101030. https://doi.org/10.1016/J.STUEDUC.2021.101030

Svoboda, P., Mynaříková, L. (2021). MOOC Courses as a tool for the development of digital competencies of teachers. In S. Nazir, T. Z. Ahram, & W. Karwowski (Eds.), *Advances in human factors in training, education, and learning sciences. AHFE 2021. Lecture Notes in Networks and Systems, vol 269.* Springer. https://doi.org/10.1007/978-3-030-80000-0_29

Tondeur, J., Braak, J. v., Siddiq, F., & Scherer, R. (2016). Time for a new approach to prepare future teachers for educational technology use: Its meaning and measurement. *Computers & Education, 94*, 134–150. https://doi.org/10.1016/j.compedu.2015.11.009

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology, 50*(3), 1189–1209. https://doi.org/10.1111/bjet.12748

Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The digital competence framework for citizens - With new examples of knowledge, skills and attitudes*. Publications Office of the European Union. https://doi.org/10.2760/490274

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. *Frontiers in Psychology*, *14*(1), Article 1202728. https://doi.org/10.3389/fpsyg.2023.1202728

Biographical note

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Primary Programming: Teachers' Attitudes and Skills in the Light of Computing Reform

Jiří Vaníček*[1] and Jan Pršala[2]

Two global trends that can be observed in computing education all over the world are moving the beginning of teaching computing as a compulsory school subject to primary education and moving from the teaching of user approaches to digital technologies to computer science content. The Czech Republic is currently the scene of such changes within the ongoing reform of informatics education. This paper presents the visions and principles that have served as the foundational framework for the reform initiative. A significant term for the introduction of computing in schools is programming. The key figure for the implementation of the changes is the primary school teacher who has no background in computer science and no experience in the subject as a student. The topic of our inquiry is therefore the attitudes of primary teachers towards teaching programming at the time of the ongoing school reform. The aim of the research is to identify the personal, pedagogical and environmental factors that influence teachers' attitudes towards teaching programming. We measured programming attitudes using Sun's Teacher Programming Attitude Scale, while the relationship of these attitudes to teachers' computational thinking was explored using Bebras Challenge tasks. A survey of primary school teachers revealed a positive attitude towards the teaching of programming, coupled with very good computing skills. The study also found that previous experience in teaching programming is a significant factor in influencing teachers' positive attitudes towards the subject.

Keywords: national curricula innovation, programming, primary teacher, attitudes, programming skills

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Programiranje v osnovni šoli: odnos in veščine učiteljev v luči reforme poučevanja računalništva in informatike

Jiří Vaníček in Jan Pršala

Dva globalna trenda, ki ju lahko opazimo v računalniškem izobraževanju po vsem svetu, sta premik začetka poučevanja računalništva kot obveznega šolskega predmeta v osnovnošolsko izobraževanje in prehod od poučevanja uporabe digitalnih tehnologij k obravnavi vsebin računalništva. Češka te spremembe uresničuje s sistemsko reformo poučevanja računalništva in informatike. Članek predstavlja vizije in načela, ki so oblikovali temeljni okvir reforme. Pomemben vidik uvedbe računalništva in informatike v šolah je programiranje. Ključna oseba za izvajanje sprememb je osnovnošolski učitelj, ki pogosto nima ustreznega znanja iz računalništva in izkušenj s tem predmetom kot učenec. Raziskava se osredinja na odnos osnovnošolskih učiteljev do poučevanja programiranja med šolsko reformo. Cilj raziskave je identificirati osebne, pedagoške in okoljske dejavnike, ki vplivajo na njihov odnos do poučevanja programiranja. Odnos do programiranja smo merili z uporabo Sunove lestvice odnosa učiteljev do programiranja, medtem ko smo raziskali povezavo med temi odnosi in računalniškim mišljenjem učiteljev z uporabo nalog tekmovanja Bober. Raziskava med osnovnošolskimi učitelji je pokazala pozitiven odnos do poučevanja programiranja, ki ga spremljata dobro računalniško znanje in zadostna raven računalniškega mišljenja. Študija je tudi ugotovila, da so pretekle izkušnje s poučevanjem programiranja pomemben dejavnik, ki vpliva na pozitiven odnos učiteljev do tega predmeta.

Ključne besede: inovativnost v nacionalnih učnih načrtih, programiranje, osnovnošolski učitelj, odnos, programerske veščine

Introduction

The present study examines the implementation of a paradigm shift in the realm of information and communication technology education towards informatics education. The focus is on the shift from a user-oriented approach to the mandatory inclusion of informatics in the curriculum at primary level. The paper describes two steps to this implementation, together with the ideas and sources of inspiration for these steps, as well as the changes in the system. To illustrate the outcomes of these changes, we present the findings of a survey conducted among primary school teachers on their programming attitudes and skills several years after the reform's inception.

The terms used in the paper are defined as follows:

Information and communication technology (ICT) is used in the sense of teaching a user approach to digital technology, the area for the development of digital literacy and everyday use of computers as a learning tool. The acronym ICT is employed for the designation of the compulsory school subject of Information and Communication Technology, as it was previously designated until 2021.

Computing is used as the new name of the school subject in the sense of computer science or informatics, which is one of the STEM disciplines. It focuses on an author-oriented approach to digital technology (not only consumption, but creation) with an emphasis on understanding computers and development of computational thinking. In the article, we distinguish between computing, which is related to the school subject, and computer science as a scientific field.

Primary education (ISCED1, age 6–11 in Czechia), lower-secondary education (ISCED2, age 11–15), upper-secondary education (ISCED3, age 15–19).

Two steps to primary computing in Czechia

As civilisation becomes increasingly aware of the expanding potential for the integration of computers and automation into all facets of our lives, and the consequences for prosperity, the digital world is assuming an ever-larger share of our environment. Consequently, as Gander (2014, p. 4) asserts, computer education has become an integral component of general education. Three global trends have been observed in the field of computer and computing education over the past few decades: a shift from a user approach in computer training, from controlling the computer to understanding the principles on which it works; the transformation of the school subject dedicated to this area from an optional to a compulsory subject; and a shift in the start of the teaching in this field towards a younger age.

The Tucker committee for the ACM K-12 curriculum claims that "the goals of a K-12 computer science curriculum are to introduce the fundamental concepts of computer science to all students, beginning at the elementary school level" (Tucker, 2003, p. 6). Gander (2014, p. 7) states the formula "*Computer science in Schools = Digital Literacy + Informatics*", where informatics means "the science behind information technology".

First step: Compulsory primary ICT education

Czech professional institutions responsible for running education, such as the Panel for ICT Teaching Innovations at the Pedagogical Research Institute, noted a growing discrepancy between the aforementioned trends and the reality in schools. This led to the implementation of a reform that can be described as consequentialist in accordance with Kodelja (2021). The practical implementation of these trends was reflected in two significant steps that dramatically altered the situation in Czech schools with regard to school legislation. Since the early 1990s, ICT including computing had been incorporated into the curriculum of Czech secondary schools as a non-compulsory topic within other educational areas such as mathematics or technology. Subsequent to the Czech Republic's accession to the European Union in 2004, the nation's Education Act (MŠMT, 2005) came into force in 2006, introducing compulsory ICT education at primary and lower secondary levels. The main focus of this subject was the search, processing and utilisation of information and communication (NÚV, 2005), while the pedagogical framework was rooted in office software training, file management, Internet browsing and creating graphics. Notably, the curriculum did not incorporate any computer science components, reflecting the UNESCO model of ICT development in the 2002 curriculum (UNESCO, 2002). The gradual introduction of the subject resulted in a situation where, after 2011, ICT was taught on a compulsory basis in all schools, with one lesson per week in one grade at the primary level.

At the lower secondary level, computer science activities were included in the curricula in some schools; for example, in the form of programming courses in a children's environment such as Logo or Baltie. In practice, however, this did not actually occur in primary schools, where the ICT subject was mainly used to introduce work with computers. The support provided by textbooks and teaching materials, as well as teacher training in the field, was weak and unsystematic. The vast majority of schools lacked computer labs suitable for younger pupils, and ICT was typically taught by secondary school teachers rather than primary specialists. It should be noted that this model did not stipulate the use of digital technology in other school subjects, so computers were frequently employed solely in the context of the ICT subject, resulting in the isolation of ICT and the somewhat impractical use of computers. This model remained unchanged until 2021.

Models of inspiration for the second step

In order to develop a model for innovating teaching in this area in the Czech Republic, an analysis of international best practice was conducted. A study was undertaken of the situation in Slovakia, which introduced computing as a compulsory subject before 2010 with a focus on algorithmic thinking, procedures, problem solving, digital technologies and creativity in the user approach to digital technology (Blaho & Salanci, 2011; Blaho, 2012). The Slovakian approach – as demonstrated by the introduction of a national curriculum, educational content, teacher support, pedagogical research, and the establishment of a community of educators through the project Infovek and the DidInfo conference (UMB, 2024) – provided a valuable model for the development of informatics education in Czechia. The introduction of a new computing curriculum in Poland was also examined (Sysło, 2015). The study Shut down or restart?, which established the subject Computing in the United Kingdom, claimed that "ICT and informatics, which is a scientific discipline similar to mathematics and physics, are two different subjects in school education with different missions and functions, although they have common areas of synergy" (The Royal Society, 2012, p. 10). Instead of the term ICT, the concept of digital literacy was introduced, which also inspired the second step.

Conception of the second step: The strategy of digital education

The introduction of computing was facilitated by the creation of a new digital education strategy around 2014. During expert discussions involving computer specialists, educators and teachers, the public, schools, employers and IT companies, a section on the development of computational thinking was added to the original discussion on innovations in digital literacy. Subsequently, the Czech government adopted a strategic document entitled Strategy for Digital Education until 2020, which set out three primary objectives: "the development of computational thinking, the development of digital literacy, and the opening of education to new methods and ways of learning through digital technologies" (MŠMT, 2014).

The introduction of computational thinking in the Czech Republic was justified as enabling students to understand today's world from the computer science perspective and to acquire the skills required to resolve a wide array of issues that arise in the context of automation. This document initiated a series of actions that, over the subsequent six years, led to the transformation of the school and computer-assisted and computer education, the implementation of which we are currently experiencing.

Computational thinking and digital literacy

The utilisation of the prevailing terms ICT and informatics proved to be insufficient to capture the necessary substantive changes in the pedagogical context. These terms were commonly perceived as semantically equivalent, with an overreliance on the content aspect of education. There was a real risk that teachers would think of the current ICT under the term informatics and nothing would change in their teaching. The necessity for novel terminology therefore emerged, with the objective of shifting the focus towards the objectives of education and the cultivation of the individual. With the aid of the concepts of computational thinking and digital literacy, a model of change was developed, ultimately resulting in a complete change to the compulsory subject, which shifted from a focus on digital literacy to one that is more aligned with computational thinking (Vaníček, 2021).

The employment of these two terms facilitated a more precise articulation of the impending alterations within the framework of the planned reform. This approach precluded a scenario in which, by simply adding computer science topics to the existing ICT teaching, educators would impart substantially similar content, thereby ensuring the preservation of the fundamental essence of teaching, which would be predicated on the user approach. Consequently, computer science would become a mere superstructure that would not receive enough attention in the eyes of teachers, the presumed main drivers of the reform. The utilisation of these concepts enabled a more profound elucidation of the radical transition from the user to the author approach, while concomitantly providing a more comprehensive description of the state curriculum.

Figure 1

The content of subjects in relation to computer education before and after the planned innovation. The green arrows show the main intended content shift among school subjects

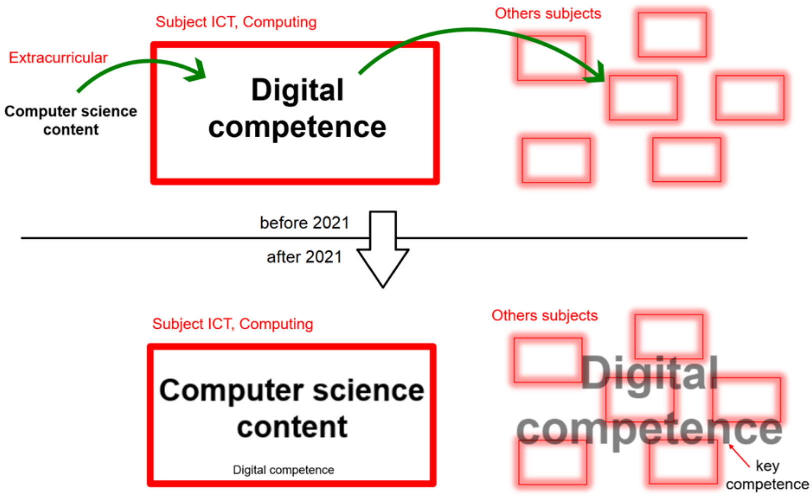


Figure 1 illustrates these changes. The big square represents the compulsory subject "computers" and the small squares represent the other school subjects. The text describes content related to computer education. The empty area on the left represents extracurricular education, organised outside of school or, rarely, in non-compulsory parts of school education.

The creation of the conditions for innovation in education and the development of computational thinking was the aim of a major strategic project, PRIM, in the years 2017–2020. All nine pedagogical faculties in the Czech Republic involved in the training of primary school teachers collaborated on the implementation of the necessary modifications to the undergraduate education of ICT teachers, including primary school teachers. These modifications included the creation of new educational content in the form of sets of freely accessible textbooks, the establishment of a system of further education for teachers for the so-called *New Informatics*, and the promotion of computing in society (JU, 2017).

New national informatics curriculum

In January 2021, the Ministry of Education published the new educational framework for primary education (MŠMT, 2021). This document defines the national curriculum, which includes the new concept of computer science.

The experience from the time of the Covid pandemic and the long period of online distance learning significantly contributed to the development of Czech teachers' digital competence (Pavlas et al., 2021) and subsequently increased their confidence in this area. This illustrates the possibilities that making and digital fabrication can offer to innovation, and exemplifies the meaningful integration of technology in educational contexts in terms of learning (Bosco et al, 2019, p. 69). Teaching is now seen as a mediated action with high potential for hybridisation (Perla et al, 2025, p. 149). The reform also addresses the readiness for the transition to the new computing curricula: the existence of pilot textbooks, in-service teacher training, and the availability of finances for the purchase of robotic learning tools assisted with the implementation. The subject of ICT was renamed Computing, with a compulsory minimum of one lesson per week in each of grades 4 to 9, which is three times more than the previous time allocation (see Figure 2).

Figure 2

Time allocation for the compulsory subject before and after curricular reform

<table>
<tr><th></th><th></th><th><2021</th><th>>2021</th></tr>
<tr><th>level</th><th>grade</th><th>ICT</th><th>Computing</th></tr>
<tr><td rowspan="5">primary</td><td>1</td><td rowspan="5">1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td>1</td></tr>
<tr><td>5</td><td>1</td></tr>
<tr><td rowspan="4">lower-secondary</td><td>6</td><td rowspan="4">1</td><td>1</td></tr>
<tr><td>7</td><td>1</td></tr>
<tr><td>8</td><td>1</td></tr>
<tr><td>9</td><td>1</td></tr>
</table>

The content of the subject was changed completely. It is now divided into four areas, which we illustrate by selected expected outcomes when finishing primary education in the fifth grade in Figure 3.

Computing was characterised as a subject that helps pupils understand the computer and the world around us from the informatics perspective and develops their computational thinking.

Figure 3

Expected outcomes for primary education in computing (MŠMT, 2021)

Data, information and modelling The pupil — gives examples of data that surrounds them that can help them make better decisions; pronounces answers based on data — describes a specific situation, determines what they already know about it, and illustrates it — reads information from the given model
Algorithmizing and programming The pupil — compiles and tests symbolic notations of procedures — describes a simple problem, suggests and describes the individual steps of its solution — builds a program in a block-oriented programming language, recognizes repeating patterns, uses repetition and prepared subroutines — verifies the correctness of the procedure or program proposed by them, finds and corrects any errors in it
Information systems The pupil — recognizes the individual elements and the relationships between them in the systems that surround them — records numerical and non-numerical data in an existing table or list for a defined problem
Digital technology The pupil — finds and runs the application, works with data of various types — connects digital devices, lists the possible risks associated with such a connection — observes safety and other rules for working with digital technologies

With regard to the organisation of teaching, it was emphasised that pupils should actively construct their knowledge by discovering, discussing and solving problems, for example. Group activities are recommended. The emphasis is not placed on the reproduction of knowledge or on memorising information (MŠMT, 2021).

The other area of innovation, digital literacy, has become a so-called key competence, which means it must be implemented in all educational areas (NPI ČR, 2025). All school subjects are responsible for achieving outcomes related to this competence. Thus, the subject of computing is not specifically responsible for achieving goals in digital literacy such as, but not limited to, using spreadsheets for calculations in pupils' research in science classes, typewriting in Czech language classes, safety and interpersonal relationships on the Internet in civics, etc. On the other hand, it is obligatory for all subjects to use the computer as a teaching aid to fulfil their subject educational goals. Digital technologies can be expected to change teachers' working methods.

The revised curriculum emphasises the development of computational thinking and digital literacy, aligning closely with international frameworks such as the K-12 Computer Science Framework Steering Committee (K12CS) and Informatics for All (I4ALL). While K12CS provides a comprehensive structure for integrating computing across school levels (K12CS, 2016) and I4ALL focuses on establishing computing as a foundational discipline in education (I4ALL, 2025), the Czech curriculum reflects a similar ambition by embedding computing as a core subject and fostering digital literacy as a cross-curricular skill.

Introducing innovation at schools

From September 2021, schools commenced the transition to the new computing curriculum by mixing traditional and new educational content. This transition was optional and schools could opt out of it. Since September 2024, all grades at primary and lower-secondary level must be taught according to the new national curriculum.

The publication of the new national curriculum triggered a massive discussion in the professional community. The discourse addressed the anticipated queries surrounding the curriculum and the financial implications of acquiring computers and educational robots. The pivotal question for primary education pertained to the identification of suitable candidates for the instruction of this novel discipline. The absence of new teachers with expertise in computing, coupled with the unlikelihood of higher-grade teachers providing assistance due to their own teaching loads, highlighted a critical shortage of qualified educators.

The most viable solution identified was to focus on primary teachers who teach regular subjects in grades 4 and 5 (pupils aged 9–10 years) also teaching computing in their classes. The solution in which computing would be taught at primary level by secondary teachers who are specialists in computing was not supported. Teachers who were encouraged or chose to teach computing received short voluntary training programmes and were provided with textbooks and methodological guides. These educational materials were prepared and tested for use by teachers without previous training who had never taught programming. The process was aided by the publication of exemplary school educational programmes for computing, allowing easier planning of teaching the new subject (PRIM, 2021).

Research problem and research questions

The issue under consideration in the present study is whether the decision to rely on existing teachers to reform computer science in primary education was the correct one. The question therefore arises as to how these teachers, who have not undergone any pre-service training, perceive teaching programming and what knowledge they have in this area.

The topic of programming was chosen because it is one of four main areas (see Figure 3) of the new school subject. Moreover, programming was historically the least popular computer science topic among teachers (even when teaching it was not mandatory) (Rambousek et al., 2015).

Processes associated with programming require skills such as problem decomposition, algorithmisation, abstraction and automation, thereby helping to develop computational thinking (Yadav et al., 2017). This is consistent with our findings in the Czech national Bebras task archive (JU, 2024), where each task contains tags about its connection to some computer science topic and to the computational thinking components it develops. Tasks categorised as programming and algorithmic are consistently tagged with all of the computational thinking components.

We do not assume that primary teachers have programming skills, so these were not tested in the research, which instead focused on the components of computational thinking. Thus, the main aim of the present paper is to describe the overall level of primary teachers' attitudes towards teaching programming and their computational thinking. Another aim is to identify the personal and pedagogical factors that influence primary teachers' attitudes towards programming and algorithmic thinking. We are interested in whether there are groups of teachers who have significantly more positive or negative attitudes towards teaching programming. In addition, we would like to determine the relationship and interaction of the selected factors with teachers' attitudes towards teaching programming.

With these goals in mind, the following research questions were established:

RQ1: What are teachers' overall attitudes towards teaching programming?

RQ2: What is the level of teachers' computational thinking?

RQ3: What factors influence primary teachers' attitudes towards teaching programming and their level of computational thinking?

Method

Participants

The research sample consisted of 239 primary education teachers from the Czech Republic who teach all of the regular subjects in grades 4 and 5, including computing. The research did not include specialised secondary school computing teachers who also teach computing at the primary level. The intention was for the research to reflect the specificities of computer science teaching by primary teachers who have not received any pre-service training in teaching computer science and thus are not trained in teaching this subject. The distribution of research participants per factor can be seen in Table 1.

The participants took part in the research voluntarily and anonymously. Each school participating in the Bebras Challenge contest (JU, 2025) has a designated contact person, the so-called school coordinator. The participants were approached through these school coordinators, who forwarded the request to their colleagues in the target group at school. A total of 1,450 schools from the contest database were approached, representing approximately one third of all target schools.

Table 1

Distribution of research participants per factor

Factor	*n*	%
Gender		
Female	54	22.6
Male	185	77.4
Age		
25–30	22	9.3
31–40	99	41.4
41–50	73	30.5
51–60	35	14.6
61+	10	4.2
Length of teaching		
<1	11	4.6
1–3	57	23.8
4–6	26	10.9
7–9	23	9.6
10+	122	51.1
Experience with teaching programming		
Yes	189	79.1
No	50	20.9

Research instruments

The main research instrument employed was an online questionnaire, which incorporated the Teacher Programming Attitude Scale (TPAS) and the Bebras Challenge tasks test (JU, 2025).

Created by Lihui Sun and Danhua Zhou (2023), the TPAS analyses teachers' attitudes towards programming and teaching programming using a 5-point Likert scale. The TPAS is divided into five dimensions: Programming Interests, Programming Self-Efficacy, Programming Utility, Cognition and Belief, and Reflection and Monitoring. Each item is scored from 0 (Strongly Disagree) to 4 (Strongly Agree). It is hypothesised that a higher score is indicative of a more positive attitude towards programming and teaching programming. In our work, we translated the scale into Czech and used the first three dimensions relevant to our environment and educational situation: Programming Interests, Programming Self-efficacy, and Programming Utility (17 items, 68 points in total). Although the other two dimensions – Cognition and Belief, and Reflection and Monitoring – capture important aspects of teachers' broader pedagogical approaches, they were deemed less applicable to our context, where programming is still being established as a new topic in primary schools. An example of the scale questions from the Programming Interests dimension in the interactive questionnaire environment can be seen in Figure 4.

Figure 4
A sample of the scale questions used from the TPAS, with an example of filling out the questionnaire (selected answer highlighted in green)

In order to evaluate the level of programming competencies, we designed a test consisting of so-called Bebras tasks from the Czech edition of the Bebras Challenge. These tasks are a popular way to measure computational thinking (Zapata-Cáceres, 2024). Bebras tasks require no prior knowledge or experience in programming. Each task involves at least one computer science concept (Dagienė & Futschek, 2008).

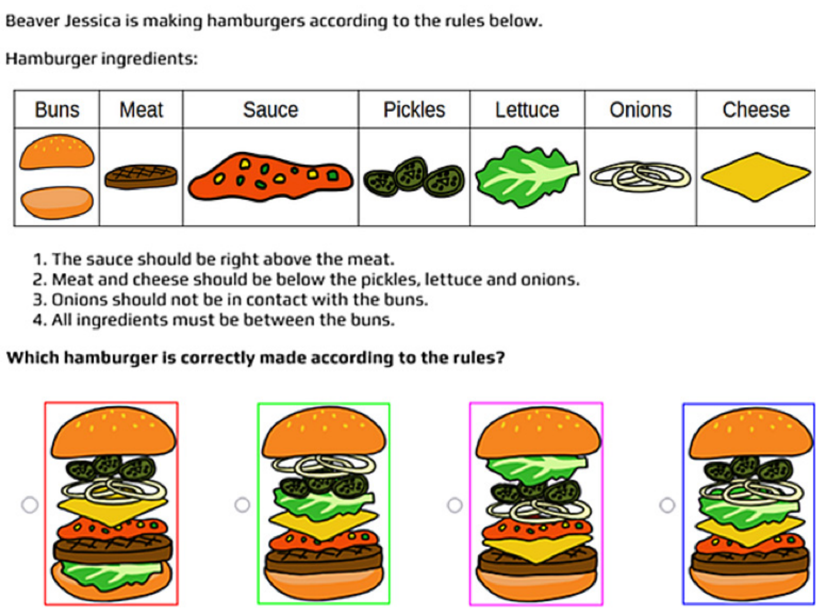
A total of eight Bebras tasks were included in our test. The individual tasks were selected from the five years of the contest (2019 to 2023), and their use in the contest verified their validity and reliability. The tasks were selected from the age category designed for pupils in grades 3, 4 and 5, so the difficulty of the selected tasks matched that of the tasks teachers are expected to use in their classes. The overall success rate of these tasks among pupils in the challenge was less than 50%, although this increased to 70% in two tasks where pupils were permitted to adjust their solutions according to immediate feedback.

We limited ourselves to Bebras tasks involving algorithmic thinking and programming. Our tasks covered the following computational thinking components: abstraction, algorithmisation, evaluation, decomposition and generalisation.

An example of the Bebras tasks used can be seen in Figure 5. This task presents an algorithm for making a hamburger and the goal is to evaluate the correctness of the given hamburgers.

Figure 5

An example of a Bebras task used in the test (Bebras code 2022KR03)



The complete set of tasks (in a form of web link) can be found online at *https://www.ibobr.cz/papers/ceps25.pdf*.

Research design

In order to address our research questions, we employed a quantitative research design using a survey-based approach. The research follows a correlational design, as it aims to examine relationships between the participating teachers' attitudes towards teaching programming, their level of computational thinking, and various influencing factors. Data collection was conducted through an online questionnaire that combined self-reported measures of the teachers' attitudes and an objective assessment of their computational thinking skills. After anonymously signing up for the online questionnaire, the participants filled out an attitude questionnaire and a Bebras Challenge computing test. They also provided information about their gender, age, length of teaching and prior experience with teaching programming. No other personal data was collected.

Data analysis was conducted separately for each factor (gender, age, length of teaching, prior experience with programming). Using the statistical software R, we compared the respondents' scale scores and looked for differences based on the given factor. All of the statistical tests below were performed at a significance level of , which was chosen considering the size of the research sample.

In order to answer RQ1, the scale and test results were analysed using tools of descriptive statistics. The mean and median of the overall scale results were computed, followed by an examination of the results per dimension (Programming Interest, Programming Utility, Programming Self-Efficacy). The test outcomes were then considered separately. For each task, the success rate was calculated and subsequently compared across tasks.

In order to answer RQ2 and RQ3, we first planned to use the statistical test of analysis of variance. We used the Shapiro-Wilk test to test the normality of the data and found that our data does not follow a normal distribution, which is one of prerequisites for using the test of analysis of variance. We therefore tested for differences using the Mann-Whitney-Wilcoxon test to test the influence of gender and prior experience with teaching programming, and the Kruskal-Wallis test to test the influence of the age and length of teaching.

Results

The results are divided into sections based on each research question.

Overall teachers' attitudes towards teaching programming

Table 2

Descriptive statistics of teachers' attitudes by TPAS dimension

Dimension	Questions	Highest achievable score	Median score	%	Min	Max
Programming interests	7	28	19	68	6	28
Programming self-efficacy	4	16	9	56	0	16
Programming utility	6	24	17	71	0	24
Overall programming attitudes	17	68	45	66	16	68

The overall results of the TPAS were analysed as well as the results by dimension. Table 2 shows the number of questions used, the total number of achievable points of the teachers' attitudes towards teaching programming, the median of the points achieved by the participants, the percentage of the median to the total number of points, and the minimum and maximum achieved points by the participants.

Examining the results by dimension (Table 2), it is clear that each dimension's score is at a middle upper level, which corresponds to the findings of the scale authors (Sun & Zhou, 2023). The programming self-efficacy score, which contained four questions, is the lowest of the three dimensions (Table 3). A detailed examination of the scores reveals that the surveyed teachers are not confident about their programming skills but are optimistic about their ability to learn programming and to deal with the various difficulties encountered in the process of learning programming.

Table 3

Results of the Programming self-efficacy dimension (in % of participants)

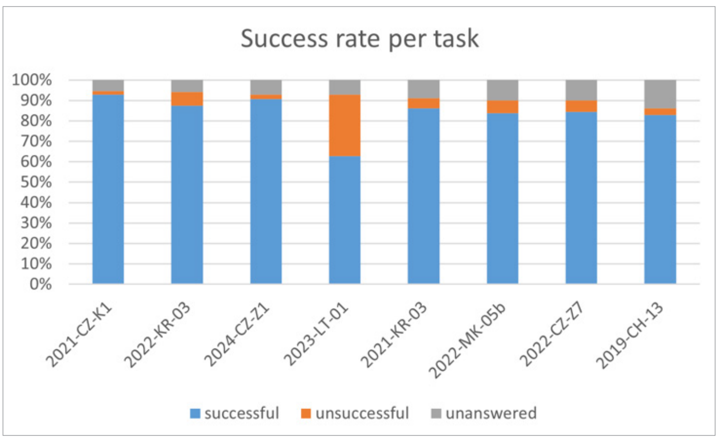
Scale question	Strongly Disagree	Disagree	I don't know	Agree	Strongly Agree
I am good at programming.	4	33	48	13	2
I believe that I am capable of dealing with the difficulties encountered in learning programming.	3	19	28	47	3
I believe I can learn to program if I work hard enough.	1	3	15	66	15
In the eyes of others, I am good at programming.	3	8	66	23	0

Overall primary teachers' computational thinking level

We then focused on the results of the Bebras tasks. The overall success rate per task can be seen in Figure 6. At least 80% of the teachers successfully answered each task, except for task 2023-LT-01, which proved to be difficult for more than one third of the respondents. According to Vaníček and Šimandl (2020), the subjective difficulty of a task is more aptly expressed in terms of the proportion of participants who did not answer the task than the proportion of participants who answered incorrectly. As shown in Figure 6, each task was answered by the vast majority of the teachers. We interpret these findings as demonstrating that the results are positive, and that the teachers surveyed have a good level of computational thinking.

Figure 6

Success rate of each of the eight used test tasks



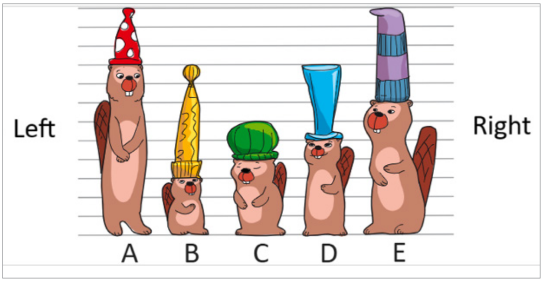
Let us look at what caused the significantly higher error rate in task 2023-LT-01, which was worded as follows:

Sort the beavers (in Figure 7) in ascending order according to their hats' heights. The beavers to the right must have taller hats than the beavers to the left. In which sequence will the beavers stand?

Check one of the answers: 1) C A D E B 2) B E D A C 3) C A E D B 4) E B D A C

Figure 7

Part of the settings of Task 4 "Sort the beavers by hats"



An analysis of the answers to this task reveals that the participants perceived the task as easy (only 7% did not answer). Nonetheless, approximately one quarter of them selected solution 2, in which the order of letters was flipped horizontally compared to the correct solution 1. This indicates a weak accommodation or misunderstanding of the rule "the beavers to the right have taller hats than the beavers to the left". These participants sorted hats in the descending order from the left, as they were probably used to doing from previous experience.

Factors influencing teachers' attitudes towards teaching programming

We then focused on the factors that influence teachers' attitudes towards teaching programming. First, the normality of our data set was tested using the Shapiro-Wilk test. The results (p-value = 0.00011) indicate that our data comes from non-normal distribution. We then used the Mann-Whitney-Wilcoxon test to test the influence of gender and prior experience with teaching programming, and the Kruskal-Wallis test to test the influence of the age and length of teaching. The results can be seen in Table 4.

Table 4

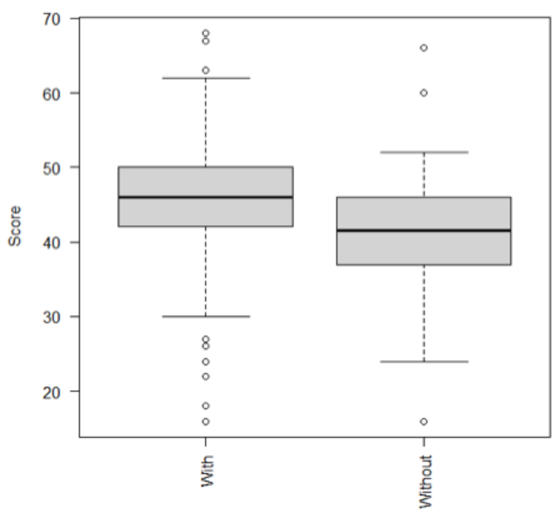
Results of the Mann-Whitney-Wilcoxon test and the Kruskal-Wallis test for teachers' attitudes towards teaching programming

Factor	p-value
Gender	0.5748
Age	0.3511
Length of teaching	0.5710
Prior experience with teaching programming	0.0001

No statistical significance was found in the influence of gender, age and length of teaching. However, the influence of prior experience with teaching programming was found to be statistically significant at the level 0.01, which means that it is hard to justify the hypothesis that prior experience of teaching programming has no influence. We interpret this result as demonstrating that teachers who have already taught programming in their classes have a more positive attitude towards teaching the topic. This finding is illustrated in the scale results in Figure 8.

Figure 8

Boxplots of TPAS scores of teachers with and without prior experience with teaching programming



We then analysed the differences between the teachers with and without prior experience with programming per scale dimension of the TPAS (Table 5). The results show statistically significant differences in both the Programming self-efficacy and the Programming utility dimensions. This can be interpreted as demonstrating that teachers with prior experience have more positive attitudes in programming self-efficacy and utility (Figure 9). However, there are no statistically significant differences between the two groups in the Programming interest dimension. We interpret this result as demonstrating that all of the surveyed teachers have similar attitudes in programming interests. It has therefore not been proven that more experienced teachers are more interested in programming.

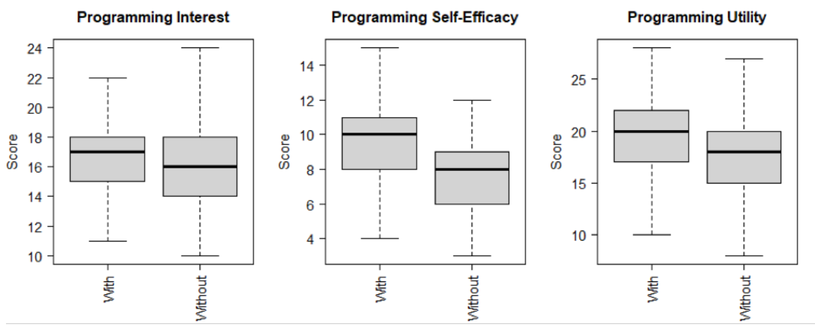
Table 5

The results of the Mann-Whitney-Wilcoxon test for teachers' attitudes in TPAS dimensions

Dimension	*p*-value
Programming interest	0.1012
Programming self-efficacy	0.0038
Programming utility	0.0000

Figure 9

Boxplots of the TPAS dimension scores of teachers with and without prior experience with teaching programming within each dimension



A similar strategy was employed to determine the factors that influence the teachers' level of computational thinking. The normality of our data set was first tested using the Shapiro-Wilk test. The results (p-value = 0.0000) indicate that our data comes from non-normal distribution. We then used Mann-Whitney-Wilcoxon test to test the influence of gender and prior experience with teaching programming, and the Kruskal-Wallis test to test the influence of the age and length of teaching. The results (Table 6) show no statistically significant influence of any of the factors on the teachers' level of computational thinking. All of the types of teachers achieved similar results in the Bebras tasks test.

Table 6

Results of the Mann-Whitney-Wilcoxon test and the Kruskal-Wallis test for teachers' level of computational thinking

Factor	*p*-value
Gender	0.8240
Age	0.7540
Length of teaching	0.7191
Prior experience with teaching programming	0.4200

Discussion and conclusion

The present study revealed several key insights into the attitudes of primary school teachers towards teaching programming within the context of the Czech educational reform. The findings indicate that teachers generally have a positive attitude towards programming and recognise its value in education. Programming was historically the most unpopular computer education topic in Czech schools both before (Rambousek et al., 2015) and during (Bryndová, 2021) the educational reform, suggesting that the reform has had a positive effect on the implementation of these changes, especially with regard to its realisation in the form of practical training and workshops that enabled teachers to experience programming first hand. The same effect can be seen in other countries. For example, German primary teachers who participated in training on teaching programming and algorithmisation had a significantly more positive approach to teaching these topics than before; they also had greater trust in their ability to teach these topics to their pupils and saw more meaning and benefit in such teaching (Geldreich et al., 2018). Similarly, pre-service primary teachers in Portugal had a positive attitude towards teaching programming after completing a robotics course (Piedade et al., 2020). In-service training and a feeling of participation were also key factors mentioned by Finnish teachers when asked about their attitudes towards teaching programming (Korhonen et al., 2023).

The present study also revealed that factors such as gender, age and general length of teaching did not show statistically significant effects on teachers' attitudes. The only factor that had a statistically significant effect on teachers' attitudes was their prior experience with teaching programming. This finding is not entirely consistent with previous studies, some of which found that male teachers have more positive attitudes towards programming (Sun & Lhou, 2023). In the context of primary education, however, it was found that female teachers can have more positive attitudes towards programming, especially when using visual programming languages (Witherspoon et al., 2018). Similarly, some studies indicate that age and length of teaching can be an influencing factor, with younger teachers with less than five years of teaching having a positive attitude towards teaching programming (Sun & Lhou, 2023).

The weakest aspect of the surveyed teachers' attitudes is self-assessing their programming skills, which suggests a need for confidence-building measures. Teachers with prior experience of teaching programming exhibit significantly higher self-efficacy. Similarly, Rich et al. (2021) found that teachers who participated in a continuous professional development course showed increased self-efficacy for both programming and teaching programming.

Our analysis of primary teachers' computational thinking found that their level is high enough to effectively teach programming in primary schools. It should be noted, however, that the tasks used in our testing were designed for pupils from grades 3, 4 and 5 and had a low success rate among pupils. We also focused on factors influencing the level of teachers' computational thinking and found no statistically significant effect of any of the examined factors. This is consistent with other studies, such as that by Günbatar and Bakırcı (2019), who examined the relationship between gender (among other factors) and the level of pre-service primary school teachers' computational thinking and found no differences between male and female teachers. Moreover, Bati and Yetişir (2021) found that the general length of teaching has no significant impact on teachers' computational thinking skills.

Practical implications and recommendations

Considering that our research shows that the only important factor influencing the respondents' attitudes towards teaching programming is their previous experience with teaching programming, it follows that teachers need to be "thrown into the water": let them teach. Through their own teaching, they gain self-confidence and better self-esteem. The findings of the present study demonstrate that primary teachers can be competent teachers of programming for their pupils, as confirmed by the test results. A good level of computational thinking is a necessary foundation for building primary programming teaching on the basis of primary teachers, rather than on secondary computing teachers specialists.

This leads to one recommendation for the state policy of introducing the subject of computing: there is no need to wait until teachers are trained, can program, and somehow acquire a positive attitude towards programming. This cautious approach prevents teachers from gaining experience in teaching programming and consequently having a better attitude to teaching, which is key to initiating these changes.

In implementing the paradigm shift in the field of information and communication technology education towards computer education in Czechia, we have gained experience at a practical level, which we can formulate in the following paragraphs. In order to facilitate the transition from novice to competent programming teacher, it is imperative that several conditions are met:

Using age-appropriate visual block-oriented programming software for pupils, which enables rapid initial progress, as well as a wide range of varied activities including advanced ones. In other words, activities with low floors, high ceilings (Papert, 1980) and wide walls (Resnick, 2017), on which pupils will be able to develop basic programming approaches without being burdened with formal knowledge.

Creating high-quality textbooks that offer engaging programming activities for pupils, that are easy for teachers to understand, and that are accompanied by clear methodologies and detailed descriptions of teaching procedures. In schools in remote areas, where introductory face-to-face training is difficult to carry out, these materials must be sufficient for teachers to prepare themselves for teaching.

Running an introductory training system that will help teachers to familiarise themselves with the subject matter. Teachers need to gain self-confidence, and this will not be achieved through theoretical lectures. Instead, this objective needs to be realised through intensive short training in which teachers complete programming lessons in the role of pupils, using tasks from a primary school textbook.

It is necessary to provide space and comfort for teachers for innovative work, i.e., a kind of time cushion of several years, during which the curriculum will be expanded to encompass additional programming topics and methodologies. During this period, teachers should not be stressed by inspections. Furthermore, the implementation of tandem teaching or the provision of mentoring assistance from the methodological centre directly in the classroom can help reduce teachers' feelings of uncertainty.

It is imperative that teachers are adequately motivated. Teacher motivation plays a central role in the successful integration of programming and computing into school curricula. Research indicates that motivation significantly shapes the quality of implementation of programming education and the extent to which teachers feel confident in engaging with the topic (Wangenheim et al., 2017).

In order for programming to be successfully integrated into teaching, it is essential that teachers experience teaching programming lessons in practice;

by seeing their pupils' engagement and their own sense of success and meaningfulness, teachers become more motivated and genuinely feel like they are part of the change. The present research did not demonstrate the influence of any of the factors examined, including previous experience with programming teaching, on increasing the level of teachers' computational thinking. It can therefore be deduced that computational thinking at the level that was examined is already good before the first actual teaching. It is questionable whether teaching experience increases the teacher's didactic competences in this area, although our research did not specifically investigate this.

Limitations of the study

Only a specific group of teachers was included in the research, i.e., teachers from schools that participate in the Bebras contest and are therefore more involved in computing innovation. This fact must be considered in interpreting the results, even though more than a third of all schools were approached. Although the method of approaching teachers through the local organisers of the contest did not affect the final selection of the teachers, as the selection was not limited to teachers involved in the competition, the selection process is nonetheless a limiting filter to some extent.

Due to the selection of questions for the test to assess the level of the teachers' computational thinking, the test became less sensitive, as it turned out to contain questions that were too easy. However, the main interest of the research was not to assess the general level of teachers' computational thinking, but rather to assess whether teachers were able to understand the tasks given to their students. Using more difficult tasks would probably give a more accurate picture of the impact of individual factors, but with the risk that many teachers would not complete the test, resulting in the segment of the weakest and least confident respondents being missing from the research sample.

Possible future research

When sufficient time has elapsed since the introduction of the reform and teaching outcomes can be collected, further research could examine whether core primary teachers have good teaching outcomes and therefore sufficient pedagogical content knowledge.

It would be possible to compare the results of the present research with those of lower secondary computing teachers who also teach computing at primary level and therefore have previous computing training.

In order to further analyse and examine core primary teachers' attitudes towards teaching programming, in-depth interviews could be conducted with them.

Ethical statement

The research study was approved by the Ethical Research Committee of the Faculty of Education, University of South Bohemia, Czechia.

Disclosure statement

The authors have no conflict of interest to declare.

References

Bati, K., & İkbal Yetişir, M. (2021). Examination of Turkish middle school STEM teachers' knowledge about computational thinking and views regarding information and communications technology. *Computers in the Schools*, *38*(1), 57–73.

Blaho, A. (2012). Informatika v štátnom vzdelávacom programe [Informatics in a state educational programme]. In I. Kalaš (Ed.), *DidInfo 2012* (pp. 7–14). Katedra informatiky, FPV, Univerzita Mateja Bela MPC, Regionálne pracovisko v Banskej Bystrici UIPŠ, Školské výpočtové stredisko Banská Bystrica. http://www.didinfo.net/images/DidInfo/files/didinfo_2012.pdf

Blaho, A., & Salanci, Ľ. (2011). Informatics in primary school: Principles and experience. In I. Kalaš, & R. T. Mittermeid (Eds.), *Informatics in Schools. Contributing to 21st Century Education* (pp. 129–142). Springer.

Bosco, A., Santiveri, N., & Tesconi, S. (2019). Digital making in educational projects. *Center for Educational Policy Studies Journal, 9*(3), 51–73. https://doi.org/10.26529/cepsj.629

Bryndová, L. (2021). The approach of computer science teachers to the concepts of computational thinking and the implementation of its development in primary schools. *Journal of Technology and Information Education*, *13*(2), 151–163.

Dagienė, V., & Futschek, G. (2008). Bebras International Contest on Informatics and Computer Literacy: Criteria for good tasks. In R. T. Mittermeir, & M. M. Sysło (Eds.), *Informatics education – Supporting computational thinking* (pp. 19–30). Springer. https://doi.org/10.1007/978-3-540-69924-8_2

Gander, W. (2014) Informatics and general education. In Y. Gülbahar, & K. Erinç (Eds.), *Informatics in schools, teaching and learning perspectives* (pp. 1–7). Springer.

Geldreich, K., Talbot, M., & Hubwieser, P. (2018). Off to new shores: Preparing primary school teachers for teaching algorithmics and programming. In A. Mühling, & Q. Cutts (Eds.), *WiPSCE 2018: Proceedings of the 13th Workshop in Primary and Secondary Computing Education* (pp. 1–6). https://doi.org/10.1145/3265757.3265783

Günbatar, M.S., & Bakırcı, H. (2019). STEM teaching intention and computational thinking skills of pre-service teachers. *Educ Inf Technol*, *24*, 1615–1629. https://doi.org/10.1007/s10639-018-9849-5

I4ALL. (2025). *Informatics for All Coalition*. https://www.informaticsforall.org/

JU. (2017). *Jihočeská univerzita. PRIM project homepage*. Jihočeská univerzita v Českých Budějovicích. https://imysleni.cz

JU. (2024). *Bobřík informatiky, archiv úloh [Website of the Bebras Challenge contest, archive of Bebras tasks]*. Jihočeská univerzita v Českých Budějovicích. https://www.ibobr.cz/test/archiv

JU. (2025). *Bobřík informatiky [Website of the Bebras Challenge contest]*. Jihočeská univerzita v Českých Budějovicích. https://www.ibobr.cz/

K12CS. (2016). *K–12 Computer Science Framework*. Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative. http://www.k12cs.org

Kodelja, Z. (2021). Consequentialist reasons for some education reforms. *Center for Educational Policy Studies Journal*, *11*(2), 111–124. https://doi.org/10.26529/cepsj.1061

Korhonen, T., Salo, L., Laakso, N., Seitamaa, A., Sormunen, K., Kukkonen, M., & Forsström, H. (2023). Finnish teachers as adopters of educational innovation: Perceptions of programming as a new part of the curriculum. *Computer Science Education*, *33*(1), 94–116. https://doi.org/10.1080/08993408.2022.2095595

MŠMT. (2005). *The Education Act*. Ministerstvo školství, mládeže a tělovýchovy České republiky. https://www.msmt.cz/dokumenty-3/act-no-561-2004-collection-of-law-on-pre-school-basic

MŠMT. (2014). *Strategie digitálního vzdělávání* [Strategy of digital education]. Ministerstvo školství, mládeže a tělovýchovy České republiky. https://www.msmt.cz/uploads/DigiStrategie.pdf

MŠMT. (2021). *Rámcový vzdělávací program pro základní vzdělávání* [Frame educational programme for basic education]. Ministerstvo školství, mládeže a tělovýchovy České republiky. https://www.edu.cz/wp-content/uploads/2021/07/RVP-ZV-2021.pdf

NPI ČR. (2025). *Klíčová kompetence digitální* [Key digital competence]. National Pedagogical Institute of the Czech Republic. https://prohlednout.rvp.cz/zakladni-vzdelavani/klicove-kompetence/kdi

NÚV. (2005). *Rámcový vzdělávací program pro základní vzdělávání – základní verze* [Frame educational programme for basic education – basic version]. National Institute for Education of the Czech Republic. http://www.nuv.cz/file/493/

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.

Pavlas, T., Zatloukal, T., & Andrys, O. (2021). *Návrat žáků k prezenčnímu vzdělávání v základních a středních školách [Return of students to full-time education in primary and secondary schools]*. Czech School Inspectorate. https://www.csicr.cz/cz/Dokumenty/Tematicke-zpravy/Tematicka-zprava-%E2%80%93-Navrat-zaku-k-prezencnimu-vzdel

Perla, L., Vinci, V., & Agrati, L. S. (2025). The Italian way to the Europeanisation of teacher education: An analysis of reforms and the ongoing experience of digital transformation. *Center for Educational Policy Studies Journal*, *15*(1), 147–174. https://doi.org/10.26529/cepsj.1714

Piedade J., Dorotea N., Pedro, A. & Matos, J. F. (2020). On teaching programming fundamentals and computational thinking with educational robotics: A didactic experience with pre-service teachers. *Education Sciences*, *10*(9), Article 214. https://doi.org/10.3390/educsci10090214

PRIM. (2021). *Modelové školní vzdělávací programy* [Exemplary school educational programmes]. Jihočeská univerzita v Českých Budějovicích. https://imysleni.cz/svp

Rambousek, V., Štípek, J., & Wildová, R. (2015). ICT competencies and their development in primary and lower-secondary schools in the Czech Republic. *Procedia - Social and Behavioral Sciences*, *171*, 535–542.

Resnick, M. (2017). *Lifelong kindergarten: Cultivating creativity through projects, passion, peers, and play*. MIT Press.

Rich, P. J., Mason S. L., & O'Leary J. (2021). Measuring the effect of continuous professional development on elementary teachers' self-efficacy to teach coding and computational thinking. *Computers & Education*, *168*, Article 104196. https://doi.org/10.1016/j.compedu.2021.104196

Sun, L., & Zhou, D. (2023). K-12 teachers' programming attitudes among different disciplines: Analysis of influential factors. *Journal of Computer Assisted Learning*, *40*(2), 538–556.

Sysło. M., & Kwiatkowska, A. (2015). Introducing a new computer science curriculum for all school levels in Poland. In A. Brodnik (Ed.), *Informatics in schools. Curricula, competencies, and competitions* (pp. 141–154). Springer.

The Royal Society. (2012). *Shut down or restart? The way forward for computing in UK schools*. https://royalsociety.org/~/media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf

Tucker, A. (Ed.). (2003). *A model curriculum for K–12 computer science: Final report of the ACM K–12 task force curriculum committee*. Association for Computing Machinery. https://people.cs.vt.edu/~kafura/CS6604/Papers/K-12ModelCurr2ndEd.pdf

UMB. (2024). *DidInfo Homepage*. Fakulta prírodných vied, Univerzita Mateja Bela. http://www.didinfo.net/en

UNESCO. (2002). *Information and communication technology in education – A curriculum for schools and programme for teacher development*. UNESCO.

Vaníček, J. (2021). Towards a compulsory computing curriculum at primary and lower-secondary schools: the case of Czechia. In E. Barendsen, & C. Chytas (Eds.), *Informatics in schools. Rethinking computing education ISSEP 2021* (pp. 109–120). https://doi.org/10.1007/978-3-030-90228-5_9

Vaníček, J., & Šimandl, V. (2020). Participants' perception of tasks in an informatics contest. In K. Kori, & M. Laanpere (Eds.), *Informatics in Schools. Engaging Learners in Computational Thinking* (pp. 55–65). Springer. https://doi.org/10.1007/978-3-030-63212-0_5

Wangenheim, A. von, Wangenheim, C. G. von, Pacheco, F. S., Hauck, J. C. R., & Ferreira, M. N. F. (2017). Motivating teachers to teach computing in middle school: A case study of a physical computing taster workshop for K-12 teachers. *International Journal of Computer Science Education in Schools*, *1*(4), 35–49. https://doi.org/10.21585/ijcses.v1i4.17

Witherspoon, E. B., Schunn, C. D., Higashi, R. M., & Shoop, R. (2018). Attending to structural programming features predicts differences in learning and motivation. *Journal of Computer Assisted*

Learning, *34*(2), 115–128.

Yadav, A., Good, J., Voogt, J., & Fisser, P. (2017). Computational thinking as an emerging competence domain. In M. Mulder (Ed.), *Competence-based vocational and professional education: Bridging the worlds of work and education*, *23* (pp. 1051–1067). Springer International Publishing. https://doi.org/10.1007/978-3-319-41713-4_49

Zapata-Cáceres, M., Marcelino, P., El-Hamamsy, L., & Martín-Barosso, E. (2024). A Bebras Computational Thinking (ABC-Thinking) program for primary school: Evaluation using the competent computational thinking test. *Education and Information Technologies*, *29*(12), 14969–14998.

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Assessing Computational Thinking Practices and Engagement: Primary Teachers' Reflections on an Unplugged Activity

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Developing computational thinking in early primary education has gained increasing attention, with unplugged methods recognised as particularly effective for young learners. However, teachers' assessment of computational thinking, especially through process-oriented approaches, remains underexplored. The present study investigates how the participating Slovenian primary school teachers assessed computational thinking practices and students' engagement during an unplugged activity based on Bebras Challenge tasks. The results show that the teachers most frequently identified algorithmic thinking, pattern recognition and debugging, while decomposition and abstraction were observed less commonly. The activity received high ratings regarding the students' motivation and engagement, which several of the teachers attributed to the fact that it was conducted outdoors and involved physical movement. Collaboration and communication were also positively evaluated, although some teachers noted that competitiveness occasionally distracted the students. Overall, the findings support the feasibility of using process-oriented observation to assess computational thinking practices in unplugged settings, highlighting the need for targeted professional development to help teachers implement and assess computational thinking meaningfully. These insights contribute to the growing body of research on computational thinking assessment in primary education, underscoring the importance of providing teachers with structured support and context-specific tools.

Keywords: assessment, computational thinking, primary school, STEM education, unplugged

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Vrednotenje veščin računalniškega mišljenja in angažiranosti: refleksije učiteljev razredne stopnje o dejavnosti računalništva brez računalnika

Jakob Škrobar, Andrej Flogie, Alenka Lipovec in Nika Golob

Razvijanje računalniškega mišljenja v začetnih letih osnovnošolskega izobraževanja dobiva vse večjo pozornost, pri čemer je pristop računalništva brez računalnika posebej učinkovit pri mlajših učencih. Kljub temu ostaja vrednotenje računalniškega mišljenja na strani učiteljev, zlasti z uporabo procesno usmerjenih pristopov, premalo raziskano. V tej študiji analiziramo, kako so sodelujoči slovenski učitelji razredne stopnje vrednotili veščine računalniškega mišljenja in angažiranost učencev pri dejavnosti računalništva brez računalnika, zasnovani na nalogah tekmovanja Bober. Izsledki kažejo, da so učitelji najpogosteje prepoznali algoritmično mišljenje, vzorce ter prepoznavanje in odpravljanje napak, medtem ko sta bila dekompozicija in abstrakcija zaznani redkeje. Dejavnost je prejela visoke ocene glede motivacije in angažiranosti učencev, kar so učitelji pogosto povezovali z izvedbo na prostem in vključevanjem fizičnega gibanja. Sodelovanje in komunikacija sta bila prav tako pozitivno ocenjena, čeprav je nekaj učiteljev opozorilo, da je lahko učence občasno ovirala tekmovalnost. Ugotovitve kažejo, da je pri pristopu računalništva brez računalnika smiselno uporabiti procesno usmerjeno vrednotenje veščin računalniškega mišljenja, hkrati pa poudarjajo potrebo po profesionalnem usposabljanju, ki učiteljem omogoča učinkovito izvajanje in vrednotenje pristopov računalniškega mišljenja. Rezultati naše študije prispevajo k naraščajočemu korpusu raziskav o vrednotenju računalniškega mišljenja v osnovni šoli ter poudarjajo pomen zagotavljanja strukturirane podpore in kontekstno specifičnih orodij za učitelje.

Ključne besede: vrednotenje, računalniško mišljenje, osnovna šola, STEM-izobraževanje, računalništvo brez računalnika

Introduction

Over the past two decades, there has been growing interest in promoting computational thinking (CT) and integrating it into school curricula. This trend reflects the increasing recognition that, in a digitally driven world, students require CT skills to navigate and meet the demands of the twenty-first century (Yadav, Caeli, et al., 2022; Bocconi et al., 2022). Today, CT is widely acknowledged as a key problem-solving skill that can be applied in various disciplines and contexts (Humble & Mozelius, 2023; Rich et al., 2020; Shute et al., 2017; Wu et al., 2024; Yadav, Ocak, et al., 2022).

In the early years of primary education, educators and researchers often use the unplugged approach to introduce and foster CT among students (Bell & Vahrenhold, 2018; del Olmo-Muñoz et al., 2020; Škrobar et al., 2025). However, teachers must know how to assess CT in order to promote it effectively. Although there is widespread agreement on the importance of understanding computational foundations, research on how teachers assess CT in primary education, especially through process-oriented methods, remains limited and underexplored (Sherwood et al., 2024; Ukkonen et al., 2024).

In the following literature review, we examine key aspects of CT, focusing on unplugged approaches to promoting it, and current practices and challenges related to its assessment in the classroom.

Defining CT

The concept of CT has evolved over the decades. Seymour Papert (1980) first mentioned it in relation to children's interaction with computing. Later, Wing (2006) brought widespread attention to the concept, emphasising its importance as a foundational skill for everyone, not just computer scientists. She argued that, alongside reading, writing and arithmetic, CT must be added to every child's analytical ability (Wing, 2006, p. 8). Wing (2017, p. 8) later defined CT as "the thought process involved in formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out". She emphasised abstraction as its core component (Wing, 2017).

Despite growing research interest, there is still no consensus on the definition and components of CT (Bocconi et al., 2022). Within the framework of the block-based coding environment Scratch, Brennan and Resnick (2012) identified three essential dimensions of CT: CT concepts, which refer to the core programming constructs children need to understand; CT practices, which involve the problem-solving strategies children use while coding; and

CT perspectives, which encompass the attitudes and mindsets children develop through engaging in programming. In order to address the close relationship between CT and programming, Zhang and Nouri (2019, p. 3) defined CT as "a thought process, through skills that are fundamental in programming, to solve problems regardless of discipline". Shute et al. (2017, p. 151) further highlighted the transferability of CT across disciplines, defining it as "the conceptual foundation required to solve problems effectively and efficiently (i.e., algorithmically, with or without the assistance of computers) with solutions reusable in different contexts".

A recent study by Wu et al. (2024) compared the CT practices of decomposition, pattern recognition, abstraction and algorithm design with traditional problem-solving phases: preparation, analysis, production, verification and reapplication. Their findings suggest that CT stages fulfil similar functions to these established problem-solving steps. Given the potential overlap between metacognition and CT, Yadav, Ocak et al. (2022) concluded that there is an opportunity to exploit the potential of CT as a general problem-solving strategy in the service of broad learning. This perspective is particularly relevant given that research has consistently demonstrated the significant potential of problem-solving for learners (Antunović-Piton & Baranović, 2022; Hodnik & Kolar, 2022; Papadopoulos et al., 2022). Finally, Bers (2020) expanded the understanding of CT beyond problem-solving, framing it as an expressive process that allows for new ways to communicate ideas.

Given the diverse approaches to defining CT, the methods and tools used to promote it vary. Consequently, the integration of CT into educational curricula can take various forms. In the following section, we present the unplugged approach in more detail.

The unplugged approach to computational thinking

Unplugged activities represent pedagogical strategies designed to develop CT without using digital devices. These activities often involve logic games, physical movement, strings, cards or other tangible materials to help learners understand and represent core computational concepts such as algorithms (Brackmann et al., 2017). The origins of unplugged approaches in computer science education date back to the 1960s, when educators sought ways to understand computing without the aid of user-friendly interfaces (Caeli & Yadav, 2020). Despite technological advances, unplugged methods remain relevant due to their focus on cognitive processes rather than tools. Bell and Roberts (2016) emphasised that CT is rooted in human reasoning, rather than in machines. Similarly, Caeli and Yadav (2020) noted that problem-solving is fundamentally a human activity, with technology being a support.

Cortina (2015) argued that one of the key strengths of unplugged activities is their ability to engage learners actively. These activities are often designed to include physical interaction and promote collaboration, encouraging children to work together to solve problems. Furthermore, Weigend et al. (2019) highlighted the fact that unplugged activities can promote student creativity. They emphasised the value of these activities, particularly as an engaging introduction to new topics. Del Olmo-Muñoz et al. (2020) recommended introducing unplugged approaches before transitioning to plugged activities in order to support CT development effectively. They found that combining unplugged activities with subsequent plugged-in tasks enhances skill acquisition and boosts students' motivation, creating a dual benefit. More recently, Liu and Hu (2025) showed that unplugged programming is effective in rural Chinese schools, where students and teachers used simple materials to overcome limited access to technology, resulting in significant gains in the students' CT skills.

Despite these benefits, effectively measuring primary students' progress in CT remains a critical challenge for educators.

Teachers assessing CT

Assessment is the art of concluding evidence about what students know and/or can do (National Research Council, 2001). From this evidence-centred perspective, assessments create opportunities for students to demonstrate observable signs of their knowledge and skills, enabling educators and researchers to gain insight into students' understanding (Weintrop et al., 2021). However, assessing CT poses challenges. The existence of multiple correct solutions and the complexity of CT practices often render traditional assessment methods unsuitable (Yadav et al., 2015). Two key issues are particularly relevant: what to assess and how to assess it. Determining what to assess is complicated by the lack of consensus regarding the definition of CT and its core practices. In terms of how to assess, a variety of methods exist; however, formative assessment, despite its potential to guide learning, is not yet widely implemented in CT research (Ukkonen et al., 2025).

Poulakis and Politis (2021) identified three primary approaches to CT assessment: programming environments, CT-specific instruments and qualitative methods, including portfolios and observations. They noted that most tools target older students and emphasise programming, highlighting the need for age-appropriate methods. Similarly, Tang et al. (2020) categorised assessments into tests, portfolios, interviews and surveys, noting that traditional tests remain dominant. They observed that CT tends to be viewed as a learning outcome rather than a cognitive process. Furthermore, Fields et al. (2019) argued that such traditional approaches inadequately capture the learning process involved in CT, particularly when students engage in hands-on, project-based tasks.

Compared to traditional assessment methods, Ukkonen et al. (2024) promoted a process-oriented view of CT, in which students are assessed through their engagement with the material and their interactions with peers and teachers. Similarly, Sherwood et al. (2024) argued that process-oriented strategies, such as observing students while they work, listening to their discussions during collaboration, and posing reflective questions, are more suitable for young learners. Both studies emphasise that effectively assessing CT through such process-oriented methods requires adequate teacher preparation, particularly through targeted professional development (PD) programmes (Sherwood et al., 2024; Ukkonen et al., 2024). This includes helping teachers to recognise the relevance of CT to their practice and moving beyond generic overviews towards subject-specific integration (Yadav et al., 2017). Through PD programmes, researchers should therefore support teachers with concrete lesson plans and practical methods for assessing classroom implementations (Kónya & Kovács, 2022).

Aim of the study

Recent research highlights growing interest in process-oriented methods for assessing CT, particularly in early primary education. However, despite their growth (e.g., Sherwood et al., 2024; Ukkonen et al., 2025; Ukkonen et al., 2024), these methods remain underexplored in practice. The present study examines how primary teachers with limited prior experience in CT assessed students' engagement and CT practices through observation during a treasure hunt unplugged activity, implemented as part of a PD programme.

The study addresses the following research questions:

1. How do primary teachers assess CT practices in the context of an unplugged activity using observation?
2. What do teachers observe about students' engagement with and response to an unplugged CT activity?

Methods

Participants

The study sample consists of a non-randomised group of 18 teachers (see Table 1) from Slovenia who were participating in the project Innovative Pedagogy 5.0. All of the participating teachers taught either the second or third grade. Ten of the teachers implemented the activity in Grade 2 (with students approximately 8 years old), and eight in Grade 3 (with students approximately 9 years old). Across these implementations, 316 students participated (M = 17.56, SD = 5.12 students per class).

Table 1
Teachers participating in the study.

Teacher (pseudonym)	Grade level	Number of students participating
Ana	3	22
Maja	2	26
Tanja	2	11
Petra	2	15
Nika	3	23
Jasna	3	24
Lea	2	10
Špela	2	14
Urška	3	22
Katja	3	17
Miha	2	9
Mojca	3	15
Nina	3	21
Barbara	2	18
Andreja	2	15
Simona	3	22
Sonja	2	14
Maša	2	18

Instrument

We designed a post-lesson reflection instrument in which we asked the teachers to rate the extent to which the students demonstrated each of the five CT practices (i.e., algorithmic thinking, pattern recognition, debugging, decomposition and abstraction) using a five-point Likert scale (1 = Not at all, 5 = To a very large extent) and to provide written explanations through a targeted open-ended question (i.e., *"Please describe how the students demonstrated the skill of algorithmic thinking during the activity. Provide specific examples or tasks that supported this."*). Formal definitions of the five CT practices (Table 2), adapted from Zeng et al. (2023), were provided to guide the teachers. In the second part of the instrument, the teachers also rated student engagement, motivation, communication and collaboration on the same scale and provided open-ended reflections on the students' experiences.

Table 2

Descriptions of CT practices

CT Practice	Description
Algorithmic thinking	Planning and/or following structured steps to solve a problem.
Pattern recognition	Identifying patterns or regularities in data or a problem.
Decomposition	Breaking a problem into smaller, more manageable components.
Debugging	Identifying and resolving errors when a solution is incorrect.
Abstraction	Focusing on key information while ignoring irrelevant details in a problem.

Research design

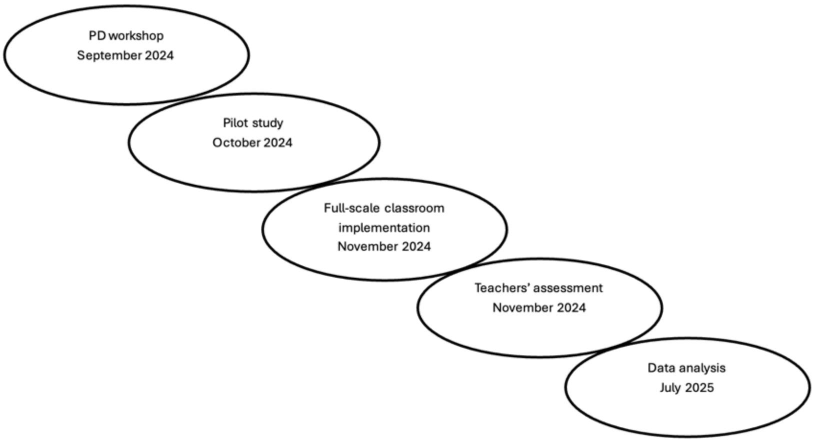
The study employed a mixed-methods research design to examine how the participating teachers reflected on an unplugged CT activity in early primary education. All of the teachers took part in a PD session in late September 2024, where they were introduced to unplugged activities designed to promote CT in early primary education (grades K–3). While the PD session familiarised the teachers with activities intended to promote CT, it did not specifically focus on training them to recognise and assess individual CT practices. The PD session followed the framework of the Teacher Training and Support for Innovative Pedagogy and Creativity Development model (Skrbinjek et al., 2024), which is designed to enhance teachers' professional competencies through a cyclical process involving participation in PD, classroom implementation, evaluation of activities, sharing the new practices with colleagues and self-assessment.

Following the PD workshop in late September 2024 and a pilot study in early October (Škrobar et al., 2025), the teachers implemented the activity in November 2024 as part of STEM subjects. Working in groups, the participating students solved Bebras Challenge tasks arranged as a treasure hunt throughout and around the school. Each location featured a hidden task sheet with four answer options, each linked to a letter. After solving the task, the students recorded the letter corresponding to their chosen answer. Correct answers led to the next location, while incorrect answers led to decoy locations, requiring students to reassess and retry the previous task. After completing all of the tasks, the students used the collected letters to form the final word. The teachers were asked to observe the activity closely; however, no structured observation list was provided at this stage, allowing them to rely on their natural impressions and interpretations of student behaviours. After the lesson, the teachers' impressions and reflections were gathered using the instrument presented in the previous subsection. A total of 22 structured responses were collected, of which 18 met the inclusion criteria (i.e., the assessment was completed and the teacher worked with Grade 2 or Grade 3 students) and were retained for analysis.

In order to analyse the data, a mixed-methods approach was used, combining qualitative and quantitative analyses in line with the nature of the responses. Quantitative responses from the Likert-scale items were analysed in SPSS (version 29.0.2.0) using descriptive statistics, while open-ended responses were analysed using Atlas.ti (version 9.24.0), following a deductive approach with magnitude coding (Saldaña, 2021). The responses were first organised according to the five predefined CT practices and the final question, which focused on the students' experiences. In magnitude coding, categories reflect the frequency of codes and are suitable for qualitative educational studies that also incorporate quantitative evidence of outcomes (Saldaña, 2021). For each CT practice, the responses were coded as either "practice seen in the activity" or "practice seen in the tasks". For the final open-ended question, sentiment analysis was applied within the magnitude coding framework in order to capture positive, negative and neutral perspectives expressed in the text (Saldaña, 2021). Two researchers independently coded the responses within the pre-existing framework. In order to ensure coding consistency, interrater reliability was calculated using Cohen's kappa, with results indicating high agreement ($\kappa = 0.82$). Discrepancies were resolved through discussion.

Figure 1

Overview of the research procedure



Results

Teachers' assessment of computational thinking practices

The teachers observed the students throughout the activity and completed the assessment instrument at the end of the lesson.

Table 3

Teachers' ratings of students' use of computational thinking practices

CT practice	*N*	Mean	Std. dev.	Median	IQR
Algorithmic thinking	18	3.83	1.10	4	2
Decomposition	18	3.33	1.24	3	2.25
Pattern recognition	18	3.83	1.10	4	2
Debugging	18	3.67	1.14	4	1.25
Abstraction	18	3.22	1.11	3	1.25

As shown in Table 3, the teachers most often recognised algorithmic thinking and pattern recognition in the activity (both $M = 3.83$, $SD = 1.10$), followed closely by debugging ($M = 3.67$, $SD = 1.14$). In contrast, decomposition ($M = 3.33$, $SD = 1.24$) and abstraction ($M = 3.22$, $SD = 1.11$) received comparatively lower scores. These quantitative ratings were further supported by the teachers' qualitative reflections, which provide insights into their assessment of the students' use of each CT practice during the activity. In the following paragraphs, we present the results from the open-ended questions.

The teachers most frequently identified algorithmic thinking in following the sequence of steps during the treasure hunt, where completing one task revealed the location of the next task ($N = 10$). As Mojca explained, *"Regarding the sequence of steps, the activity was designed so that once the students completed one task, it led them to the next. They had to follow the planned steps precisely until the final challenge."* Two other teachers observed algorithmic thinking when the students had to return to a previous location if they arrived at the wrong destination, requiring them to re-evaluate and follow the correct sequence of steps, which indicates debugging as part of algorithmic thinking. Furthermore, two teachers noted that algorithmic thinking was encouraged at a specific station involving a task where the students had to place stickers on an image of an aquarium in a fixed order. Four teachers did not respond to this item.

Four teachers explicitly observed decomposition within the structure of the activity itself. For example, Špela noted: *"To solve the activity, the students had to break it down into steps –read the instructions, identify the correct answer and follow the guidance provided – which led them to the next challenge."* Several of these responses resembled those describing algorithmic thinking, indicating that some of the teachers may have interpreted the two practices in overlapping ways. Nine teachers referred to specific tasks that required decomposition, with the aforementioned aquarium sticker task and the clothing preparation task mentioned most frequently. Tanja explained, *"The students had to break down the tasks at different locations into smaller steps in logical order; for example, the aquarium activity, the clothing task and the table setting."* Five teachers did not respond to this item.

Pattern recognition was most frequently observed in the students' interaction with specific tasks ($N = 8$). The most frequently mentioned example was the bracelet task, in which the students had to identify which of several circular arrangements matched the original linear sequence of coloured shapes. Seven teachers noted that the structure of the overall activity also reinforced pattern recognition. Most of them explained that the students moved from one station to the next by following a recurring pattern: each correctly solved task revealed the location of the next task. Others highlighted more strategic uses of pattern recognition. Andreja observed that "*the students recognised patterns by reflecting on where they had already been and what they had already checked; they used these patterns to infer the location of the next station*." Similarly, Miha noted that "*the students recognised recurring features while testing different solutions, which helped them determine the correct answer*". Three teachers did not respond to this item.

Debugging was most frequently observed when the students had to return to a previous station after solving a task incorrectly ($N = 13$). As Mojca described, "*Tasks offered four possible answers. Only one was correct, while the other three led to dead ends. When the students arrived at a location without a new challenge, they realised their solution was incorrect. They then had to return to the original task and try again. On the second attempt, they usually read the problem more carefully and approached the solution with greater focus.*" Two teachers also recognised debugging in the process of solving tasks themselves. Simona mentioned that it occurred "*while solving tasks*", without further elaboration. At the same time, Maša noted that "*the students developed debugging skills by selecting from possible answers, excluding less likely options, and trying out alternatives.*" Three teachers did not respond to this item.

The teachers frequently observed abstraction in the students' task engagement ($N = 10$). The most frequently mentioned tasks required the students to focus on essential features while ignoring irrelevant details, such as selecting an image that matched a given set of criteria or identifying a specific house based on a limited number of visual elements. Some of the teachers provided more general reflections but still included tasks. Jasna noted: "*The students had to focus on essential information that was critical for solving the task and ignore everything else.*" Two teachers described the use of the abstraction in the activity more broadly. Nika wrote: "*The students tried to solve tasks quickly and efficiently. They filtered out irrelevant information, chose a reader, thought aloud, coordinated with each other… and identified the most likely solution.*" In comparison, Lea reflected on attention: "*When they reached a location where they had made a mistake, they knew they had to look more carefully at the previous station and pay closer attention.*" Six teachers did not respond to this item.

Overall, the quantitative data show that teachers identified algorithmic thinking, pattern recognition and debugging more frequently than decomposition and abstraction. These findings are supported by the qualitative responses, where decomposition and abstraction were the most frequently left unanswered. The teachers primarily identified algorithmic thinking and debugging in the overall structure of the activity, while pattern recognition was observed both in the structure and in specific tasks. In contrast, decomposition and abstraction were mentioned primarily in relation to individual tasks, rather than the overall activity.

Students' experience of the activity

In addition to assessing CT practices, the teachers also assessed the students' overall experience of the activity, focusing on motivation, engagement, collaboration and communication.

Table 4
Teachers' ratings of students' experience of the activity

Dimension	*N*	Mean	Std. dev.	Median	IQR
Engagement	18	4.61	0.92	5	0
Motivation	18	4.89	0.47	5	0
Communication	18	4.39	0.92	5	1
Collaboration	18	4.50	0.79	5	1

As shown in Table 4, motivation received the highest mean rating (M = 4.89, SD = 0.47), followed by engagement (M = 4.61, SD = 0.92). Collaboration (M = 4.50, SD = 0.79) and communication (M = 4.39, SD = 0.92) received slightly lower ratings. As in the previous subsection, the teachers' open-ended responses provided additional insights into the students' experiences during the activity.

We received thirteen positive reflections, four mixed assessments and one negative response. The teachers frequently described the students as "*enthusiastic*", noted that the activity was "*fun*" and commented that the students enjoyed it. For instance, Špela reported: "*They said this was the best math lesson so far and asked when we would do it again. They were delighted.*" Jasna similarly noted that "*the students were highly motivated to work. Ultimately, they expressed a desire to do similar tasks more often.*" Petra added that the activity was novel and enjoyable for the students: "*They found it fun and did not feel like they were learning. They want to work this way more often.*"

Several teachers (N = 6) emphasised that the students' motivation increased because the activity took place outdoors. As Tanja explained, "*Most of the students said it was fun. Since we had a sunny day, we conducted the activity outside, which the students especially enjoyed.*"

Three teachers also highlighted the fact that the students were motivated because the activity involved physical movement. Miha noted that the students were "*excited about the activity because it was new and involved a lot of movement*". Two teachers added that the element of mystery and searching for clues also motivated many of the students. For example, Barbara shared that her students asked: "*When will we be detectives again?*"

Three teachers expressed general satisfaction with the activity, but also noted that some of the students treated it as a competition, which occasionally led to students being less focused and rushing. Lea commented: "*The students were very committed to solving the tasks; they found them difficult but interesting. However, I repeatedly told them that time was unimportant, and they rushed because they wanted to be the first.*"

Only one teacher provided a negative reflection. Sonja explained: "*My students are poor readers and did not attempt to solve the problems. Instead, they looked at the possible answers and guessed their way to the next station and final solution.*"

In summary, both the quantitative ratings and the qualitative reflections indicate that most of the students responded positively to the activity. High ratings of motivation and engagement were reported, with outdoor implementation, physical movement and mystery as contributing factors. A few of the teachers raised concerns about the students rushing due to competitive behaviour, and one reported difficulty due to the students' poor reading skills. However, the overall feedback suggests that the activity was well received and offered an enjoyable learning experience for most of the participants.

Discussion

In the present study, we examined how primary school teachers assessed CT practices and students' experiences of the activity following their observation of a treasure hunt. The next section presents the findings related to the two research questions.

Addressing teachers' assessment of computational thinking practices (RQ1)

Regarding CT practices, the teachers most frequently assessed evidence of algorithmic thinking, pattern recognition and debugging during the activity, while decomposition and abstraction were noted less often. These findings align with those of Rich et al. (2020), who found that, following a PD session presenting four CT practices, eight primary teachers most frequently incorporated debugging and patterns in their classroom implementations, while abstraction and decomposition were less commonly framed, prompted or reflected upon by teachers. In the following paragraphs, we examine each practice in greater detail.

The teachers in our study frequently identified algorithmic thinking. Primary teachers tend to be familiar with algorithms, which are often introduced through everyday tasks such as sequencing routines or designing simple, step-by-step instructions (Rich et al., 2021). Notably, the teachers in our study often described decomposition in a manner closely aligned with algorithmic thinking when assessing the activity. This alignment in teacher responses suggests an understanding consistent with Wu et al. (2024), who argue that decomposition represents the initial phase of problem solving, identifying sub-problems, while algorithmic thinking constitutes the final phase, involving the formulation or execution of step-by-step procedures to reach a solution. Four teachers in the present study explicitly described this sequential relationship, where decomposition involved breaking down the task and was directly followed by algorithmic processes to solve it. Furthermore, two teachers presented algorithmic thinking in terms of debugging algorithms. This conflation of algorithmic thinking with decomposition and debugging highlights the overlapping nature of CT practices (Ukkonen et al., 2024). It also underscores the need for greater conceptual clarity in defining the practices.

Decomposition appeared to be less evident to the teachers than algorithmic thinking when assessing the activity. Most of them recognised decomposition in tasks such as setting the table. Humble and Mozelius (2023) also noted that some teachers perceived decomposition as challenging, suggesting that while it may be conceptually easier to grasp, it remains unfamiliar to many students and more challenging to apply in practice. Similarly, Norwegian teachers have called for more precise guidance on assessing decomposition (Ukkonen et al., 2025). In contrast, teachers from the Midwestern United States appeared more successful in recognising and assessing decomposition in classroom contexts (Ukkonen et al., 2024).

Debugging emerged as the most coherently described CT practice in the teachers' reflections. The majority of the teachers explained that when the students selected an incorrect answer, they were required to return to the previous station and attempt the task again. This observation aligns with the findings of Humble and Mozelius (2023), who noted that debugging is likely the most accessible component of CT to implement with young learners. Teachers in their study emphasised that debugging could help students develop patience as they search for and resolve errors, a point similarly noted by several teachers in our study. Brennan and Resnick (2012) likewise observed that outcomes in programming rarely unfold as expected, making it essential for children to develop strategies to anticipate and manage problems. They described trial and error as one of the approaches to debugging. Although a few of the teachers in our study mentioned this method, it was often framed negatively, suggesting that teachers preferred more deliberate forms of debugging in which students actively identify and correct errors through reasoning rather than guesswork.

Pattern recognition was similarly prominent, with the teachers frequently identifying it in both the individual tasks and the overall structure of the activity. The patterns within the tasks appeared straightforward to identify, while solving an activity based on patterns seems to represent a more advanced application of this practice, one that few teachers noted in the activity. In contrast to our results, Ukkonen et al. (2024) found that teachers experienced difficulties in assessing pattern recognition. This discrepancy may be due to the specific structure of the tasks in our activity, which likely made instances of pattern recognition more salient than in the lessons observed in the aforementioned study.

Wing (2017) argued that abstraction is the highest-level and most important CT practice, as computer science fundamentally involves abstraction processes. However, it appears to be one of the hardest practices to assess (Ukkonen et al., 2024). Abstraction does not easily align with concrete classroom tasks, which may explain why teachers often find it challenging to recognise and assess in practice. For example, Rich et al. (2020) found that teachers made fewer connections to abstraction when integrating CT into mathematics and science instruction than other practices. In our study, abstraction was most often recognised in individual tasks, with only two teachers connecting it to the overall activity. In those examples, the teachers equated abstraction with speed and attention. This conflation suggests that the two teachers interpreted abstraction through observable student behaviours rather than through the students' mental processes of focusing on the main ideas of the problem or activity.

Overall, our findings suggest that the teachers were relatively successful in observing and assessing CT practices through the students' behaviours, which aligns with the process-oriented approach to CT assessment described by Sherwood et al. (2024) and Ukkonen et al. (2024). In our PD session, we introduced teachers to unplugged activities but did not focus explicitly on assessment. To further support teachers in developing assessment skills, Ukkonen et al. (2025) suggest that targeted PD can help alleviate teachers' challenges when assessing CT. Similarly, Sherwood et al. (2024) reported that PD programmes targeting assessment skills enhanced teachers' confidence and understanding in evaluating students' use of CT.

Reflecting on the students' experience of the activity (RQ2)

The results show that the unplugged treasure hunt activity was motivating and fostered active engagement among the students. Unplugged methods are widely considered suitable for young learners, particularly those who are just beginning to develop CT skills (Looi et al., 2018). Research also indicates that students in early primary education, especially girls, find unplugged activities more motivating than plugged ones (del Olmo-Muñoz et al., 2020). Cortina (2015) argued that a significant factor contributing to the widespread adoption of unplugged methods in CT is their ability to engage children physically. These activities often incorporate movement, aligning with learning theories that advocate learning through movement, which encourages students to break away from typical classroom routines (Weigend et al., 2019). Several teachers in our study also highlighted the fact that the students were both motivated and engaged because the activity took place outside the classroom and involved physical movement.

The teachers also gave high ratings to the students' collaboration and communication during the activity. Cortina (2015) emphasised that unplugged activities foster group work, encouraging children to collaborate in solving problems. Similarly, Weigend et al. (2019) argued that unplugged activities provide a foundation for cooperation and teamwork, thereby supporting the development of communication skills. While prior studies support the use of unplugged methods to foster engagement and collaboration, our findings suggest a potential drawback: a few of the teachers observed that the students' competitiveness occasionally undermined their focus, resulting in rushed problem-solving. Our observation that competitiveness sometimes disrupts students' focus highlights the need to design collaborative tasks that ensure fairness and maintain attention on learning outcomes.

Overall, our findings affirm the value of unplugged methods for promoting motivation, engagement, communication and collaboration, while also underscoring the need for thoughtful activity design to mitigate potential challenges.

Conclusion

In the present study, we explored how Slovenian primary school teachers recognised CT practices and evaluated student engagement during an unplugged treasure hunt learning activity. Our findings advance the limited body of work on process-oriented methods for assessing CT in early primary education. The results show that the participating teachers most frequently identified algorithmic thinking, pattern recognition and debugging, while abstraction and decomposition were less visible. This pattern suggests that abstraction and decomposition may be inherently more challenging to detect. The teachers also tended to conflate algorithmic thinking with decomposition and debugging, which is not surprising given the overlapping nature of CT practices (Ukkonen et al., 2024). The high ratings of the students' engagement, motivation, collaboration and communication, together with the teachers' qualitative reflections, indicate that physical activity, group-based activities and outdoor learning environments can effectively foster these aspects.

While these findings provide valuable insights, several limitations should be acknowledged. First, the study relied on the teachers' self-reported reflections without a structured observation protocol, which restricts the depth and validity of the findings. Self-reported reflections are inherently subjective and may overstate student engagement, motivation, collaboration and communication. Although triangulated with quantitative data, the qualitative insights are influenced by the participants' reporting styles and the researchers' interpretations. Second, given that the results are primarily descriptive and were not triangulated with classroom observations or student outcomes, and considering the narrow sample from a single national context within the project Innovative Pedagogy 5.0, the generalisability of the findings is limited.

Future research should address these limitations by developing systematic strategies to support teacher monitoring of CT practices, such as observation rubrics, annotated exemplars and video-based reflection. There is also potential to design hybrid assessment approaches that integrate teacher perceptions with tangible student artefacts, allowing for triangulation between observed behaviour and demonstrated problem-solving outputs. Given our finding that teachers conflate different practices, it is essential to ensure that teachers have a conceptual clarity of CT practices. However, instead of treating this overlap as a limitation, future work should focus on examining the shared properties among CT practices and investigating their similarities and distinctions more closely.

To conclude, based on the results of the present study, we recommend the inclusion of more unplugged activities in early primary curricula and call for PD programmes that strengthen teachers' practical and conceptual understanding of CT practices and their assessment.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of the Institute of Contemporary Technologies, University of Maribor.

Disclosure statement

The authors declare no relevant financial or non-financial interests and report no conflicts of interest.

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Literature

Antunović-Piton, B., & Baranović, N. (2022). Factors affecting success in solving a stand-alone geometrical problem by students aged 14 to 15. *Center for Educational Policy Studies Journal*, *12*(1), 55–79. https://doi.org/10.26529/cepsj.889

Bell, T., & Roberts, J. (2016). Computational thinking is more about humans than computers. *Set: Research Information for Teachers*, *2016*(1), 3–7. https://doi.org/10.18296/set.0030

Bell, T., & Vahrenhold, J. (2018). CS unplugged – How is it used, and does it work? In H. J. Böckenhauer, D. Komm, & W. Unger (Eds.), *Adventures between lower bounds and higher altitudes* (pp. 497–521). Springer. https://doi.org/10.1007/978-3-319-98355-4_29

Bers, M. U. (2020). *Coding as a playground: Programming and computational thinking in the early childhood classroom* (2nd ed.). Routledge. https://doi.org/10.4324/9781003022602

Bocconi, S., Chioccariello, A., Kampylis, P., Dagienė, V., Wastiau, P., Engelhardt, K., Earp, J., Horvath, M. A., Jasutė, E., Malagoli, C., Masiulionytė-Dagienė, V., & Stupurienė, G. (2022). *Reviewing computational thinking in compulsory education*. Publications Office of the European Union. https://doi.org/10.2760/126955

Brackmann, C. P., Román-González, M., Robles, G., Moreno-León, J., Casali, A., & Barone, D. (2017). Development of computational thinking skills through unplugged activities in primary school. In E. Barendsen, & P. Hubwieser (Eds.), *Proceedings of the 12th Workshop on Primary and Secondary Computing Education – WiPSCE'17* (pp. 65–72). Association for Computing Machinery. https://doi.org/10.1145/3137065.3137069

Brennan, K., & Resnick, M. (2012, April 13–17). *New frameworks for studying and assessing computational thinking* [Paper presentation]. Annual Meeting of the American Educational Research Association, Vol. 1, Vancouver, Canada.

Caeli, E. N., & Yadav, A. (2020). Unplugged approaches to computational thinking: A historical perspective. *TechTrends*, *64*(1), 29–36. https://doi.org/10.1007/s11528-019-00410-5

Cortina, T. J. (2015). Reaching a broader population of students through "unplugged" activities. *Commun. ACM*, *58*(3), 25–27. https://doi.org/10.1145/2723671

Del Olmo-Muñoz, J., Cózar-Gutiérrez, R., & González-Calero, J. A. (2020). Computational thinking through unplugged activities in early years of primary education. *Computers & Education*, *150*, Article 103832. https://doi.org/10.1016/j.compedu.2020.103832

Fields, D. A., Lui, D., & Kafai, Y. B. (2019). Teaching computational thinking with electronic textiles: Modeling iterative practices and supporting personal projects in exploring computer science. In S.-C.

Kong, & H. Abelson (Eds.), *Computational Thinking Education* (pp. 279–294). Springer. https://doi.org/10.1007/978-981-13-6528-7_16

Hodnik, T., & Kolar, V. M. (2022). Problem solving and problem posing: From conceptualisation to implementation in the mathematics classroom. *Center for Educational Policy Studies Journal*, *12*(1), 7–12. https://doi.org/10.26529/cepsj.1418

Humble, N., & Mozelius, P. (2023). Grades 7–12 teachers' perception of computational thinking for mathematics and technology. *Frontiers in Education*, *8,* Article 956618. https://doi.org/10.3389/feduc.2023.956618

Kónya, E., & Kovács, Z. (2022). Management of problem solving in a classroom context. *Center for Educational Policy Studies Journal*, *12*(1), 81–101. https://doi.org/10.26529/cepsj.895

Liu, W., & Hu, L. (2025). Unplugged programming practice in Chinese rural primary schools: A method to foster students' computational thinking and resilience. *Interactive Learning Environments*, *33*(1), 387–407. https://doi.org/10.1080/10494820.2024.2349883

Looi, C.-K., How, M.-L., Longkai, W., Seow, P., & Liu, L. (2018). Analysis of linkages between an unplugged activity and the development of computational thinking. *Computer Science Education, 28*(3), 255–279. https://doi.org/10.1080/08993408.2018.1533297

National Research Council. (2001). *Knowing what students know: The science and design of educational assessment.* National Academies Press.

Papadopoulos, I., Patsiala, N., Baumanns, L., & Rott, B. (2022). Multiple approaches to problem posing: Theoretical considerations regarding its definition, conceptualisation, and implementation. *Center for Educational Policy Studies Journal*, *12*(1), 13–34. https://doi.org/10.26529/cepsj.878

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books, Inc.

Poulakis, E., & Politis, P. (2021). Computational thinking assessment: Literature review. In T. Tsiatsos, S. Demetriadis, A. Mikropoulos, & V. Dagdilelis (Eds.), *Research on e-learning and ICT in education: Technological, pedagogical and instructional perspectives* (pp. 111–128). Springer International Publishing. https://doi.org/10.1007/978-3-030-64363-8_7

Rich, K. M., Yadav, A., & Larimore, R. A. (2020). Teacher implementation profiles for integrating computational thinking into elementary mathematics and science instruction. *Education and Information Technologies*, *25*(4), 3161–3188. https://doi.org/10.1007/s10639-020-10115-5

Rich, P. J., Mason, S. L., & O'Leary, J. (2021). Measuring the effect of continuous professional development on elementary teachers' self-efficacy to teach coding and computational thinking. *Computers & Education*, *168*, Article 104196. https://doi.org/10.1016/j.compedu.2021.104196

Saldaña, J. (2021). *The coding manual for qualitative researchers*. SAGE Publications Ltd.

Sherwood, H., Culp, K. M., Ferguson, C., Kaiser, A., Henry, M., & Negron, A. (2024). Teacher practices for formatively assessing computational thinking with early elementary learners. *Education Sciences*, *14*(11), Article 1250. https://doi.org/10.3390/educsci14111250

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational Research Review*, *22*, 142–158. https://doi.org/10.1016/j.edurev.2017.09.003

Skrbinjek, V., Vičič Krabonja, M., Aberšek, B., & Flogie, A. (2024). Enhancing teachers' creativity with an innovative training model and knowledge management. *Education Sciences*, *14*(12), Article 1381. https://doi.org/10.3390/educsci14121381

Škrobar, J., Golob, N., & Flogie, A. (2025). Promoting computational thinking in primary education: An unplugged approach with team-based activity. In L. Gómez Chova, C. González Martínez, & J. Lees (Eds.), *Proceedings of the 19th International Technology, Education and Development Conference – INTED2025* (pp. 3528–3532). IATED. https://doi.org/10.21125/inted.2025.0895

Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. (2020). Assessing computational thinking: A systematic review of empirical studies. *Computers & Education*, *148*, Article 103798. https://doi.org/10.1016/j.compedu.2019.103798

Ukkonen, A., Pajchel, K., & Mifsud, L. (2025). Teachers' understanding of assessing computational thinking. *Computer Science Education*, *35*(4), 794–819. https://doi.org/10.1080/08993408.2024.2365566

Ukkonen, A., Yadav, A., Pajchel, K., & Xenofontos, C. (2024). Elementary teachers assessing computational thinking. *Journal of Technology and Teacher Education*, *32*(4), 521–546. https://www.learntechlib.org/primary/p/225061/

Weigend, M., Vaníček, J., Pluhár, Z., & Pesek, I. (2019). Computational thinking education through creative unplugged activities. *Olympiads in Informatics*, *13*, 171–192. https://doi.org/10.15388/ioi.2019.11

Weintrop, D., Rutstein, D., Bienkowski, M., & McGee, S. (2021). Assessment of computational thinking. In A. Yadav, & U. Berthelsen (Eds.), *Computational thinking in education* (pp. 90–111). Routledge. https://doi.org/10.4324/9781003102991-6

Wing, J. M. (2006). Computational thinking. *Commun. ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Wing, J. M. (2017). Computational thinking's influence on research and education for all. *Italian Journal of Educational Technology*, *25*(2), Article 2. https://doi.org/10.17471/2499-4324/922

Wu, T.-T., Asmara, A., Huang, Y.-M., & Permata Hapsari, I. (2024). Identification of problem-solving techniques in computational thinking studies: Systematic literature review. *Sage Open*, *14*(2), Article 21582440241249897. https://doi.org/10.1177/21582440241249897

Yadav, A., Burkhart, D., Moix, D., Snow, E., Bandaru, P., & Clayborn, L. (2015). *Sowing the seeds: A landscape study on assessment in secondary computer science education*. Computer Science Teachers Association.

Yadav, A., Caeli, E. N., Ocak, C., & Macann, V. (2022). Teacher education and computational thinking: Measuring pre-service teacher conceptions and attitudes. In B. A. Becker, K. Quille, M.-J. Laakso, & E. Barendsen (Eds.), *Proceedings of the 27th ACM Conference on Innovation and Technology in Computer Science Education* (pp. 547–553). Association for Computing Machinery. https://doi.org/10.1145/3502718.3524783

Yadav, A., Good, J., Voogt, J., Fisser, P. (2017). Computational thinking as an emerging competence domain. In M. Mulder (Ed.), *Competence-based vocational and professional education. technical and vocational education and training: Issues, concerns and prospects* (pp. 1051–1067). Springer. https://doi.org/10.1007/978-3-319-41713-4_49

Yadav, A., Ocak, C., & Oliver, A. (2022). Computational thinking and metacognition. *TechTrends*, *66*(3), 405–411. https://doi.org/10.1007/s11528-022-00695-z

Zeng, Y., Yang, W., & Bautista, A. (2023). Computational thinking in early childhood education: Reviewing the literature and redeveloping the three-dimensional framework. *Educational Research Review, 39*, Article 100520. https://doi.org/10.1016/j.edurev.2023.100520

Zhang, L., & Nouri, J. (2019). A systematic review of learning computational thinking through Scratch in K-9. *Computers & Education*, *141*, Article 103607. https://doi.org/10.1016/j.compedu.2019.103607

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Video Games and the Development of Computational Thinking

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For many, video games represent a popular form of entertainment. However, numerous research studies confirm that playing video games is a complex process with a significant educational component in addition to entertainment. Several researchers, including Papert and other authorities, have argued that we can learn a great deal about the learning process through video games, either by playing them ourselves or by observing others play and discussing the processes and thinking strategies involved. The present paper aims to explore the potential of commercial off-the-shelf video games, particularly with regard to developing computational thinking. Five games representing different genres were analysed using standard content analysis. The analysis was based partly on the researchers' own gameplay, but primarily on observing and interviewing other participants during their gameplay. Four experienced video game players, all adults aged between 26 and 32, were invited to join the study as part of a purposefully formed sample. They were observed while playing and engaged in conversations about their practices and thought processes. The goal was to identify cognitive processes perceived as intrinsically related to computational thinking. The findings support claims made by Papert and Gee, demonstrating that video games can significantly enhance our understanding of computational thinking itself. Based on the analysis, it was concluded that video games offer rich opportunities for the development of certain components of computational thinking, particularly algorithmic thinking, decomposition and evaluation, as well as generalisation and abstraction. The findings are primarily relevant to adult learners, but ideas for school-age students are also discussed. While considering these ideas, we noted another phenomenon that intriguingly aligns with our other area of

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research, that is, the development of structural thinking within school informatics.[3]

Keywords: content analysis, development of computational thinking, informatics education, qualitative research, video games

3 In some countries, informatics is referred to as computer science or computing; however, in Slovakia, it is called informatics and is a mandatory school subject from Year 3 to Year 11, which includes all learners aged between 8 and 17.

Videoigre in razvoj računalniškega mišljenja

Mária Čujdíková in Ivan Kalaš

Za veliko posameznikov so videoigre priljubljena oblika zabave, številne raziskave pa potrjujejo, da je igranje videoiger zapleten proces, ki poleg zabave vključuje tudi pomemben izobraževalni vidik. Številni raziskovalci, med njimi Papert in drugi strokovnjaki, trdijo, da se lahko prek videoiger veliko naučimo o procesu učenja, in sicer tako, da jih igramo sami ali z opazovanjem drugih pri igranju ter razpravo o procesih in miselnih strategijah, ki so vključeni v igranje. Namen tega članka je raziskati potencial komercialnih videoiger, ki so prostodostopne na trgu, zlasti v povezavi z razvojem računalniškega mišljenja. Analizirali smo pet iger različnih žanrov z uporabo standardne vsebinske analize. Ta je deloma temeljila na lastnem igranju raziskovalcev, predvsem pa na opazovanju in intervjuvanju drugih udeležencev med njihovim igranjem. Štirje izkušeni igralci videoiger, vsi odrasli, stari od 26 do 32 let, so bili povabljeni k sodelovanju v študiji kot namenski vzorec. Opazovali smo jih med igranjem ter se z njimi pogovarjali o njihovih praksah in miselnih procesih. Cilj je bil identificirati kognitivne procese, ki so videti neločljivo povezani z računalniškim mišljenjem. Ugotovitve podpirajo trditve Paperta in Geeja, saj kažejo, da lahko videoigre pomembno prispevajo k razumevanju računalniškega mišljenja. Na podlagi analize smo ugotovili, da videoigre ponujajo bogate možnosti za razvoj nekaterih komponent računalniškega mišljenja, zlasti algoritmičnega mišljenja, razčlenjevanja in vrednotenja ter posploševanja in abstrakcije. Ugotovitve so relevantne predvsem za odrasle učence, vendar v raziskavi obravnavamo tudi ideje za učence, ki še hodijo v šolo. Pri obravnavanju teh idej smo opazili še en pojav, ki se zanimivo ujema z našim drugim področjem raziskovanja, tj. razvojem strukturne miselnosti v okviru šolske informatike.[4]

Ključne besede: vsebinska analiza, razvoj računalniškega mišljenja, izobraževanje na področju informatike, kvalitativna raziskava, videoigre

4 V nekaterih državah se za označevanje šolskega predmeta informatika uporablja izraz računalništvo ali računalniška znanost, na Slovaškem pa ga imenujemo informatika in je obvezen predmet od 3. razreda osnovne šole do 3. letnika srednje šole, kar torej vključuje vse učence, stare od približno 8 do 17 let.

Introduction

Video games are intrinsic to today's digital age and serve as a popular form of entertainment for many individuals. However, a growing body of research confirms that playing video games is not merely a form of entertainment but a complex process with strong educational implications. Video games facilitate the development of various cognitive skills, such as attention (Bediou et al., 2023; González-Pérez et al., 2025; Nguyen & Bavelier, 2023; Oei & Patterson, 2013; Ruiz-Marquez et al., 2019; Sattar et al., 2021), visual working memory (Blacker et al., 2014; Martinez et al., 2022; Sattar et al., 2021), decision-making (Reynaldo et al., 2021) and problem solving (Bediou et al., 2023; Gyaurov et al., 2022; Reynaldo et al., 2021). Players often engage in challenging scenarios that require complex thinking and promote continuous active and critical learning.

In his influential book *What Video Games Have to Teach Us About Learning and Literacy*, Gee (2003) pointed out that the principles of learning are effectively mastered in video games, and we can learn a great deal about learning from them. He argues that the principles of learning inherent in well-designed games closely align with the most effective theories of learning. Similarly, Papert (1998) discussed how video games foster thinking in children. He suggested that by observing children playing computer games and discussing their actions, we can gain valuable insights into their cognitive processes. In another work (Papert, 1995), he stated that computer games encourage children to tackle difficult problems that they might not otherwise encounter.

In our project, we aim to explore what commercial off-the-shelf (COTS) video games can teach us about informatics education. More specifically, we seek to explore the thought processes involved in playing these games from a computational thinking (CT) perspective. But what is CT? Wing (2006) describes it as a way of thinking employed by computer scientists. She argues that this way of thinking is essential for everyone, not just computer scientists, and highlights its relevance across various disciplines and everyday activities. In her words: "Computational thinking involves solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science" (p. 33). In the same publication, she elaborates that CT is "a way that humans, not computers, think. Computational thinking is a way humans solve problems; it is not trying to get humans to think like computers. Computers are dull and boring; humans are clever and imaginative. We humans make computers exciting" (p. 35).

As early as 1980, Papert wrote about the exciting new avenues of thinking and *thinking about thinking* opened up by computers in his seminal work

Mindstorms: Children, Computers, and Powerful Ideas. It is here that he first introduced the term CT, viewing it as a way of thinking closely linked to self-creation and experimentation within software environments. Later, during his lecture at the ICMI [5] Study Conference in Hanoi, he stated that the true power of CT lies in "the making and understanding of computational objects" (Papert, 2006, p. 8). According to him, these objects facilitate a deeper understanding, as we can engage with them similarly to our interactions with people. They possess properties and behaviours that we can comprehend, and through programming, we can participate in their co-creation by adding new behaviours or altering their properties.

Lodi and Martini (2021) note that Wing's perception of CT differs from that of Papert. They argue that Wing adopts a more technical approach to CT, viewing it as a tool for understanding the algorithmic structure of the world. In contrast, Papert emphasises its affective dimension, which is linked to the creation and exploration of one's own artefacts. According to Lodi and Martini, these two perspectives complement each other, together forming a comprehensive picture of what CT truly encompasses. Several authors also seek to understand not only what CT is but also its core components. Cansu and Cansu (2019) analysed how CT is perceived by different authors in scholarly publications and identified the following core components:

- *Abstraction* – the ability to step back from certain details to clarify and simplify the problem;
- *Decomposition* – breaking a problem down into smaller, clearer subproblems;
- *Algorithmic thinking* – working with uniquely executable schemes for solving related problems and reasoning about their properties;
- *Automation* – creating and employing schemes for the automated processing of repetitive situations;
- *Generalisation* – identifying patterns, similarities and connections and applying them in different contexts, as is also characteristic of an inquiry-based learning approach (Golob & Ungar, 2023).

Selby and Woollard (2013) added *evaluation* as another component of CT, understood as the ability to assess situations, solutions and processes in terms of their effectiveness and resource utilisation, as well as the ability to recognise and evaluate outcomes. Although Cansu and Cansu (2019) did not include *evaluation* as a component of CT, they did mention *reflection* as one of the practices used in this context. The *reflection* component involves identifying

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criteria and making accurate evaluations in relation to these criteria in order to effectively solve a problem.

In agreement with the referenced authors, we acknowledge that attempts to define a comprehensive concept of CT by identifying a suitable set of components are inherently approximate.[6] For the purposes of the present research project, however, we find this approach to be beneficial. We pose the following research question: *What opportunities for CT development do video games provide?* A qualitative design is employed to seek an answer, as we aim to understand the phenomenon under investigation rather than test predefined hypotheses (Creswell & Creswell, 2022). Several adult gamers were observed playing video games and then engaged in detailed discussions about their thought processes while playing and the problems they solved. In coding the collected data and conducting subsequent analysis, we employ the components presented by Cansu and Cansu (2019), extending them to include six preselected themes. We believe that our findings will enrich our understanding of cognitive processes in informatics and highlight the importance of playing video games in the context of CT development. The study focused on adult players, so the results primarily reflect the experiences of this age group. We hope that the results will be useful for future research projects, but above all that they will contribute to the evidence-based development of educational content for school informatics in an appropriate format. A similar call comes from Glasnović Gracin and Krišto (2022), albeit for different opportunities afforded by digital technologies. In our case, such contributions should be viewed as inspirations that require careful adaptation for younger learners, rather than direct evidence of how school-age students engage with COTS video games.

Method

The research question was addressed using content analysis of selected video games. According to Krippendorff (2004), this research strategy involves examining the content of a selected product to answer specific research questions. Historically, content analysis was primarily used to analyse documents, especially texts from print media. Today, however, it is also applied to the analysis of non-textual materials, such as paintings, films and artworks. Schmierbach (2009) and Malliet (2007) assert that it is a suitable tool for examining video games. Nevertheless, as these authors emphasise, it is crucial to respect the specificity of the medium under investigation. Unlike written texts or films, the course of a video game often depends on the particular player and their actions.

6 We will revisit this topic in the conclusions of the Discussion section.

Consequently, the player who engages with the video game is also a co-creator of the content being analysed.

Sample

This section highlights why we considered the sample in our study to be a two-dimensional structure. In one dimension, we focused on the individual video games included in the sample; in the other dimension, we considered the specific players, that is, the participants we observed while playing the games. We deliberately selected four young individuals (Creswell & Creswell, 2022) who were active video game players with extensive experience across various genres. They were prepared to be observed and interviewed about their practices and thought processes during gameplay. At the time of the research, they had recently played one or more games from our selection. It was also important that they not only agreed to participate in the research but also collaborated with us in the initial data analysis and formulation of our observations. The participants are characterised as follows:

- Martin, 32, is a graphic designer with a passion for video games that dates back to his childhood. He possesses extensive experience across various genres. His favourite games include KOTOR,[7] Beyond Good and Evil, the Dark Souls series, the Gothic series, Gris, Disco Elysium, Life is Strange, Deus Ex and Hades.
- Viktor, 26, is a PhD student in the Applied Informatics programme at our university, focusing on automated traffic tracking and object detection in both 2D and 3D environments. His relationship with gaming has been largely positive, and he has played games of various genres. Nowadays, he still enjoys gaming but plays less frequently, preferring more challenging games that he can invest hundreds of hours into improving. Some of his favourite games are Europa Universalis IV, Crusader Kings II, Victoria II, Baldur's Gate II: Shadows of Amn, Empire: Total War, Gothic and Team Fortress 2.
- Tomas, 32, graduated as an English language teacher and currently works as a bookseller. He has had extensive gaming experience since childhood. His favourite games include League of Legends, World of Warcraft, Fallout and Diablo.
- Adam, 27, is a PhD student focusing on future teachers' attitudes towards mathematics. He, too, has many years of experience playing video games. His favourite video games include Machinarium, Hollow Knight, Supraland, Hidden Folks and The Whispered World.

7 Star Wars: Knights of the Old Republic, commonly abbreviated as KOTOR.

A purposeful selection was employed in choosing the games. The goal was to select games from different genres to ensure that interesting opportunities for CT development were not overlooked. Two main considerations guided the selection. First, we focused on titles with higher cognitive complexity, which we expected would elicit a variety of problem-solving approaches and thought processes. Second, we focused on games that we intuitively recognised as containing a rich set of CT-related procedures. Additionally, we considered the recommendations of the participants and the games they had recently played, which allowed us to observe them in action. Five titles were selected that differ in genre and *game mechanics*.[8] Table 1 provides basic information about these titles. Our sample consisted exclusively of COTS video games intended for the general gaming audience.

Table 1

Basic information on the selected games, source https://howlongtobeat.com. The game ID in the first column is used only internally for the purposes of this paper.

Game ID	Video game	Production	Released in	Game genre	Playing time
❶	Hollow Knight	Team Cherry	2017	Metroidvania	26 to 57 hrs
❷	A Plague Tale: Innocence	Asobo Studio	2019	Action stealth adventure	9 to 24 hrs
❸	Hades	Supergiant Games	2020	Rogue-like game	21 to 95.5 hrs
❹	KOTOR	BioWare	2003	Turn-based role-playing game	29 to 48 hrs
❺	Divinity: Original Sin 2	Larian Studios	2017	Tactical role-playing game	56 to 148 hrs

The selected games can be briefly characterised as follows:

- Hollow Knight ❶ is a *Metroidvania* game, meaning that the player gradually explores a complex interconnected world. Initially, the player has very limited skills at their disposal, and many areas remain inaccessible. However, as the player gains new abilities, they can venture into previously unreachable areas. The game is notable for its atmospheric graphics, sombre music and non-linear exploration (allowing different parts of the world to be explored in various orders). The player assumes the role of a lone warrior exploring the mysterious underground realm of Hallownest, which is inhabited by an insect nation. During the quest, the player uncovers its enigmatic history, meets strange inhabitants and

8 Game mechanics are the basic rules and schemes that determine how the game works and what the player can do. These are repeatable actions or interactions, such as moving, collecting items, solving puzzles, battling or trading.

faces dangerous enemies. In battles, they must upgrade their sword and magical skills while timing their healing correctly.

- A Plague Tale: Innocence ❷ is an *action stealth adventure game* that combines story elements, combat and tactical evasion of enemies. Set in fourteenth-century France during the Hundred Years' War and the plague epidemic, the story follows young Amicia and her little brother Hugo as they strive to escape the cruelty of the Inquisition and survive in a dark world beset by war, disease and swarms of deadly rats. Although the game provides an authentic atmosphere of the time and portrays some historical aspects accurately, it also intersperses realistic elements with fictional and supernatural components. To progress, players must solve puzzles, fight enemies and use *stealth mechanics* that facilitate discreet movements, while avoiding direct conflict and using tactical elements such as hiding in the environment or silently eliminating foes. In this game, the correct use of light and fire is crucial for repelling rats and creating safe passages.
- Hades ❸ is set in the realm of Greek mythology, where the player assumes the role of Zagreus, the son of Hades, who is attempting to escape from his father's underworld. The game belongs to the *rogue-like genre*, characterised by a randomly generated environment that makes each subsequent run unique. The player progresses linearly from one room to another (meaning there is no possibility to go back or skip a room). Each room is inhabited by enemies and contains rewards or special challenges. To survive in combat, Zagreus must continuously attack, dodge and effectively combine attacks with his powers. Upon death, he must restart from the beginning, losing all temporary upgrades but retaining some permanent items that can enhance his abilities in the opening room, known as the House of Hades. This system allows the player to progressively improve and acquire new weapons, upgrades and story interactions with characters from Greek mythology. Each successful run reveals more about Zagreus's lineage.

Two *role-playing games* (RPGs) were also included in the sample. In these games, players assume the role of fictional characters with specific characteristics and abilities. Throughout the gameplay, players continuously develop their characters by acquiring new skills and abilities, improving chosen attributes and obtaining better equipment, weapons and armour. RPGs also emphasise storytelling, with the plot's development depending on the players' decisions.

- Star Wars: Knights of the Old Republic (KOTOR) ❹ is a *turn-based*

RPG set in the fictional Star Wars universe, thousands of years before the events of the film saga. The player can control up to three characters as they explore different planets. The game employs a turn-based combat system, where the player selects attacks or other character actions to be performed in each turn, followed by a sequential execution of these choices. The success of each action depends on the character's attributes and rolls of the virtual dice. Outside of combat, the player shapes their character's fate through various choices, leaning towards either the light or dark side of the Force.

- Divinity: Original Sin 2 5 is a *tactical RPG* set in a fantasy world. At the beginning, the player creates a character according to their preferences. As the game progresses, the player meets other characters who can become members of the team. The player can gradually improve all of the characters and undertake individual quests with up to four of them. This game also utilises a turn-based combat system, where the order of turns for both player-controlled characters and enemies is predetermined. Each character has *action points* to use during their turn for actions such as moving, attacking, casting spells or interacting with the environment. Each combat scenario requires careful tactics, necessitating strategic planning for every move and action. Additionally, the player's decisions outside of combat impact the development of the story. However, unlike in Game 4, there is not just a simple choice between good and evil. The player's decisions have an impact on who their hero befriends, who survives and who gains or loses power. The game also has a number of different possible endings depending on the choices made during gameplay.

The participants had varying levels of experience with these games. Martin had played all of them, Adam had played Games 1 and 3, while Viktor and Tomas had both played Games 4 and 5.

Data gathering instruments

The data were collected using multiple methods. First, we played all of the selected games ourselves and recorded situations that offered opportunities for CT development. However, the primary source of data was the observation of the participants while they played, along with interviews conducted during and after gameplay, including reflections on the thought processes employed. The interviews were semi-structured, allowing several stimulating topics to arise during discussions. We worked more closely with Martin, as we had many opportunities to observe him playing all the selected games, and he was willing to elaborate on his thinking repeatedly and in detail afterwards.

Research design

Since the research focused on the development of CT in video gameplay, the content analysis of the collected data concentrated on identifying themes typically associated with the core components of CT, namely abstraction, decomposition, algorithmic thinking, automation, generalisation and evaluation. We employed a deductive approach to analysis with preselected themes (Braun & Clarke, 2021). In the first cycle, the observed gameplay situations, together with the players' solutions, were coded against the six CT components. We then conducted supplementary interpretative interviews with the participants, during which we presented our preliminary interpretations and invited them to critically evaluate them. Insights from these interviews were integrated by refining the codes, adjusting their boundaries and expanding the analytic perspective. The participants also highlighted additional aspects and described further in-game situations related to the CT components. These were documented and incorporated into the subsequent round of analysis.

We believe that the diverse experience levels of our team – one author being an experienced video game player and the other a novice – constituted an advantage. This dynamic aided our choice of games and participants, as well as the data collection and analysis processes. In this context, the second author's role was to oversee the interpretation and presentation of the results, ensuring that the findings are accessible to readers who may be unfamiliar with the world of video games.

Throughout the research, we adhered to the ethical principles recommended for qualitative educational research (Creswell & Creswell, 2022). All of the participants were informed in advance about the purpose and nature of the research, and all of them agreed to participate, with the freedom to withdraw at any time. In accordance with ethical principles, we also ensured that the video games analysed were correctly licensed.

Special attention was devoted to validation, which was secured through several measures. Data triangulation was employed by collecting data through multiple methods, as outlined in the Data gathering instruments sub-section of this chapter. We also consistently utilised member checking during our analysis and interpretation of findings, repeatedly consulting the participants on our intermediate findings and refining them based on their feedback. Furthermore, the fact that one author is an experienced gamer while the other is not, as described at the beginning of this sub-section, provided an opportunity for internal validation (Oluwatayo, 2012). Having an author without gaming experience ensured that the interpretation of the findings would be comprehensible to readers unfamiliar with the gaming world.

Results

This section presents the results of the content analysis, focusing on the opportunities that video games offer for CT development. Although the themes and components of CT are addressed separately, they are often intertwined and cannot be consistently separated during gameplay. Moreover, they are not presented in the order typically found in the literature but rather according to the significance assigned to them by the results of the analysis.

Algorithmic thinking

Algorithmic thinking is essential for success in most video games. Players frequently encounter a variety of challenging situations that require them to plan steps to overcome obstacles successfully. Importantly, there is often no single correct sequence of steps to resolve a given situation; instead, multiple approaches can lead to a successful outcome.

A recurring sub-theme is the behaviour of enemies. In each of the analysed games, players must understand the algorithms governing enemy actions: what they do, when they do it, how they move, how and when they attack, and their strengths and weaknesses. With this understanding, players can devise strategies for combat or avoidance.

While we identified opportunities for the development of algorithmic thinking in all of the games in our sample, the nature of these opportunities varies, influencing how players reason and act. In Games ❶, ❷ and ❸, where all actions, including combat, occur in real time, players must analyse and adapt quickly to dynamic situations. In these games, players must act in tandem with the enemy's actions based on their understanding of the enemy's operational algorithm. During combat, they need to determine when to dodge, how and when to attack, and where to aim their strikes. Timing for healing is also critical; otherwise, players may lose more health than they recover or be defeated outright. However, combat is not always the best approach. Some enemies may be too strong, or players may not be adequately prepared. In such cases, the best defence is to flee: players must discern the rules for hiding from specific enemy types and strategize how to escape successfully. Of the games analysed, this strategy is particularly useful in Game ❷, where the protagonists (young siblings) are physically significantly weaker than the enemies they face.

In contrast, turn-based games, such as ❹ and ❺, require advanced planning. In Game ❹, players can pause the battle and select the sequence of actions their character will perform. This mechanic allows players to effectively programme their character's future behaviour. Players must carefully consider which actions to choose and in what order; an incorrect sequence can lead to defeat. For instance, if a player attacks first and then activates defence, they may lose too much health. Alternatively, if they exhaust limited resources too early, they may find themselves unprepared when those resources are most needed.

Unlike Game ❹, in Game ❺, players do not input the entire sequence of actions upfront; instead, they choose actions sequentially during their turn, with immediate execution. However, it remains essential to plan the sequence in advance to ensure actions build on one another effectively. When planning, players must consider that some spells and skills require recovery periods during which they cannot be reused. If players use a spell or skill at the wrong moment, they risk being unprepared when it could be most beneficial. If they allocate all action points to an attack, they may miss the opportunity to reposition themselves advantageously. By observing the effects of each specified action immediately, players can further adjust their strategy based on the current situation. This approach is analogous to direct control in programming tasks.

Another opportunity for developing algorithmic thinking identified in the analysis is the game environment itself. Like enemies, the environment operates according to specific rules that players must uncover through analysis and experimentation. To progress, players must understand how these rules affect their movement, interactions and problem-solving opportunities. For example, in Game ❶, players discover that certain areas are only accessible after acquiring new skills, prompting them to plan their routes strategically and utilise their available skills effectively. In Game ❷, players may learn that shadows provide safe hiding spots from enemies or that rats avoid illuminated areas. Understanding these principles is crucial for survival and progress in the game. Game ❺ further complicates the rules governing the environment and the players' options for interaction. Here, players can combine magical abilities with various environmental elements to achieve specific effects. For instance, they can trigger explosions of toxic gases with fire spells or ignite oil puddles to obstruct enemies' paths. Ice spells can freeze bodies of water, creating slippery surfaces, while electric spells can conduct electrical discharges through water and stun characters within range. This interplay of game mechanics necessitates a systematic analysis of conditions, the ability to anticipate the consequences of actions, and effective adaptation of solutions to new circumstances.

In addition to the environment, friendly characters – known as *non-playing characters* (NPCs) – play a significant role in gameplay. These characters operate under specific rules, which players must understand and leverage to their advantage. Appropriate interactions with NPCs can yield novel items, experience points or valuable information to aid progress. Players must comprehend what NPCs offer, the conditions they impose, and the expected benefits of meeting those conditions. Rewards from NPCs are primarily earned by completing various tasks or engaging in suitable interactions during conversations. Notable NPCs include merchants who offer various goods. For each purchase, players must carefully consider which items are most worthwhile. Moreover, in Games ❺ and ❹, the prices of goods are not fixed; they depend on the player character's abilities, reputation and relationship with the merchant. Thus, players must make meaningful decisions to secure the most favourable terms.

In summary, the analysis indicates that algorithmic thinking in video games develops through the recognition of algorithms (governing the basis of enemies, friendly characters and environmental elements) and the planning of a sequence of steps to successfully resolve in-game situations and progress through the game.

Decomposition

Another component of CT that was observed developing during video gameplay is decomposition. Many problem situations require sequential resolution. In some games, the subproblems and their order are predetermined, particularly in Game ❷. In contrast, other games allow players to choose from multiple alternative problems at any given time. Thus, players apply decomposition to break down the given situation or problem into subproblems independently. This aspect was identified in the analysed games, especially in Games ❶ and ❺. Game ❶ offers considerable freedom in progression, allowing players to decide which tasks to complete first, second and so on. The only limitation is that some areas of the map are initially inaccessible. However, after acquiring new skills, players can return to face new challenges that may now be more manageable. These new challenges can again be completed in any order the player chooses. Additionally, not all of the challenges must be solved; however, completing optional challenges often provides advantages that facilitate progress. Similarly, in Game ❺, the player breaks down the completion of each task according to their priorities. It is then up to the player to determine the order in which to tackle them. When breaking the game down into individual tasks, the player must also consider their interconnectedness.

A typical problem in video games that requires decomposition occurs when players face multiple enemies. In such cases, it is beneficial to find a way to divide them and engage either one at a time or in smaller groups (employing a *divide et impera* strategy). In the video games from the research sample, such situations were identified mainly in Games ❷, ❶ and ❺. For example, in Game ❷, upon discovering a group of enemies, players must first analyse their distribution, recognise their movement patterns and assess environmental elements that can assist in luring or safely eliminating some of them. In addition to determining how to eliminate individual enemies, players must carefully consider the order in which they are engaged to avoid being detected by multiple foes simultaneously. Similarly, in Game ❶, players need to assess their surroundings and strategize how to eliminate enemies gradually. Dividing enemies into smaller groups and confronting them gradually is also crucial in Game ❺. However, this game offers the advantage of a turn-based system, allowing players more time to analyse the involved enemies and devise a meaningful division. Furthermore, if the battle does not proceed according to plan, players can adjust their strategy based on the current situation and rethink their next division each time.

Based on these findings, we conclude that decomposition is a key element of problem-solving in video games, and its principles are analogous to those found in informatics and programming. In both contexts, players and programmers strive to understand the structure of the problem, decompose it into manageable segments, and systematically address each part to achieve an overall solution.

Evaluation

Playing video games necessitates constant evaluation of various aspects. Players continuously experiment with different strategies and assess their effectiveness. Whenever a strategy appears ineffective, players analyse the underlying reasons and contemplate alternative approaches to resolving the problem. Some situations require several iterations of such refinements, akin to the debugging process in programming.

Additionally, players often evaluate whether to engage in solving a particular problem at any given moment. For example, in Game ❶, they must consider whether they have sufficient health to tackle the problem at that time, whether they possess the necessary skills, and whether they are adequately equipped. Similarly, in Game ❺, players need to assess whether each character on their team is prepared to confront the situation.

Another crucial aspect of analysing and evaluating the gaming situation is optimising resource utilisation. This is particularly important in games where resources are limited, as in Games ❷ and ❶. Here, players must constantly evaluate which items or upgrades to utilise in a given situation. In Game ❷, they need to determine which item is most worthwhile to create with the available resources. This consideration is essential; if an item or raw material is used to create something unnecessary at a given time, it may be lacking later. In Game ❶, players must optimise their choice of upgrades to gain specific advantages. Only a limited number of such upgrades can be selected and activated simultaneously, making it beneficial for players to choose those that are most advantageous for the current situation.

In Games ❶ and ❺, as well as in other games where healing is possible, players constantly assess whether they have enough health or need to regenerate. In the latter case, the player considers when and where they can do so safely. Healing operates on a different principle in ❸ but remains important. After completing each room, players must decide which door is most advantageous to enter next to enhance their future chances. If they choose the door leading to a healing room, they forfeit the opportunity to enter the door that would have provided an upgrade.

In conclusion, we note that evaluation is an integral part of video gaming. Regardless of the game genre, players are continuously analysing the results of their actions, adapting their strategies based on the experiences gained and optimising their progress.

Generalisation

Generalisation is another important aspect of successful video gaming. Once a player learns a new procedure or discovers a specific connection in a game, they typically apply this knowledge in other situations. Thus, generalisation and the application of previous experiences occur continuously during gameplay.

One of the most common areas where players utilise generalisation is in combat with enemies. If a player understands the rules applicable to fighting a particular enemy, they will apply this knowledge when encountering the same or a similar type of enemy again. For example, if a player in ❶ encounters a flying enemy and recognises that it attacks from above, they will anticipate this behaviour when they face another type of flying enemy. Moreover, the more behaviour patterns a player recognises in common enemies, the more effective they will be when fighting *bosses*,[9] who often combine a greater number of behavioural elements from standard enemies.

Generalisation is also crucial for understanding the rules of the environment. Players gradually learn how the environment reacts to different actions and then apply these findings in new situations. For instance, in game ❷, if players understand that rats avoid light, they can use a lit torch to navigate past them. When they encounter another group of rats, they will search the vicinity for other available sources of light to ensure continued successful advancement.

Abstraction

When playing video games, players are constantly exposed to a complex environment filled with various characters – dangerous, harmless or beneficial – along with numerous visual and audio cues and other details. However, in addressing each situation, players must first identify the elements that will help solve the immediate problem while filtering out those that could unnecessarily delay or endanger them. For example, in ❶, players must observe the enemy's mode of attack, their own character's health, and the opportunities the surrounding space offers for successfully dodging the attack, retreating or counterattacking safely. If players focus on visual details in the background, they may miss important moments requiring immediate reaction. Similarly, in ❸, players need to concentrate on the enemies present during the fight, the traps set to injure them, and the items that can assist them in healing or attacking.

Abstraction also plays a significant role in conversations with NPCs. Players gather a wealth of information during these interactions, from which they must identify what is relevant for further progress in the game. For example, during conversations in Games ❹ and ❺, NPCs share their personal stories or details about the history and culture of their world. Players need to discern the main message conveyed by this information, recognising what they are specifically supposed to do, where they should do it, what rewards they can expect, and how it will affect the overall gameplay.

Abstraction is also important for overall progression within the game environment. Players must notice elements that they can potentially use later in appropriate ways. For example, in Game ❷, they may identify objects to hide behind, items and resources to collect or sources of light that may be needed. Other environmental details, such as building surfaces or the animations of non-interactive objects, are irrelevant to actual progression in the game, and

9 Bosses are powerful enemies that typically appear at key moments in the game. Enemies of this type usually present a greater number of attacking behavioural elements than common enemies.

players do not need to focus on them, provided they can accurately distinguish these elements.

Automation

Automation is less explicitly represented in the analysed games than the other CT components. It primarily manifests in the way players are repeatedly exposed to similar situations, allowing them to solve these challenges more efficiently. In such situations, players draw on previously detected behavioural patterns; the more frequently they encounter these patterns, the more automated and effective their solutions become. From a CT perspective, this process involves generalising and automatically applying strategies.

Automation is particularly noticeable in the repeated battles found in Games ❶ and ❸. After a certain period, players stop consciously analysing every move of the enemy, and their reactions to familiar attacks and behavioural patterns become automatic. Consequently, the ability to dodge, time an attack precisely or heal can become almost reflexive. In turn-based games such as ❹ and ❺, automation is associated with the repeated use of effective tactical sequences; for example, choosing the optimal order of attacks in ❹ or regularly employing specific combinations of spells and abilities in Game ❺. In Game ❷, automation manifests in the repeated use of verified strategies for hiding, luring enemies away and using light to scare off rats. These activities become almost routine as the game progresses.

At the same time, we found that automation is the component of CT that is most challenging to distinguish from the others, as it intersects with them in significant ways, especially decomposition, algorithmic thinking and generalisation, as presented in previous sections.

Discussion

In the present research project, we conclude that, consistent with the claims of Papert (1995, 1998), Gee (2003) and others, we have successfully enriched the understanding of how playing video games can contribute to the development of each component of CT as listed by Cansu and Cansu (2019), along with an expanded evaluation. All of the results presented in detail in the Results section are compactly summarised in Table 2. In formulating its content, we aimed to shift the focus away from the context of the games themselves and formulate the results from the perspective of school informatics and its programming. The research question posed at the beginning of the project is thus considered answered within the framework of the two-dimensional sample, which will be discussed in the Conclusions.

While we view the aforementioned context as primarily beneficial for the research component of our work, we also consider the presented analysis and its results to be significant for our ongoing development of educational content.[10] Given the scope and diversity of how video gaming supports CT development, the results motivate us to explore additional game elements to incorporate into our curriculum and how to do so. Naturally, there are connections between the worlds of video games and the Scratch programming environment. In Scratch, we are currently seeking a productive balance between two extreme approaches: the first is 'learn programming by creating your own game', while the second is the more academic and systematic 'develop programming skills by solving appropriately chosen problems' in designing the programming curriculum for Years 6–9.[11] Several observed results from the analysis presented above inspire new ideas for us to work with concepts such as scenes and their scenarios; behaviours and reactions; multiple characters along with their dynamic clones; interactions between characters and their responses to different situations; synchronisation and cooperation of characters and their clones through messaging; and the evolving behaviours of characters based on changing situations in their environment. It is essential that all inspiring themes from the world of video games undergo careful transformation into forms that respect the developmental appropriateness and cognitive demands of pupils in this age group and level of CT and digital literacy.

In the Results section, we presented the results demonstrating how inherent it is for games to gradually explore the behaviours of characters, their changing skills and constraints. In fact, we implement a similar approach in our development work, even for lower primary pupils, as seen in Kalas et al. (2022), Kalas and Horvathova (2022) or Cujdikova and Kalas (2025). For these age groups, we employed a design principle with three intersecting challenges: (a) exploring the behaviours, reactions and constraints of the character and the environment; (b) exploring tools to control the character and using them for direct manipulation; and (c) in the character's language, planning its future re-executable behaviours, as discussed by Blackwell (2002) and Kalas et al. (2018).

10 In our work, the components of research and development intertwine and complement each other productively, which is characteristic of a research strategy called design research or design-based research (see Plomp & Nieveen, 2013).

11 Pupils in Slovakia in Year 6 have already participated in developmentally appropriate programming from Years 3–5. For example, they have engaged with programming environments of Informatics with Emil (Kalas et al., 2018; Kalas et al., 2022; Kalas & Horvathova, 2022; Cujdikova & Kalas, 2025).

Table 2

Opportunities for CT development through playing video games (identified components of CT as introduced in the Introduction section)

Component of CT	Contribution to developing CT
Abstraction	• Constantly analysing the situation and environment to filter out irrelevant aspects. • Distinguishing the aspects that are relevant for addressing the current situation and registering aspects that may be relevant for future situations. • Extracting important information from conversations with different characters.
Decomposition	• Understanding the structure of the problem, state or situation, as well as the possibilities of breaking it down into smaller units. • Proceeding from the evaluation of a situation, state or behaviour to its decomposition into smaller components, e.g., subproblems or other elements (*divide et impera* strategy). • Considering whether the parts of the overall situation can be addressed in parallel or sequentially. • Choosing a strategically appropriate sequence for dealing with the individual elements, subproblems or sub-situations.
Algorithmic thinking	• Examining the state of the environment and the situation or the behaviour of a character, along with their reactions, skills, capacities and limitations. • When appropriate, responding with some action, in the sense of *direct control*.[12] • When appropriate, planning a sequence of steps leading to the resolution of a problem or situation, in the sense of *planning* or *programming*[13] a solution. • Selecting one of the appropriate alternative courses of action.
Generalisation	• Recognising certain patterns and rules in the functioning of the environment or in the behaviour of characters. • Generalising these patterns and rules, and applying them repeatedly in other similar situations, where similarity can mean various things.
Evaluation	• Continuously evaluating the current state, resources and capacity of all characters. • Analysing and evaluating different strategies and actions, iteratively refining them. • Optimising (usually limited) resources, considering how to acquire new skills and resources. • Considering various alternatives when choosing the next step.
Automation	• Learning how to deal more effectively with recurring situations. • Automating reactions to certain patterns of enemy behaviour. • Regularly using effective tactical sequences of actions.

Finally, we would like to highlight one more aspect that we consider important. As mentioned earlier, we also examine the results obtained in terms of our curriculum design for programming with Scratch. This leads us to contemplate the concept of CT itself. We align with Brennan and Resnick (2012), who argue that "programming with Scratch provides a context and set of opportunities for contributing to active discussions about computational thinking" (p. 2). This position is supported by reasons articulated by others, such

12 For this level of control, see Kalas et al. (2018).
13 As the highest level of control, see e.g. (Kalas et al., 2018).

as Voogt et al. (2015), Cansu and Cansu (2019) and Lodi and Martini (2021). Specifically, the characterisation of the concept of CT in the research literature, through the identification of its individual components, is neither definite nor definitive. In analysing the data collected from the present video game research, we adopted a deductive approach with preselected themes; namely, the aforementioned components of CT. However, we identified one skill that we perceive to be important and challenging for pupils in Scratch programming. This skill repeatedly emerged in our analysis but does not fit well within the existing system of CT components. It involves considering the *overall structure* of the game or project, its elements (i.e., computational objects, as described by Papert (2006)), the relationships and interactions between these elements, as well as the overall state of the environment and the momentary states of the individual elements.

We believe that the issues surrounding a better understanding of *structural thinking* in school informatics and its relation to CT are important and understudied in the literature. We consider this an intriguing challenge for further research activities.

Conclusions

The aim of the present research project was to explore what video games can teach us about developing CT. Above, we have outlined the results obtained and how we interpret them in the context of our research and development activities. The findings show that the selected video games provide rich opportunities for developing various components of CT. Specifically, we noted a strong presence of algorithmic thinking, as players are continually required to plan sequences of actions and respond flexibly to dynamic environments or turn-based challenges. We also found substantial instances of decomposition, as players naturally break down complex problems into manageable subproblems. Furthermore, through repeated exposure to similar challenges, players are prompted to generalise their experiences and gradually automate effective responses, applying learned strategies flexibly in new and varied situations. These results demonstrate how video games offer a cognitively rich environment that aligns well with the core constructs and practices of CT and provides authentic opportunities for players to experience and reflect on problem-solving processes. We also believe that the results offer a valuable contribution to the current discourse on what constitutes CT itself, particularly by illustrating how it can emerge and develop through rich, interactive and situated experiences such as video games.

The results may serve as a resource for informatics educators and curriculum developers aiming to support CT in engaging and meaningful ways. The detailed analyses of in-game cognitive processes provide a foundation for designing educational interventions that mirror game-based challenges. For example, programming activities in Scratch can be designed to replicate common game mechanics such as exploration, interaction with characters, dynamic responses or strategic decision-making. We believe that such an approach could make CT more accessible, relatable and motivating, particularly for pupils who already engage with video games in their leisure time.

In interpreting the results, we also observed a phenomenon that interestingly fits with our other area of research, namely *the development of structural thinking* within school informatics and programming. In video games, structural thinking involves recognising relationships between characters, actions and environmental states, and designing coordinated behaviours for these elements. However, such skills are crucial not only in the context under study, but also in school programming. We believe that this deserves further attention in evidence-based design of educational content, particularly in exploring how game-inspired reasoning processes can inform the programming curriculum and related pedagogy.

We acknowledge the various limitations of the research and the need for its continuation, particularly in investigating the opportunities that playing video games provides for the development of mathematical thinking. The main limitation of the research is the small number of players involved. Since different players engage with games in various ways, a broader participant base could yield different approaches and additional findings. Furthermore, the analysis did not cover all existing game genres. In follow-up research, it would be interesting to focus on analysing other games, such as real-time strategy, choice-based adventures, simulations, sandbox games and puzzle games. Since automation was represented less explicitly in the selected games compared to the other analysed CT components, it would certainly be interesting to examine games such as Factorio or Satisfactory, where automation plays a key role. It might also be worthwhile to explore other aspects of informatics education that develop in the context of playing video games, such as the aforementioned structural thinking.

Ethical statement

The research was conducted in accordance with ethical standards for pedagogical research, as confirmed by the Ethics Committee of the Faculty of Mathematics, Physics, and Informatics of Comenius University in Bratislava, Slovakia.

Disclosure statement

The authors declare no conflict of interest.

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References

Bediou, B., Adams, D. M., Mayer, R. E., Tipton, E., Green, C. S., & Bavelier, D. (2018). Meta-analysis of action video game impact on perceptual, attentional, and cognitive skills. *Psychological Bulletin*, *144*(1), 77–110. https://doi.org/10.1037/bul0000130

Bediou, B., Rodgers, M. A., Tipton, E., Mayer, R. E., Green, C. S., & Bavelier, D. (2023). Effects of action video game play on cognitive skills: A meta-analysis. *Technology, Mind, and Behavior*, *4*(1:Spring 2023). https://doi.org/10.1037/TMB0000102

Blacker, K. J., Curby, K. M., Klobusicky, E., & Chein, J. M. (2014). Effects of action video game training on visual working memory. *Journal of Experimental Psychology: Human Perception and Performance*, *40*(5), 1992–2004. https://doi.org/10.1037/a0037556

Blackwell, A. F. (2002). What is programming? In J. Kuljis, L. Baldwin, & R. Scoble (Eds.), *Proceedings of the 14th Annual Workshop of the Psychology of Programming Interest Group (PPIG 2002)* (pp. 204–218). Brunel University. https://www.ppig.org/files/2002-PPIG-14th-blackwell.pdf

Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE.

Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking. In A. Ball, & C. Tyson (Eds.), *Proceedings of the 2012 Annual Meeting of the American Educational Research Association* (pp. 1–25). AERA.

Cansu, F. K., & Cansu, S. K. (2019). An overview of computational thinking. *International Journal of Computer Science Education in Schools*, *3*(1), 17–30. https://doi.org/10.21585/ijcses.v3i1.53

Creswell, J. W., & Creswell, J. D. (2022). *Research design-international student edition: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications Limited.

Cujdikova, M. & Kalas, I. (2025). Tables and the development of computational thinking in programming with Emil for primary school. *Informatics in Education, 24*(3), 471–502. https://doi.org/10.15388/infedu.2025.15

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave Macmillan.

Glasnović Gracin, D., & Krišto, A. (2022). Differences in the requirements of digital and printed mathematics textbooks: Focus on geometry chapters. *Center for Educational Policy Studies Journal*, *12*(2), 95–117. https://doi.org/10.26529/cepsj.1285

Golob, N., & Ungar, V. (2023). The development of science process skills and of content knowledge with inquiry boxes in early childhood education. *Center for Educational Policy Studies Journal*, Article 1631. https://doi.org/10.26529/cepsj.1631

González-Pérez, C., Fernández-Jiménez, E., Morán, E., Melero, H., Malpica, N., Álvarez-Linera, J., Puig, M. A., Plaza, D., & Pérez-Martínez, A. (2025). Study protocol for a randomized controlled clinical trial of a multifaceted cognitive training program using video games in childhood cancer survivors. *PLoS One, 20*(9), Article e0314118. https://pubmed.ncbi.nlm.nih.gov/40892751

Gyaurov, D., Fabricatore, C., & Bottino, A. (2022). Features of entertainment digital games for learning and developing complex problem-solving skills: A protocol for a systemic review. *International Journal of Qualitative Methods*, *21(1)*, 16094069221128491. https://doi.org/10.1177/16094069221128491

Kalas, I., Blaho, A., & Moravcik, M. (2018). Exploring control in early computing education. In S. Pozdniakov, & V. Dagienė (Eds.), *Informatics in schools. Fundamentals of computer science and software engineering, ISSEP 2018. LNCS, vol 11169* (pp. 3–16). Springer. https://doi.org/10.1007/978-3-030-02750-6_1

Kalas, I., Blaho, A., & Moravcik, M. (2022). Programming in year 4: An analysis of the design research process. In M. Cukurova, N. Rummel, D. Gillet, B. McLaren, & J. Uhomoibhi (Eds.), *Proc. of 14th Int. Conf. on Computer Supported Education – Volume 2, CSEDU* (pp. 425–433). SciTePress. https://doi.org/10.5220/0010988000003182

Kalas, I., & Horvathova, K. (2022). Programming concepts in lower primary years and their cognitive demands. In D. Passey, D. Leahy, L. Williams, J. Holvikivi, & M. Ruohonen (Eds.), *Digital transformation of education and learning – past, present and future. OCCE 2021. IFIP advances in information and communication technology*, *642* (pp. 28–40). Springer. https://doi.org/10.1007/978-3-030-97986-7_3

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology* (2nd ed.). Sage Publications Limited. https://doi.org/10.1177/1094428108324513

Lodi, M., & Martini, S. (2021). Computational thinking, between Papert and Wing. *Science & Education*, *30*(4), 883–908. https://doi.org/10.5220/001098800000318210.1007/s11191-021-00202-5

Malliet, S. (2007). Adapting the principles of ludology to the method of video game content analysis. *Game Studies*, *7*(1). http://gamestudies.org/0701/articles/malliet

Maloney, J., Resnick, M., Rusk, N., Silverman, B., & Eastmond, E. (2010). The Scratch programming language and environment. *ACM Transactions on Computing Education (TOCE)*, *10*(4), 1–15. https://doi.org/10.1145/1868358.1868363

Martinez, L., Gimenes, M., & Lambert, E. (2022). Entertainment video games for academic learning: A systematic review. *Journal of Educational Computing Research*, *60*(5), 1083–1109. https://doi.org/10.1177/07356331211053848

Nguyen, A., & Bavelier, D. (2023). Play in video games. *Neuroscience & Biobehavioral Reviews*, *153*, Article 105386. https://doi.org/10.1016/j.neubiorev.2023.105386

Oei, A. C., & Patterson, M. D. (2013). Enhancing cognition with video games: A multiple game training study. *PLoS One*, *8*(3), Article e58546. https://doi.org/10.1371/journal.pone.0058546

Oluwatayo, J. A. (2012). Validity and reliability issues in educational research. *Journal of Educational and Social Research*, *2*(2), 391–400.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.

Papert, S. (1995, November 13). The parent trap. *Time Magazine*. http://papert.org/articles/parent_trap.html

Papert, S. (1998). Does easy do it? Children, games, and learning. *Game Developer Magazine*. http://www.papert.org/articles/Doeseasydoit.html

Papert, S. (2006, December 5). *Keynote lecture. Keynote at ICMI 17 Conference in Hanoi, Viet Nam* [Lecture transcript]. DailyPapert. http:// dailypapert.com/wp-content/uploads/2012/05/Seymour-Vietnam-Talk-2006.pdf.

Plomp, T., & Nieveen, N. (Eds.). (2013). *Educational design research. Part A: An Introduction*. SLO, The Netherlands Institute for Curriculum Development.

Reynaldo, C., Christian, R., Hosea, H., & Gunawan, A. A. S. (2021). Using video games to improve capabilities in decision making and cognitive skill: A literature review. *Procedia Computer Science*, *179*, 211–221. https://doi.org/10.1016/j.procs.2020.12.027

Ruiz-Marquez, E., Prieto, A., Mayas, J., Toril, P., Reales, J. M., & Ballesteros, S. (2019). Effects of nonaction videogames on attention and memory in young adults. *Games for Health Journal*, *8*(6), 414–422. https://doi.org/10.1089/g4h.2019.0004

Sattar, S., Iqbal, D. Y., & Yousaf, R. (2021). Impact of playing video games on cognitive functioning and learning styles of adolescents. *Sukkur IBA Journal of Computing and Mathematical Sciences*, *5*(2), 49–59. http://dx.doi.org/10.30537/sjcms.v5i2.885

Schmierbach, M. (2009). Content analysis of video games: Challenges and potential solutions. *Communication Methods and Measures*, *3*(3), 147–172. https://doi.org/10.1080/19312450802458950

Selby, C. C., & Woollard, J. (2013). Computational thinking: The developing definition. In J. E. Roberts, A. Clear, & R. Lister (Eds.), *Proceedings of the 18th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE 2013)* (pp. 5–8). ACM.

Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. *Education and Information Technologies*, *20*(4), 715–728. https://doi.org/10.1007/s10639-015-9412-6

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

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Developing Conceptual Programming Knowledge in Pre-Service Computer Science Teachers: The Role of Programming Patterns

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This study examines how students enrolled in a two-subject teacher programme (computer science and mathematics) at the Faculty of Education, University of Ljubljana, develop a conceptual understanding of programming knowledge through the implementation, recognition and explanation of programming patterns. Based on over 500 programming solutions completed by first- and second-year students, we focus on four foundational patterns: linear search, guarded search, counting and extreme values. The study involved 70 students across different phases, with 17 of them tracked longitudinally over three to four years, examining their ability to recognise programming patterns, explain underlying logic and design related tasks. The results show that the students gradually improved their use of programming patterns, initially producing many redundant or incorrect solutions, which over time shifted towards correct implementations. However, this development was uneven across pattern types and programming constructs. Tasks involving while loops and guarded searches initially proved more challenging, with higher rates of incorrect or redundant solutions in the early phases. A consistent finding across all of the student groups was a substantial gap between the students' ability to implement patterns and their ability to explain them conceptually. This demonstrates that for loop implementation skills do not automatically transfer to conceptual understanding, especially for more complex cases like guarded search and extreme values. This finding is particularly concerning for prospective educators. Importantly, explanation ability strongly predicted task design quality, underscoring the fact that conceptual mastery directly supports pedagogical competence. These findings highlight the need for explicit instruction on programming patterns in teacher education, not only to support correct implementation but also to build deeper

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explanatory and pedagogical skills. Emphasising patterns as conceptual tools can help future educators better analyse code, anticipate student difficulties and design effective, pattern-based programming tasks.

Keywords: introductory programming, programming patterns, computational thinking, teachers' education

Razvijanje konceptualnega programerskega znanja pri študentih pedagoških smeri računalništva: vloga programskih vzorcev

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V raziskavi preučujemo, kako študentje študijskega programa Dvopredmetni učitelj, smer računalništvo in matematika, na Pedagoški fakulteti Univerze v Ljubljani razvijajo konceptualno programersko znanje skozi implementacijo, prepoznavanje in razlago programskih vzorcev. Na podlagi več kot 500 programskih rešitev študentov prvega in drugega letnika se osredinjamo na štiri temeljne programske vzorce: linearno iskanje, zaščiteno linearno iskanje, štetje in iskanje ekstremnih vrednosti. V raziskavi je sodelovalo 70 študentov; 17 smo jih spremljali longitudinalno (od tri do štiri leta) ter analizirali njihovo zmožnost prepoznavanja in razlage logike delovanja izbranih programskih vzorcev ter oblikovanja nalog, ki pri reševanju zahtevajo njihovo uporabo. Izsledki kažejo, da so študentje postopoma izboljševali uporabo programskih vzorcev: v začetnih fazah so pogosto reševali naloge z odvečnimi deli kode ali napačnimi rešitvami, s časom pa so prehajali k pravilnim implementacijam. Napredek je bil neenakomeren med različnimi programskimi vzorci in uporabljenimi programerskimi konstrukti. Naloge, ki so vključevale uporabo zanke »while« pri zaščitenem linearnem iskanju, so se izkazale za zahtevnejše, saj so v zgodnjih fazah pogosteje vodile v napačne rešitve ali odvečne dele kode. Kljub izboljšavam pri implementaciji se je pri vseh skupinah študentov pokazal razkorak med tem, kar znajo implementirati s programsko kodo, in tem, kar znajo konceptualno razložiti. To kaže, da pravilna uporaba programskega konstrukta, na primer zanke »for«, še ne zagotavlja razumevanja ideje koncepta programskega vzorca, kar je še zlasti očitno pri zahtevnejših vzorcih, kot sta zaščiteno linearno iskanje in iskanje ekstremnih vrednosti. Zavedanje obstoja tega razkoraka je pri bodočih učiteljih še posebej pomembno. Poleg tega se je pokazalo, da ima sposobnost razlage delovanja programskega vzorca močen vpliv na kakovost oblikovanih nalog. To potrjuje, da konceptualno razumevanje neposredno podpira razvoj pedagoških kompetenc. Rezultati raziskave kažejo, da bi bilo v izobraževanju učiteljev računalništva smiselno bolj eksplicitno vključiti poučevanje programskih vzorcev. S tem bi prispevali k njihovi pravilni implementaciji, prav tako pa bi spodbujali globlje konceptualno razumevanje in s tem povezanih pedagoških kompetenc. Umeščanje programskih vzorcev kot konceptualnih orodij v programe pedagoških smeri računalništva lahko bodočim učiteljem omogoči natančnejšo analizo kode, boljše predvidevanje pogostih učnih težav in oblikovanje učinkovitih, na vzorcih temelječih programerskih nalog.

Ključne besede: uvodno programiranje, programski vzorci, računalniško mišljenje, izobraževanje učiteljev

Introduction

In today's rapidly evolving technological society, understanding core computer science (CS) concepts is essential for meaningful and competent participation in modern life (Webb et al., 2017). High-quality computer science education (CSE) is crucial not only for meeting workforce demands but also for supporting diverse professional fields where digital skills are increasingly vital. Digital literacy enhances efficiency, fosters innovation and enables creative problem-solving (Fojcik & Fojcik, 2021). With appropriate knowledge, students can move from passive consumers to active co-creators of the digital future, becoming agents of cultural and social change rather than merely reacting to technological developments (Gretter & Yadav, 2016). However, critical discourse suggests that the concept of digitalisation in education is often framed through vague or metaphorical narratives that obscure its pedagogical implications. Vivitsou (2019) argues that digitalisation has acquired a kind of mythical status – frequently referenced, yet conceptually underdefined – leading to blurred boundaries between technological ambition and educational purpose. While general digital literacy is important, future CS educators need structured programming knowledge that develops systematic thinking and problem-solving capabilities beyond surface-level approaches. Our study responds to this need by examining how future CS teachers develop a deep understanding of programming structures, which are essential elements for teaching CS effectively.

CSE fosters not only technical skills but also essential cognitive competencies like critical thinking and problem-solving, which are vital across all sectors (Salehi et al., 2020). When integrated with digital technologies, it promotes creativity through experimentation, collaboration and personalised content creation (Weng et al., 2023). A key outcome is the development of computational thinking (CT). Introduced by Wing (2006), this includes decomposition, pattern recognition, abstraction and algorithmic thinking, offering structured strategies applicable across disciplines (Maharani et al., 2019; Shute et al., 2017; Wu et al., 2024).

The role of programming in computer science education

Programming plays a central role in CSE, as it provides the primary means for developing CT and understanding how digital systems operate (Abesadze & Nozadze, 2020; Zeng et al., 2023). While research has documented novice difficulties with reading and tracing code (Lister et al., 2004), less is known about how these foundational challenges manifest in programming pattern implementation and pedagogical understanding. Importantly, programming has been described not only as a technical skill but also as a cognitive activity that fosters logical reasoning, analytical thinking and problem-solving (Soloway, 1986; Wing, 2006; Xie et al., 2019). These strategies extend beyond the field of CS, equipping learners to address complex challenges across diverse domains (Yadav et al., 2017). Furthermore, programming encourages active creation, interdisciplinary thinking and the development of creativity and innovation (Kiesler, 2022). Its integration into CS curricula is therefore a key strategy for preparing learners with the competencies needed to navigate and shape the demands of the twenty-first century. At the heart of successful implementation of CSE – and a prerequisite for achieving these goals – is the well-trained and competent teacher. Within teacher education programmes that prepare future CS educators, it is essential that students acquire a deep and well-structured conceptual understanding of programming. Such knowledge must go beyond surface-level proficiency, enabling future teachers to meaningfully interpret and convey programming concepts to their own students. As Soloway (1986) articulated, learning to program involves "constructing mechanisms and explanations", requiring teachers to develop both coding ability and skills to explain the conceptual structures underlying effective solutions. Only with this level of understanding can they design effective, developmentally appropriate instruction that fosters CT and supports learners in becoming confident and creative problem solvers. In line with this perspective, studies have explored how hands-on digital making can foster both technical understanding and pedagogical reflection in teacher education. For example, Bosco et al. (2019) describe a multi-year project in which students in education programmes collaboratively designed and fabricated digital artifacts. Through reflective storytelling and process documentation, the students not only acquired technological knowledge but also developed pedagogical insights. These experiential approaches highlight the importance of active knowledge construction but often lack explicit focus on the conceptual structures that underpin effective teaching. In this context, our study contributes by focusing specifically on how pre-service computer science teachers develop conceptual and pedagogical understanding through engagement with programming patterns, an approach that combines algorithmic thinking with didactic purpose.

Programming patterns as pedagogical tools

Introductory programming is widely recognised as a difficult subject, especially for students in teacher education, who often lack prior programming experience. The main challenge lies not only in understanding individual constructs, such as loops or conditionals, but also in learning to integrate these constructs into coherent solutions for complex problems. Addressing this challenge requires a shift from surface-level syntactic knowledge to a deeper conceptual understanding of algorithmic structures (Proulx, 2000). Programming patterns, defined as conceptual templates for recurring algorithmic problems, have been proposed as an effective pedagogical approach because they capture expert strategies, support systematic problem-solving and encourage good programming practices (Zapušek, 2022). Prior research shows that engagement with patterns strengthens algorithmic thinking and helps bridge the gap between theory and practice (Proulx, 2000). Despite these advantages, programming patterns are rarely addressed explicitly in introductory programming courses (Weinman et al., 2021).

Few studies have investigated how novices acquire and apply programming patterns across different stages of learning. In one such study, Nurollahian et al. (2024) compared CS1 and CS2 students and found that although more advanced students produced better implementations, their ability to recognise expert structures remained limited. This indicates that implementation proficiency does not necessarily align with recognition skills and highlights the need for a broader understanding of how different dimensions of programming knowledge develop. Complementary perspectives, such as the work of Xie et al. (2019), emphasise the fact that instruction should explicitly and sequentially address distinct novice skills, moving from tracing and writing correct syntax to recognising and applying reusable templates. In this way, sequencing skills reduce cognitive load and improve both performance and conceptual understanding.

Within this broader context, pre-service computer science teachers represent a particularly under-researched population. They face a dual challenge: acquiring the ability to implement programming patterns effectively, and developing the competence to evaluate their quality, explain the underlying logic to learners and design instructional tasks that require their use. To the best of our knowledge, no study has systematically examined both the correctness and quality of programming pattern implementations among pre-service computer science teachers, nor has any study explored how implementation experience informs their ability to explain such patterns and apply them in design. The present study addresses this gap by analysing pre-service computer science teachers' ability to implement, recognise, explain and design with fundamental programming patterns.

Fundamental programming patterns in the present study

In order to study how future CS teachers develop conceptual programming knowledge, the present research focuses on the implementation and recognition of four fundamental programming patterns: linear search, guarded linear search, counting and extreme values (Astrachan et al., 1998; Astrachan & Wallingford, 1998). These four programming patterns represent fundamental algorithmic strategies that novice programmers encounter early in their learning process and offer insight into how students move from isolated constructs to structured problem-solving strategies.

Linear search sequentially examines elements in a collection to locate the first element that satisfies a given condition. It assumes that at least one matching element exists.

Guarded linear search is a variation of linear search that also considers the possibility of no element meeting the condition. It includes an explicit safeguard to handle the case where no match is found.

Counting traverses the entire collection, maintaining a counter that increments whenever an element satisfies the condition. The final value of the counter represents the total number of elements meeting the criterion.

Extreme values identify the most extreme element according to a defined criterion. During iteration, the variable storing the current extreme value represents the best candidate found so far and is updated whenever a more extreme element is found.

Research problem and questions

While programming patterns offer a structured approach to solving recurring algorithmic problems, it remains unclear how future CS teachers develop the ability to implement, recognise and explain these patterns. The present study explores how students' understanding of the target set of patterns progresses from implementation to conceptual comprehension. We examine the development of these skills across multiple years, highlighting a notable gap between pattern implementation and the ability to explain underlying logic. We also investigate how explanation skills relate to pedagogical abilities such as task design, which is critical for effective CS teaching. By tracing these cognitive developments, the study provides insights into how teacher education programmes can better prepare future educators to both apply programming solutions and convey the underlying concepts.

RQ1. To what extent do first- and second-year students accurately apply expected programming patterns when solving targeted tasks?

RQ2. How does the type of control structure (for vs. while loop) influence the correctness of students' implementations of linear and guarded linear search patterns?

RQ3. Do guarded search patterns present greater implementation challenges than unguarded patterns, regardless of loop type?

RQ4. How does students' experience with implementing programming patterns in earlier academic years influence their ability to recognise and explain the same patterns in subsequent years?

RQ5. What is the relationship between students' ability to recognise programming patterns and their ability to explain the conceptual functioning of these patterns, and how might this relationship inform pedagogical approaches in introductory programming education?

RQ6. To what extent does students' ability to conceptually explain programming patterns predict their capacity to design appropriate programming tasks that require the use of these patterns?

In order to address these questions, we relied on two primary data sources: students' programming submissions from the first and second academic year, and a mixed-method questionnaire administered in the third and fourth year. The programming submissions enabled analysis of implementation accuracy and the influence of control structures (RQ1–RQ3), while the questionnaire provided insights into students' recognition, explanation and task design abilities (RQ5–RQ6). Importantly, RQ4 was addressed through a combination of both data sources, linking earlier programming submissions with later questionnaire results to examine how prior implementation experience influenced subsequent recognition and explanation. Inspired by Robins (2019), this multi-stage design allowed us to trace the development of both implementation skills and conceptual understanding, revealing trajectories from surface-level strategies towards abstract, pattern-based reasoning. In doing so, the study seeks to connect novice programming performance with the growth of conceptual knowledge and to inform targeted instructional interventions in teacher education.

Method

This study employed non-experimental, multi-phase longitudinal educational research design.

Participants

A total of 70 students enrolled in a two-subject teacher programme with a specialisation in computer science and mathematics at the Faculty of Education, University of Ljubljana, participated in the study. The students, of which 23 were male and 47 female, were regularly enrolled in the 2020/21 and 2024/25 academic years. All of the students enrolled in the aforementioned programme during the specified period were included in the study. Participation was part of regular coursework, with the students providing informed consent for the anonymised use of their submissions and questionnaire responses. Prior to analysis, all of the data were anonymised. The study was approved by the Ethics Committee.

Instruments

Three instruments were employed to examine the students' knowledge and use of programming patterns across different stages of their study. Instrument 1 measured the students' ability to implement programming patterns in authentic tasks. Instrument 2 measured their ability to transfer the same patterns to a new context. Instrument 3 measured their ability to recognise and explain programming patterns from given code and to translate their understanding into didactic task design. All of the programming tasks and code snippets were written in Python, a programming language consistently used in the curriculum. Although the use of AI assistants could not be technically prevented for homework assignments, the students signed a declaration of non-use and oral defences were organised to verify independent work, a practice applied to cohorts since 2023, when generative AI tools became widely available.

Instrument 1 — Year 1 programming tasks

In the first year (the course Introduction to Programming*)*, the students completed four tasks, each corresponding to one of four target patterns: linear search, guarded linear search, counting and extreme values. For linear search and guarded linear search, the students were required to provide two versions of each solution, one using a for loop and one using a while loop.

For the counting and extreme values patterns, any loop construct was permitted. The tasks were embedded in a context that used COVID-19 case data from Slovenia, making the data relevant to real-world problems encountered at the time. The assignments were administered as homework with one week for completion and were followed by a mandatory oral defence in which the students demonstrated their understanding of their own code. Two instructors, with 15 and over 30 years of teaching experience respectively, independently graded all of the submissions using a three-level rubric that distinguished between correct solutions, redundant solutions (i.e., functionally correct but unnecessarily complex or containing superfluous functionality) and incorrect solutions. The rubric was developed jointly in advance. Ratings were made independently and any disagreements were resolved in consensus discussions, thus ensuring the reliability of scoring.

Instrument 2 — Year 2 programming tasks

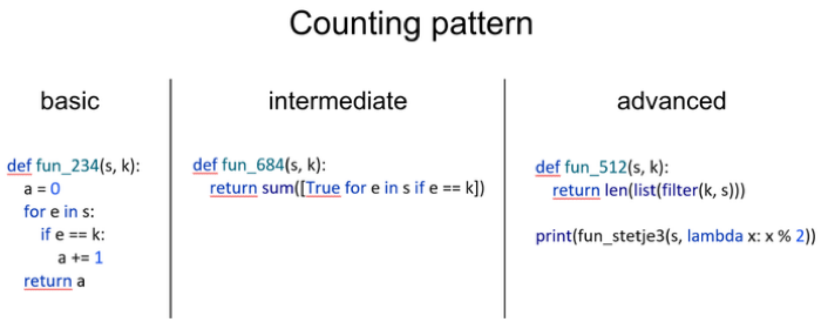
In the second year (the course Environments for CS Education), the students solved tasks that were isomorphic in algorithmic structure to those in Year 1 but embedded in a different context, namely the analysis of social media data. The same four patterns were targeted, and the same implementation requirements and rubric were applied. Evaluation followed the same procedure as in Year 1, with two experienced instructors grading independently and then resolving disagreements by consensus.

Instrument 3 — Year 3/4 questionnaire

In the third and fourth years, the students completed a paper-based questionnaire within a 45-minute classroom session. The questionnaire consisted of three parts. In the first part, the students were presented with twelve Python code snippets, three for each of the four patterns, equally distributed across basic, intermediate and advanced levels of difficulty. Figure 1 shows an example item for the counting pattern from the questionnaire. For each snippet, the students had to identify which programming pattern was implemented. In the second part, they provided written explanations of how the same twelve snippets worked. Their explanations were scored as correct, partially correct, incorrect or vague/over-general (answers that were broadly correct but too superficial to capture the actual mechanism). In the third part, the students selected one of the four patterns and designed a programming task suitable for primary school students. These tasks were scored as adequate or inadequate; in addition, for adequate tasks, the raters noted qualitatively whether the task was original or generic. As with the programming tasks in Year 1 and 2, the two instructors first developed criteria together, then graded independently, and finally discussed discrepancies until consensus was reached.

Figure 1

Example questionnaire item for the counting pattern in Instrument 3. The students were asked to identify the programming pattern and explain the code



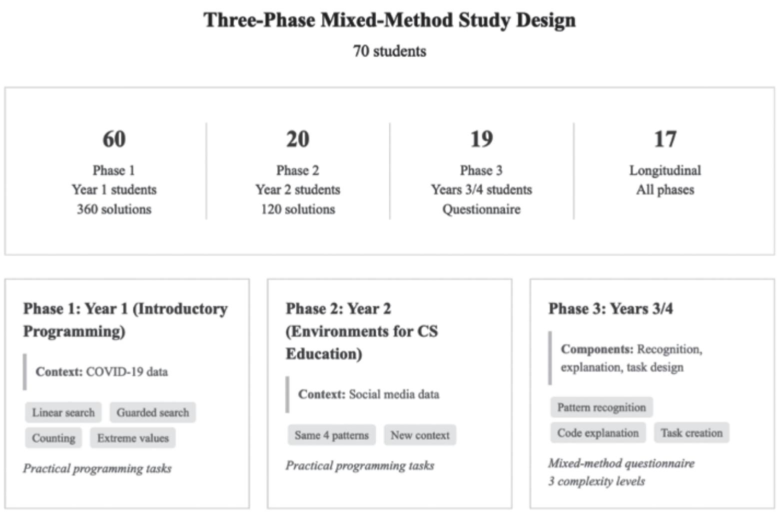
Research design

The study employed a mixed design, combining a longitudinal component with cross-sectional cohorts. This approach was necessary because the research instruments were embedded in different courses across the curriculum, which are taught in separate study years. The design thus enabled both the tracking of individual progress across multiple years and the comparison of different student cohorts. The research was carried out during the 2020/21 and 2024/25 academic years and was organised into three distinct phases (Figure 2), each with a specific aim.

- Phase 1 (Year 1, Introduction to Programming) included a total of 60 students across the target academic years and provided 360 solutions.
- Phase 2 (Year 2, Environments for CS Education) included 20 students across the target academic years and provided 120 solutions.
- Phase 3 (Years 3 and 4, questionnaire) completed by 19 students.

Within this overall sample, a longitudinal subsample of 17 students participated in all three phases, providing the opportunity to observe individual developmental trajectories over several years. At the same time, the inclusion of different cohorts across study years allowed for broader cross-sectional comparisons. This combination of longitudinal and cross-sectional data was a deliberate methodological choice. It reflects the curricular structure, in which relevant instruments could only be administered in specific courses, while at the same time ensuring both developmental insights into individual students' learning and broader cohort-level comparisons.

Figure 2
Three-phase mixed-method study design showing participant distribution and data collection procedures across academic years



Results and discussion

This section presents the findings of our longitudinal study, structured around the six research questions (RQ1–RQ6), and interprets them in the context of existing research and pedagogical implications. Quantitative and qualitative data are combined to highlight the students' progression in implementing, recognising and explaining programming patterns, as well as their development of pedagogical task design skills.

Pattern implementation accuracy (RQ1)

In order to address RQ1, we analysed the students' ability to implement target programming patterns within the assigned tasks. For search-related patterns, the students submitted both a for-loop and a while-loop version;

however, a pattern was considered correctly implemented if at least one solution was correct, reflecting our focus on conceptual understanding rather than syntactic form. Table 1 shows the distribution of correct, redundant and incorrect implementations for each pattern in the first and second research phase.

Table 1

Distribution of correct, redundant and incorrect solutions by programming pattern and academic year

Pattern	Correct			Redundant			Incorrect		
	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)
Counting	88	.259	100	6	.640	0	6	.640	0
Linear search	75	.794	81	23	.907	19	2	1.000	0
Guarded search	70	.117	90	20	.426	10	9	.335	0
Extreme values	69	1.000	72	3	1.000	0	28	1.000	28

Overall, across all of the programming tasks, the percentage of correct implementations increased from 64% in Phase 1 to 79% in Phase 2, while redundant solutions decreased from 18% to 11% and incorrect implementations declined from 18% to 10%. However, this improvement was not uniform. While linear and additive patterns (counting, linear search) and conditional patterns such as guarded search showed clear improvements, the extreme values pattern remained persistently challenging.

It should be noted, however, that none of these improvements reached statistical significance (all $p > .05$), most likely due to the small sample size in Phase 2 ($n = 20$). Therefore, the observed changes should be interpreted as trends rather than conclusive differences. Even with this limitation, the overall pattern suggests that instructional scaffolding may be particularly needed for state-tracking patterns, including both variable initialisation and the continuous updating of values (e.g., extreme values).

Since our descriptive results suggested that some programming patterns were more difficult than others, it was important to test whether these differences were statistically significant. Therefore, we conducted pairwise χ^2 tests of correct versus not-correct implementations between patterns within Phase 1, where the larger sample size ($n = 60$) provides sufficient basis for comparison. Table 2 presents the resulting p-values in a matrix format. Each cell indicates whether the difference in the proportion of correct implementations between two patterns was statistically significant.

Table 2

Pairwise χ^2 tests of correct implementation rates in Phase 1, showing that the counting pattern was significantly easier than the guarded linear search and extreme patterns, while other differences were not significant

Pattern	Counting	Linear	Guarded search	Extreme values
Counting	---	.113	0.030	0.019
Linear search		---	0.692	0.555
Guarded search			---	1.000
Extreme values				---

The results show that the counting pattern was significantly easier than the guarded search (p = .030) and extreme values patterns (p = .019), confirming that these patterns posed greater cognitive challenges, which is consistent with the findings of Astrachan and Wallingford (1998). The difference between counting and linear search was not statistically significant (p = .113), indicating that both patterns were comparably accessible to students. Linear search, guarded search and extreme values patterns were statistically indistinguishable from each other (all $p \geq .555$), which supports the interpretation that conditional and state-tracking patterns are consistently more difficult than additive patterns, thus aligning with the results of Lahtinen et al. (2005). This statistical evidence strengthens our earlier descriptive claim that not all programming patterns are equally accessible, and that state-tracking tasks such as extreme values and conditional tasks such as guarded search require additional instructional scaffolding (Astrachan & Wallingford, 1998; Fisler, 2014).

Influence of loop construct on pattern implementation accuracy (RQ2)

In order to address RQ2, we examined whether the type of loop construct (for vs. while) influenced the correctness of the students' implementations of linear and guarded search patterns. These patterns were selected because both involve iteration and were explicitly assigned with both loop types. Novice programmers often approach for and while loops differently: for loops offer structured iteration, whereas while loops require explicit control of loop variables and conditions (Soloway, 1986). By analysing the distribution of correct, redundant and incorrect solutions by loop type, we aimed to identify potential cognitive or syntactic challenges associated with each construct and how these evolved over time.

Table 3

Distribution of correct, redundant and incorrect solutions by loop type, pattern and phase. Patterns are labelled with (F) for implementations using a for loop and (W) for implementations using a while loop

Pattern	Correct			Redundant			Incorrect		
	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)
Linear search (F)	73	1.000	76	23	1.000	24	3	1.000	0
Linear search (W)	66	.963	62	16	.148	33	19	.232	5
Guarded search (F)	58	.940	62	27	.393	14	16	.600	24
Guarded search (W)	63	.196	81	11	.982	14	27	.070	5

Table 3 shows that the students' performance differed when using for versus while loops to implement linear and guarded search patterns, with distinctions in correctness, redundancy and errors across both research phases. For the linear search pattern, for loops were consistently more accurate: 73% correct in Phase 1 vs. 66% with while, and 76% vs. 62% in Phase 2. While loop solutions became more verbose over time: redundancies rose from 16% to 33% and errors declined from 19% to 5%. This suggests growing caution with while loops, possibly to avoid errors, whereas for loop solutions remained stable and efficient, with no errors by Phase 2.

Guarded search results were more nuanced. In Phase 1, correctness was low for both loop types (58% for, 63% while), with more errors in while (27%) than for (16%). By Phase 2, while loop performance had improved markedly (81% correct, 5% incorrect), whereas for loop correctness had increased only slightly (62%) and errors had risen to 24%. This suggests that the students developed a stronger conceptual grasp of while loops over time, particularly for more complex scenarios like guarded search, but reliance on for loops may have limited adaptability in handling edge cases.

While the differences observed did not reach statistical significance (all $p > .05$), the data provide suggestive evidence of distinct learning trajectories. For loops appeared to offer stable support for early mastery of simpler search tasks, minimising errors and redundancies, whereas while loops, although initially associated with higher error rates, seemed to encourage more deliberate reasoning in complex tasks as experience accumulated (Bonar & Soloway, 1983). Taken together, these tendencies emphasise the pedagogical value of engaging students with both loop types in varied problem contexts, as such exposure may strengthen their conceptual adaptability in algorithmic problem-solving.

Figure 3

Comparison of implementation correctness across loop types and phases, showing overall improvement in Phase 2, with while-based linear search shifting from incorrect to redundant solutions

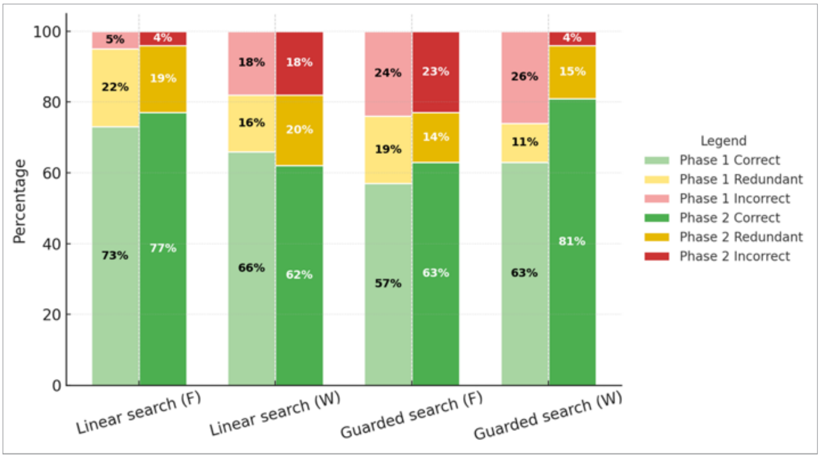


Figure 3 offers a visual comparison of implementation quality across loop types and research phases. It highlights the rise in correct implementations and the decline in incorrect ones, especially in Phase 2. Notably, in linear search with a while loop, incorrect solutions decrease while redundant ones increase, partly replacing correct implementations. This suggests that second-year students, who are still novice programmers, may adopt cautious or overly verbose coding strategies to avoid errors, which is consistent with research showing that novices often make small local fixes rather reformulating programs (Robins et al., 2003).

Learning complexity in search pattern implementation (RQ3)

Guarded search builds on basic linear search by adding control logic to handle cases where no match is found, increasing its cognitive complexity. In RQ3, we examine whether this added complexity leads to systematically lower implementation accuracy compared to linear search. The focus is on whether the pattern's logic – not its syntax – poses a greater challenge for novice programmers. In order to isolate the effect of pattern complexity from loop syntax (analysed in RQ2), we aggregated performance data across both for and while implementations. Table 4 presents the average proportions of correct, redundant and incorrect implementations for each pattern across the two research phases, calculated by averaging the results from both loop types for each pattern-phase combination.

$$Linear_{year} = \frac{(Correct_{for} + Correct_{while})}{2}$$

This approach was used because all of the students implemented both loop variants of each pattern. Averaging across loop types allowed us to assess whether the students consistently struggled more with the logic of guarded search, particularly in terms of incorrect or structurally flawed solutions. The comparison highlights differences in the cognitive demands of each pattern, offering a more pattern-focused view of the students' algorithmic understanding.

Table 4

Average distribution of solution types for linear and guarded search patterns across loop constructs

	Correct			Redundant			Incorrect		
Pattern	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)	P1 (%)	*p*	P2 (%)
Linear search	70	1.000	70	20	0.324	28	10	0.069	2
Guarded search	60	0.213	71	19	0.648	14	21	0.377	15

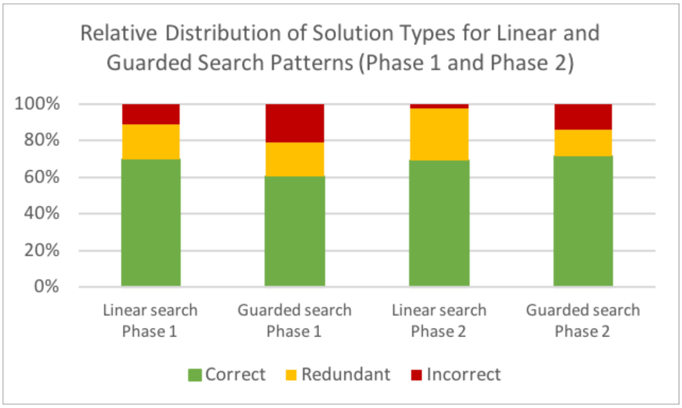
The data suggests that guarded search posed greater implementation challenges than linear search, regardless of loop type. In Phase 1, average correctness for guarded search was 60%, compared to 70% for linear search, with nearly twice as many incorrect solutions (21% vs. 10%). In Phase 2, correctness for linear search remained at 70%, whereas guarded search rose to 71%; incorrect implementations were still more frequent for guarded search than for linear search (15% vs. 2%). However, none of the Phase 1 vs. Phase 2 differences reached statistical significance with the available sample sizes (χ^2 tests, all $p \geq .318$; see Table 4). Figure 4 provides a visual representation of these tendencies: the students continued to struggle more with guarded search logic, particularly with formulating guarding conditions that prevent out-of-bounds checks or premature exit. Redundant or semantically inconsistent checks were also more common in guarded implementations in Phase 1. These patterns align with Lister et al. (2004), who emphasised that guarding conditions introduce additional complexity and require reasoning about collection bounds and logical safety.

At the same time, Phase 2 shows a higher rate of redundancy in linear search than in guarded search (28% vs. 14%). Although this difference was not statistically significant, it is pedagogically noteworthy and may reflect several mechanisms: increased caution regarding edge cases, leading to overly defensive coding practices; over-generalisation of guarding strategies to contexts where a simple linear search would suffice; and assessment practices that emphasise functional correctness over structural simplicity. Taken together, the results should be regarded as indicative rather than conclusive: they suggest that experience may reduce severe errors in linear search, whereas guarded search continues to impose higher cognitive demands; at the same time, redundancy in linear search appears to persist, or even increase, unless explicitly addressed.

Given these findings, we propose that instructional support should focus on both issues: providing scaffolding for reasoning about guarding conditions and collection bounds, thereby addressing the residual logic-safety challenges in guarded search highlighted by Lister et al. (2004); and explicitly emphasising simplicity and avoidance of redundancy in linear search, through approaches such as contrastive examples, refactoring activities and rubrics that reward clarity and minimal yet sufficient checks. This dual focus acknowledges that correctness in guarded search appears to improve naturally with experience, whereas redundancy in linear search tends to persist or even increase unless it is deliberately incorporated into instruction and assessment.

Figure 4

Guarded linear search remains more error-prone than linear search despite improvements in Phase 2, while redundancy in linear search increased



Linking implementation to pattern recognition and explanation (RQ4)

In the third study phase (Phase 3: Year 3 or 4), we assessed how prior implementation experience influenced the students' ability to recognise and explain programming patterns. The students completed a questionnaire with Python snippets representing the four target patterns at three complexity levels – basic, intermediate and advanced – where complexity reflected syntactic structure and expression. They identified the pattern and explained its implementation.

Table 5

Proportion of incorrect responses in programming pattern recognition across difficulty levels

Programming Pattern	Task Difficulty	Incorrect
	B/I/A	%
Linear search	Basic	18
	Intermediate	35
	Advanced	30
Guarded search	Basic	18
	Intermediate	12
	Advanced	29
Counting	Basic	0
	Intermediate	6
	Advanced	6
Extreme values	Basic	6
	Intermediate	24
	Advanced	12

Recognition accuracy varied by pattern and difficulty level (Table 5). The counting pattern was recognised consistently well across all levels (94–100%), indicating strong conceptual understanding and robustness to syntactic complexity. In contrast, recognition accuracy declined for linear search (82% to 65%) and guarded search (88% to 71%) from basic to intermediate levels, suggesting that more complex representations hinder abstraction and generalisation.

We computed Pearson correlations between implementation scores in Phase 1 (including both correct and redundant solutions) and recognition accuracy. As shown in Table 6, a significant correlation was found for counting at the intermediate level (r = .685, p = .002), indicating a strong connection between practical experience and conceptual recognition. Other patterns showed weak to moderate correlations, with no significant results except a borderline effect for basic-level linear search (r = .471, p = .056).

Table 6

Correlations between implementation success and pattern recognition accuracy across task levels

Pattern	Task Level	Stat. Sig.	*Pearson r*	*p-value*
	B/I/A	bor./yes/no		
Linear search	Basic	borderline	0.471	0.056
	Intermediate	no	-0.119	0.648
	Advanced	no	-0.054	0.838
Guarded search	Basic	no	-0.084	0.747
	Intermediate	no	0.345	0.175
	Advanced	no	0.173	0.506
Counting	Basic	—	nan	nan
	Intermediate	yes	0.685	0.002
	Advanced	no	-0.091	0.728
	Basic	no	0.139	0.596
Extreme values	Intermediate	no	-0.019	0.942
	Advanced	no	0.203	0.436

In order to test whether prior implementation predicted later recognition accuracy, we fitted a generalised linear mixed model (GLMM) with a binomial distribution and logit link. The dependent variable (RECOG_BIN) indicated correct pattern recognition (0 = incorrect, 1 = correct) and fixed effects included the number of successful prior implementations (IMP_TOTAL_OK), pattern type (PATTERN) and task difficulty (LEVEL) with a random intercept for each student (id). As shown in Table 7, the model was significant (F(6, 209) = 2.17, p = .047), indicating that the predictors contributed to recognition performance. However, implementation history did not significantly predict recognition (F(1, 209) = 1.27, p = .261). Only pattern type was a significant fixed effect (F(3, 209) = 3.11, p = .028), while task difficulty was not (p = .249). Nurollahian et al. (2024) similarly found that although CS2 students outperformed CS1 students overall, more than 30% still misidentified expert patterns, performing no better than CS1 students in these cases. This indicates that while experience improves implementation performance, significant difficulties in pattern recognition persist, highlighting the need for instructional approaches that explicitly support recognition and explanation.

Table 7

GLMM with binomial distribution and logit link; random intercept for subject (id); dependent variable: RECOG_BIN

Predictor	*F*	*df*	*p-value*
IMP_TOTAL_OK	1.27	1.209	.261
PATTERN	3.11	3.209	.028
LEVEL	1.40	2.209	.249
Model overall	2.17	6.209	.047

In order to further explore the impact of prior implementation on recognition accuracy, a refined GLMM was constructed using a binomial distribution with a logit link and a random intercept for each student. Fixed effects included successful implementations of GLS_FOR (Phase 1 and 2), COUNT (Phase 1), EXTREM (Phase 1) and GLS_WHILE (Phase 1). These variables were selected based on theoretical relevance to the recognition tasks and empirical trends observed in earlier models. Variables related to LS and Year 2 implementations of COUNT, EXTREM and GLS_WHILE were excluded due to low variance, convergence issues or lack of contribution to model fit.

As shown in Table 8, the model approached statistical significance overall ($F(5, 198) = 2.11$, $p = .066$), suggesting that the predictors jointly contributed to recognition performance. Significant predictors included GLS_FOR in Phase 2 ($F = 5.58$, $p = .019$), COUNT in Phase 1 ($F = 5.30$, $p = .022$) and EXTREM in Phase 1 ($F = 5.86$, $p = .016$). GLS_FOR in Phase 1 showed a marginal effect ($p = .065$), while GLS_WHILE (Phase 1) was not significant ($p = .192$).

Table 8

Fixed effects estimates in GLMM for pattern recognition accuracy

Predictor	*F*	*df1*	*df2*	*p-value*
GLS_FOR_P1	3.46	1	198	0.065
GLS_FOR_P2	5.58	1	198	0.019
COUNT_P1	5.3	1	198	0.022
EXTREM_P1	5.86	1	198	0.016
GLS_WHILE_P1	1.71	1	198	0.192
Model overall	2.11	5	198	0.066

In order to profile the students and subsequently offer tailored support, we conducted k-means clustering (Ikotun et al., 2023; Kodinariya & Makwana, 2013; Omar et al., 2020) based on the quality of programming pattern implementation in both phases and the ability to recognise and explain patterns. We evaluated implementation quality using a three-level rubric for each programming task solution: correct – accurate implementation of the required pattern; redundant – functionally correct but inefficient or unnecessarily complex solution; incorrect – failed implementation of the pattern. For each student, we then calculated the overall proportion of correct implementations across all four target patterns (linear search, guarded search, counting, extreme values) in the first and second research phase. This aggregated implementation success indicator (normalised to a 0–1 scale) was used as the basis for clustering students with the k-means algorithm.

Figure 5

Performance profiles of three student clusters: implementation quality in Phase 1 and Phase 2, pattern recognition, explanation and recognition-explanation gaps

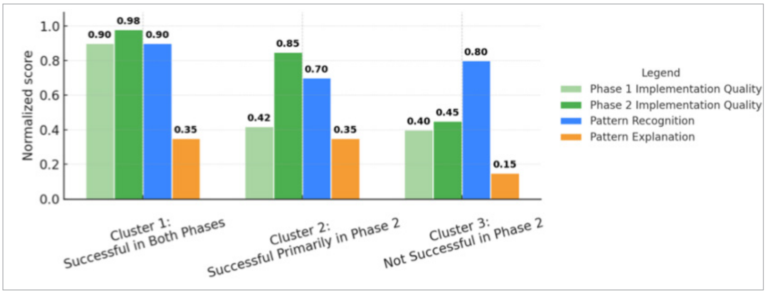


Figure 5 displays normalised average values (on a scale from 0 to 1) for different dimensions of programming pattern knowledge. The green bars indicate implementation quality in Phase 1 (light green) and Phase 2 (dark green). The blue bar (Pattern Recognition) shows the proportion of correctly recognised patterns in code analysis, assessed in Phase 3. The orange bar (Pattern Explanation) indicates the ability to verbally explain how patterns work, also assessed in Phase 3. Higher values indicate stronger performance across that dimension. The through k-means clustering. The consistent gap between recognition and explanation (blue vs. orange bars) across all three clusters further highlights the distinction between surface-level and conceptual understanding of programming patterns:

- Cluster 1 (Successful in Both Phases, n = 8): The students in this cluster achieved high implementation quality in both Phase 1 (0.90) and Phase

2 (0.98), and demonstrated strong pattern recognition ability (0.90, or 90%) but low explanation ability (0.35, or 35%). The normalised values represent the proportion of success on each dimension, scaled from 0 (0% success) to 1 (100% success). This indicates a substantial gap (0.55, or 55%) between what the students can recognise in code and what they can articulate in words.

- Cluster 2 (Successful Primarily in Phase 2, $n = 4$): These students showed lower implementation quality in Phase 1 (0.42) but improved substantially in Phase 2 (0.85). They demonstrated good pattern recognition ability (0.70, or 70%) and moderate explanation ability (0.35, or 35%), with the smallest gap between recognition and explanation (0.35, or 35%).
- Cluster 3 (Not Successful in Phase 2, $n = 5$): Despite weak implementation quality in Phase 1 (0.40) and limited improvement in Phase 2 (0.45), the students showed decent pattern recognition ability (0.80, or 80%) but very poor explanation ability (0.15, or 15%), resulting in the largest gap between recognition and explanation (0.65, or 65%).

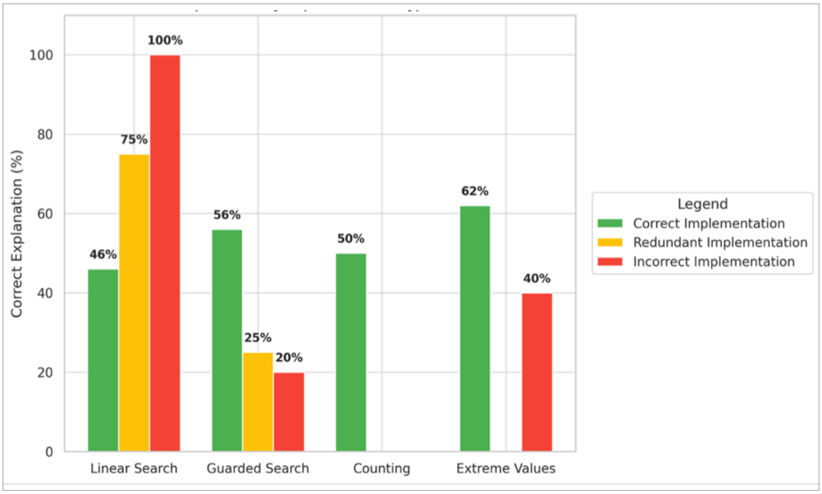
A key finding of our study is the universal presence of a gap between pattern recognition and explanation abilities across all of the student groups (Figure 5, difference between blue and orange bars). This suggests that implementation experience gained in Phases 1 and 2 alone is insufficient for developing the ability to articulate conceptual understanding. Even the students with excellent implementation skills in the earlier phases often lacked the corresponding abilities to explain the operation of these same patterns when assessed in Phase 3.

In order to examine the relationship between implementation and explanation ability, we computed Spearman rank correlations based on the students' combined implementation scores from Phase 1 (Introduction to Programming) and Phase 2 (Environments for CS Education). Implementations were rated as correct, redundant or incorrect; explanations (assessed in Phase 3) were scored from 0 to 1. Due to the ordinal and non-normal nature of the data, Spearman's ρ was used. The overall correlation was negligible ($\rho = 0.019$), indicating that code-writing proficiency and the ability to explain a solution function are largely independent skills, which is consistent with Lister et al. (2006).

As shown in Figure 6, each pattern displayed a unique implementation-explanation relationship; for example, in linear search, the students with flawed code provided better explanations than those with correct implementations. In contrast, only correct implementers explained the counting pattern successfully, although even here success was limited. Explanation accuracy rarely exceeded 60%, reinforcing the distinction between implementation accuracy and conceptual clarity.

Figure 6

Proportion of correct explanations by pattern type and implementation quality



These findings reveal a gap between procedural and conceptual knowledge: implementation competence does not necessarily translate into explanatory ability. While the students' code improved in Phase 2, explanation was assessed separately in Phase 3, so conceptual gains cannot be directly linked to implementation performance. As shown in Figure 6, explanation success varied by pattern but did not follow a consistent trend. In linear search, the students with redundant or even incorrect implementations explained the solution more successfully than those with correct code. In contrast, only the students with correct implementations explained the counting pattern successfully, although overall success remained modest even here. These results support earlier findings that novice programmers often struggle to move beyond surface-level understanding (Lister et al., 2006), thus highlighting the need for pedagogy that explicitly supports both coding accuracy and conceptual articulation.

Recognition-explanation disparity in programming pattern pedagogy (RQ5)

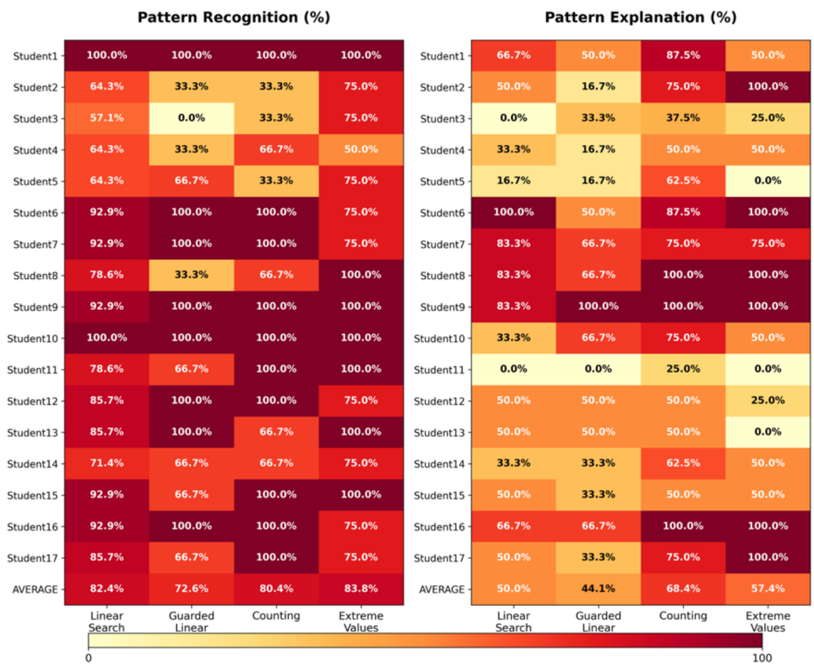
This section examines the relationship between the students' recognition and explanation of programming patterns, and its pedagogical implications in introductory CS education. Figure 7 displays shows recognition (left) and explanation (right) performance for 17 students across four programming patterns. The scores were computed as follows:

$$Recognition\_accuracy = \frac{Num\_of\_corr\_recognized\_patterns}{Num\_of\_tasks\_where\_that\_pattern\_was\_expected}$$

$$Explanation\_performance = \frac{(Num\_of\_corr\_explained\_patterns) + 0{,}5 * (Num\_\_of\_partially\_corr\_explained\_patterns)}{Num\_of\_tasks\_where\_that\_patt\_was\_expected}$$

Figure 7

Heatmap of programming pattern recognition accuracy and explanation performance among pre-service CS teachers



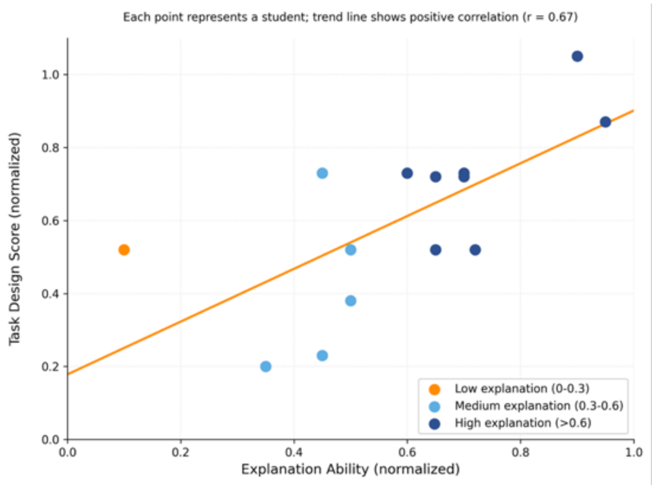
Our analysis reveals a consistent gap between the students' recognition and explanation abilities. Recognition ranged from 72.6% to 83.8%, while explanation lagged behind at 44.1% to 68.4%, indicating a 25–30% gap. This finding aligns with cognitive theory distinguishing recognition as a lower-level process and explanation as conceptually demanding (Fuller et al., 2007).

Linear search showed the largest disparity (82.4% vs. 50.0%), which is notable given its central role in novice instruction. Guarded search followed (28.4%), suggesting that error-handling increases conceptual demands. Extreme values (26.5%) similarly revealed challenges in explaining updating logic. By contrast, counting exhibited the smallest gap (12.1%), indicating its potential as a pedagogical entry point. This recognition-explanation gap aligns with Lister et al., 2006, who found that novice programmers typically provide multi-structural responses (line-by-line descriptions), while experts offer relational responses that capture the code's overall purpose. Our findings extend this phenomenon to programming patterns, where students can identify structures but struggle to explain their conceptual foundations, which is a critical limitation for future educators. These results highlight the importance of explicitly developing explanation skills in CS teacher education. As highlighted in a study by Soloway (1986), the "explanations" component of programming knowledge appears considerably more difficult to develop than the "mechanisms" component. Our findings empirically demonstrate that novices may recognise patterns but struggle to articulate their underlying mechanisms. Bridging this gap is essential for preparing teachers who can communicate not only what a pattern does but also how and why.

Pattern explanation ability as a predictor of task design quality (RQ6)

We tested whether explanation ability was correlated with the students' task design performance using correlation analysis. The results revealed a strong positive relationship ($r = 0.71$; Figure 8), supporting the role of conceptual clarity in pedagogical competence.

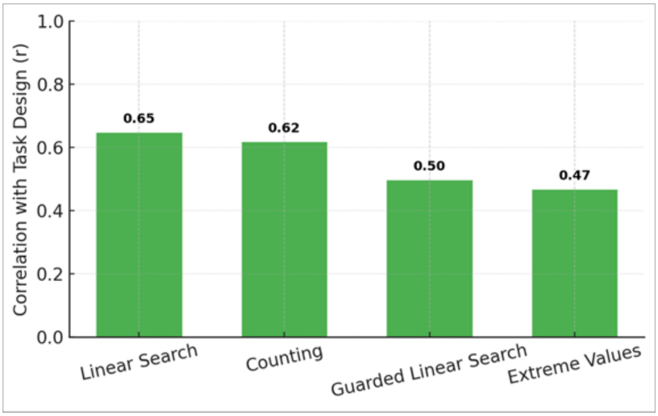
Figure 8
Relationship between explanation ability and task design quality



Pattern-specific correlations (Figure 9) show that the ability to explain **linear search** (r = 0.65) and **counting** (r = 0.62) most strongly correlates with task design quality, while **guarded search** (r = 0.50) and **extreme values** (r = 0.47) have moderate effects. This suggests that explanatory mastery of foundational patterns supports broader instructional skill more than explanations of complex cases.

Figure 9

Pattern-specific correlations (r) between explanation and task design performance



The results underscore the importance of fostering not only procedural fluency in implementing patterns but also the ability to explain them, as such explanatory clarity translates directly into higher-quality pedagogical task design. The pattern-specific correlations suggest that the ability to articulate how and why foundational patterns work is particularly important for pedagogical competence. This aligns with cognitive theory distinguishing recognition as a lower-level process and explanation as conceptually demanding (Lister et al., 2006; Venables et al., 2009), underscoring the need to prioritise explanation skills in CS teacher education (Nurollahian et al., 2025; Simon & Snowdon, 2011).

Discussion

The results of our longitudinal study highlight the multifaceted development of conceptual knowledge of programming patterns among pre-service computer science teachers. Our first research question examined how successfully students implement different programming patterns and whether this success improves with experience. The analysis showed that the proportion of correct implementations increased from 64% in the first phase to 79% in the second, indicating progress, albeit unevenly across patterns. Students encountered the fewest difficulties with counting, confirming the findings of Lahtinen et al. (2005) that additive patterns are more accessible and serve as an entry point in developing conceptual knowledge. In contrast, patterns requiring initialisation and continuous updating of variables and handling of boundary conditions – especially guarded search and extreme values – proved most problematic (Astrachan & Wallingford, 1998; Fisler, 2014). Our study adds a new contribution by showing that these challenges are also evident among pre-service teachers, a group not previously examined in detail.

The second research question investigated how the choice of loop construct (for versus while) influences pattern implementation. The results indicate that for loops supported early understanding and reduced errors in simpler patterns such as linear search, whereas while loops were initially associated with more errors. However, in more complex tasks such as guarded search, the greatest improvement was observed in while loops (63% to 81% correct solutions in Phase 2). This supports the findings of Bonar and Soloway (1983), Soloway (1986) and Soloway et al. (1983), all of whom noted that for loops provide structured support, whereas while loops require more conceptual control but ultimately foster deeper understanding. Pedagogically, this highlights the importance of exposing students to both loop types in varied contexts, as each type contributes differently to developing conceptual flexibility in algorithmic problem solving.

The third research question addressed whether guarded search is systematically more difficult than linear search due to its greater cognitive complexity. The results confirmed that students made more errors in guarded search, which is consistent with Lister et al. (2004). However, correctness improved with experience, even without explicit instructional support, suggesting that more complex patterns can become manageable over time. In contrast, linear search showed an increase in redundant solutions in Phase 2. This suggests that even in simpler patterns, students may persist in overly cautious or non-optimised strategies, either due to local line-by-line reasoning (Robins et al., 2003) or unsuccessful attempts to apply more advanced constructs. This finding is consistent with Xie et al. (2019), who emphasised that tracing, recognising templates and writing code with them are distinct skills acquired incrementally. Our contribution here is to show that while correctness increases with experience, optimisation may decline, revealing a need for instructional support specifically targeted at recognising and reducing redundancy in linear search.

The fourth research question examined whether prior implementation experience predicts later success in recognising and explaining patterns. Our analyses showed that this link was weak: GLMM results indicated that the type of pattern, rather than the history of successful implementations, was the main predictor. Similar to the findings of Nurollahian et al. (2024), our study showed that even students with more programming experience could still misidentify expert patterns, indicating persistent conceptual gaps. Cluster analyses confirmed that this disconnect between implementation experience and later understanding was evident across all of the student groups, including those who had performed well in earlier phases. This is particularly important for pre-service computer science teachers, who must be experts in both computing and pedagogy. Our study shows that successful implementation alone does not guarantee conceptual understanding, underscoring the need for deliberate instructional support in this area.

The fifth research question examined the relationship between recognition and explanation of programming patterns. The results showed a consistent gap: recognition success was relatively high (73–84%), while explanation lagged by 25–30 percentage points. The largest disparity occurred in linear search and the smallest in counting, indicating that more complex patterns place greater demands on conceptual understanding. This "recognition-explanation gap" supports the findings of Lister et al. (2006), who observed that novices often remain at a multistructural level of understanding, and Soloway (1986), who noted that explanatory knowledge develops much more slowly than procedural mechanisms. Our study extends these insights by focusing on pre-service teachers, for whom explanation ability is a critical professional competence. The findings show that recognition ability alone does not ensure explanatory ability. For teacher education, this implies that curricula must systematically include tasks that develop explanatory skills, as these are a core teaching competence. Research such as Weinman et al. (2021) further demonstrates that structured activities like faded Parson's problems can strengthen recognition and transfer without requiring major curricular reform, suggesting a promising approach for bridging this gap in teacher preparation.

The sixth research question explored the relationship between explanation ability and the quality of pedagogical task design. The results showed a strong positive correlation ($r = 0.71$), confirming that conceptual clarity directly supports pedagogical competence. The strongest associations were found for explanations of linear search and counting, suggesting that mastery of foundational patterns contributes more to high-quality task design than explanations of more complex cases. This aligns with research identifying explanation as a more cognitively demanding process than recognition (Lister et al., 2006; Venables et al., 2009). Our study builds on this by demonstrating its direct significance for pre-service teachers: a successful teacher must not only have procedural skills in implementation but also be able to clearly and meaningfully explain how patterns work and, based on this, design effective learning tasks (Nurollahian et al., 2025; Simon & Snowdon, 2011).

Overall, our findings demonstrate that procedural knowledge and conceptual understanding of programming patterns do not develop in parallel, and one does not necessarily guarantee the other. Although the participating students improved in implementation with experience, gaps remained in explanation, optimisation and the transfer of knowledge to pedagogical contexts. Our contribution is to show that pre-service teacher education must deliberately foster both implementation and explanatory skills, as only their combination enables high-quality task design and effective teaching of programming.

Conclusion

This study examined how pre-service computer science teachers develop conceptual understanding of core programming patterns over time. Across multiple phases, our findings showed that implementation accuracy improved with experience, but not all patterns progressed equally: additive patterns such as counting were more accessible, while state-tracking and conditional patterns (guarded search, extreme values) remained challenging. Differences between for and while loops confirmed that both constructs support learning in distinct ways, with while loops ultimately fostering deeper understanding in more complex tasks. At the same time, linear search revealed persistent redundancy, underscoring the need to address not only correctness but also optimisation in instruction.

Importantly, our results highlight the fact that prior implementation success does not reliably predict later recognition or explanation of patterns. A consistent gap was observed between the participating students' ability to recognise patterns and their ability to explain them, and explanation ability was strongly correlated with the quality of pedagogical task design. These findings point to a critical implication for teacher education: pre-service teachers must not only be able to write and recognise correct code but also to articulate how and why patterns work, so that they can design effective learning tasks and clearly explain programming concepts to their students, competencies that are central to becoming successful computer science teachers.

Although limited by a small, context-specific sample, our study provides novel insights by focusing on pre-service teachers, a population rarely studied in this context. This limitation highlights the need for replication with larger and more diverse cohorts, as well as for longitudinal studies that follow future teachers into classroom practice. Further research should also explore targeted interventions, such as explanation-focused training or the use of structured pattern-based activities, in order to determine whether they can reduce the recognition-explanation gap and strengthen pedagogical competence.

Ethical statement

The study was approved by the Ethics Committee of the Faculty of Education, University of Ljubljana.

Disclosure statement

The authors have no conflict of interest to declare.

References

Abesadze, S., & Nozadze, D. (2020). Make 21st century education: The importance of teaching programming in schools. *International Journal of Learning and Teaching*, 158–163. https://doi.org/10.18178/ijlt.6.3.158-163

Astrachan, O., Berry, G., Cox, L., & Mitchener, G. (1998). Design patterns: An essential component of CS curricula. In J. Lewis, J. Prey, D. Joyce, & J. Impagliazzo (Eds.), *SIGCSE '98: Proceedings of the Twenty-Ninth SIGCSE Technical Symposium on Computer Science Education* (pp. 153–160). Association for Computing Machinery. https://doi.org/https://doi.org/10.1145/273133.273182

Astrachan, O., & Wallingford, E. (1998, August). *Loop patterns*. Users.cs.duke.edu. http://www.cs.duke.edu/~ola/patterns/plopd/loops.html

Bonar, J., & Soloway, E. (1983). Uncovering principles of novice programming. In J. R. White, L. Landweber, A. Demers, & T. Teitelbaum (Eds.), *Proceedings of the 10th ACM SIGACT-SIGPLAN Symposium on Principles of Programming Languages - POPL '83* (pp. 10–13). Association for Computing Machinery. https://doi.org/10.1145/567067.567069

Bosco, A., Santiveri, N., & Tesconi, S. (2019). Digital making in educational projects. *Center for Educational Policy Studies Journal*, *9*(3), 51–73. https://doi.org/10.26529/cepsj.629

Fisler, K. (2014). The recurring rainfall problem. In Q. Cutts, B. Simon, & B. Dorn (Eds.), *Proceedings of the Tenth Annual Conference on International Computing Education Research* (pp. 35–42). Association for Computing Machinery. https://doi.org/10.1145/2632320.2632346

Fuller, U., Johnson, C. G., Ahoniemi, T., Cukierman, D., Hernán-Losada, I., Jackova, J., Lahtinen, E., Lewis, T. L., Thompson, D. M., Riedesel, C., & Thompson, E. (2007). Developing a computer science-specific learning taxonomy. *ACM SIGCSE Bulletin*, *39*(4), 152–170.

https://doi.org/10.1145/1345375.1345438

Ikotun, A. M., Ezugwu, A. E., Abualigah, L., Abuhaija, B., & Heming, J. (2023). K-means clustering algorithms: A comprehensive review, variants analysis, and advances in the era of big data. *Information Sciences*, *622*, 178–210. https://doi.org/10.1016/j.ins.2022.11.139

Kiesler, N. (2022). Reviewing constructivist theories to help foster creativity in programming education. In *2022 IEEE Frontiers in Education Conference (FIE)* (pp. 1–5). IEEE. https://doi.org/10.1109/FIE56618.2022.9962699

Kodinariya, T. M., & Makwana, P. R. (2013). Review on determining number of cluster in K-means clustering. *International Journal of Advance Research in Computer Science and Management Studies*, *1*(6), 90–95. http://ijarcsms.com/docs/paper/volume1/issue6/V1I6-0015.pdf

Lahtinen, E., Ala-Mutka, K., & Järvinen, H.-M. (2005). A study of the difficulties of novice programmers. *ACM SIGCSE Bulletin*, *37*(3), 14–18. https://doi.org/10.1145/1151954.1067453

Lister, R., Adams, E. S., Fitzgerald, S., Fone, W., Hamer, J., Lindholm, M., McCartney, R., Moström, J. E., Sanders, K., Seppälä, O., Simon, B., & Thomas, L. (2004). A multi-national study of reading and tracing skills in novice programmers. *ACM SIGCSE Bulletin*, *36*(4), 119–150. https://doi.org/10.1145/1041624.1041673

Lister, R., Simon, B., Thompson, E., Whalley, J. L., & Prasad, C. (2006). Not seeing the forest for the trees. In R. Davoli, M. Goldweber, & P. Salomoni (Eds.), *Proceedings of the 11th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education* (pp. 118–122). Association for Computing Machinery. https://doi.org/10.1145/1140124.1140157

Nurollahian, S., Keuning, H., & Wiese, E. (2025, February 16). Teaching well-structured code: A literature review of instructional approaches [Unpublished paper]. *Accepted to the 2025 IEEE/ACM 37th International Conference on Software Engineering Education and Training (CSEE&T).*

Nurollahian, S., Rafferty, A. N., Brown, N., & Wiese, E. (2024). Growth in knowledge of programming patterns: A comparison study of CS1 vs. CS2 students. In B. Stephenson, J. A. Stone, L. Battestilli, S. A. Rebelsky, & L. Shoop (Eds.), *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1* (pp. 979–985). Association for Computing Machinery. https://doi.org/10.1145/3626252.3630865

Nurollahian, S., Rafferty, A. N., & Wiese, E. (2023). Improving assessment of programming pattern knowledge through code editing and revision. In *2023 IEEE/ACM 45th International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET)* (pp. 58–69). IEEE. https://doi.org/10.1109/ICSE-SEET58685.2023.00012

Omar, T., Alzahrani, A., & Zohdy, M. (2020). Clustering approach for analyzing the student's efficiency and performance based on data. *Journal of Data Analysis and Information Processing*, *08*(03), 171–182. https://doi.org/10.4236/jdaip.2020.83010

Proulx, V. K. (2000). Programming patterns and design patterns in the introductory computer science course. In S. Haller (Ed.), *Proceedings of the Thirty-First SIGCSE Technical Symposium on Computer Science Education* (pp. 80–84). Association for Computing Machinery. https://doi.org/10.1145/330908.331819

Robins, A., Rountree, J., & Rountree, N. (2003). Learning and teaching programming: A review and discussion. *Computer Science Education*, *13*(2), 137–172. https://doi.org/10.1076/csed.13.2.137.14200

Robins, A. V. (2019). Novice programmers and introductory programming. In S. Fincher, & A. V. Robins (Eds.), *The Cambridge handbook of computing education research* (pp. 327–376). Cambridge University Press. https://doi.org/10.1017/9781108654555.013

Simon, & Snowdon, S. (2011). Explaining program code. In K. Sanders, M. E. Caspersen, & A. Clear (Eds.), *Proceedings of the Seventh International Workshop on Computing Education Research* (pp. 93–100). Association for Computing Machinery. https://doi.org/10.1145/2016911.2016931

Soloway, E. (1986). Learning to program = learning to construct mechanisms and explanations. *Communications of the ACM*, *29*(9), 850–858. https://doi.org/10.1145/6592.6594

Venables, A., Tan, G., & Lister, R. (2009). A closer look at tracing, explaining and code writing skills in the novice programmer. In M. Clancy, M. Caspersen, & R. Lister (Eds.), *Proceedings of the Fifth International Workshop on Computing Education Research Workshop* (pp. 117–128). Association for Computing Machinery. https://doi.org/10.1145/1584322.1584336

Vivitsou, M. (2019). Digitalisation in education, allusions and references. *Center for Educational Policy Studies Journal*, *9*(3), 117–136. https://doi.org/10.26529/cepsj.706

Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). Computer science in K-12 school curricula of the 2lst century: Why, what and when? *Education and Information Technologies*, *22*(2), 445–468. https://doi.org/10.1007/s10639-016-9493-x

Weinman, N., Fox, A., & Hearst, M. A. (2021). Improving instruction of programming patterns with Faded Parsons Problems. In Y. Kitamura, A. Quigley, K. Isbister, T. Igarashi, L. Bjørn, & S. Drucker (Eds.), *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1–4). Association for Computing Machinery. https://doi.org/10.1145/3411764.3445228

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Xie, B., Loksa, D., Nelson, G. L., Davidson, M. J., Dong, D., Kwik, H., Tan, A. H., Hwa, L., Li, M., & Ko, A. J. (2019). A theory of instruction for introductory programming skills. *Computer Science Education*, *29*(2–3), 205–253. https://doi.org/10.1080/08993408.2019.1565235

Yadav, A., Good, J., Voogt, J., & Fisser, P. (2017). Computational thinking as an emerging competence domain. In M. Mulder (Ed.), *Competence-based Vocational and Professional Education. Technical and Vocational Education and Training: Issues, Concerns and Prospects, vol 23* (pp. 1051–1067). Springer. https://doi.org/10.1007/978-3-319-41713-4_49

Zapušek, M. (2022). *Domenska ontologija programskih vzorcev pri uvodnem programiranju* [Domain ontology of programming patterns in introductory programming] [Doctoral dissertation, University of Ljubljana]. RUL. https://repozitorij.uni-lj.si/IzpisGradiva.php?id=136467

Zeng, Y., Yang, W., & Bautista, A. (2023). Teaching programming and computational thinking in early childhood education: A case study of content knowledge and pedagogical knowledge. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1252718

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Culturally Responsive Unplugged Integration of Computational Thinking Skills in Language/Literature and Arts Lessons: A Case Study in Greece

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Computational thinking skills are recognised as essential competencies for future citizens in an increasingly digital society, and such skills can be cultivated from the early stages of schooling through various pedagogical approaches. This article focuses on a culturally responsive, unplugged approach to teaching computational thinking skills, integrated within language/literature and arts lessons in primary education. The study examines the implementation of specially designed lesson plans for this purpose across multiple grade levels in Greek primary schools. It presents the methodology followed during the implementation of the lesson plans, emphasising the specific objectives related to linking computational thinking concepts with language/literature and arts curricula. Data drawn from the implementation process – including evidence of classroom practices and feedback collected from seven primary school teachers through questionnaires, focus group discussions and reflective journals – were analysed to address the research questions. The findings highlight effective elements of the educational design methodology, offer recommendations for teacher professional development, and underscore the potential of integrated, culturally responsive instruction in fostering computational thinking skills through unplugged activities in language/literature and arts education at the primary level.

Keywords: computational thinking, cultural responsiveness, educational design, integrated teaching, unplugged approach

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Kulturno odzivno vključevanje veščin računalniškega mišljenja v pouk jezika, književnosti in umetnosti s pristopom računalništva brez računalnika: študija primera v Grčiji

Stavroula Prantsoudi, Georgios Fesakis in Hüseyin Özçinar

Veščine računalniškega mišljenja so priznane kot bistvene kompetence za prihodnje državljane v vse bolj digitalni družbi, te veščine pa je mogoče razvijati že od zgodnjih stopenj šolanja z različnimi pedagoškimi pristopi. Ta članek se osredinja na kulturno odzivno vključevanje veščin računalniškega mišljenja v pouk jezika, književnosti in umetnosti v osnovni šoli, in sicer s pristopom računalništva brez računalnika. Študija preučuje izvajanje za ta namen oblikovanih učnih načrtov v več razredih grških osnovnih šol. Predstavlja metodologijo, ki se je uporabljala pri izvajanju učnih načrtov, s poudarkom na posebnih ciljih, ki povezujejo koncepte računalniškega mišljenja z učnimi načrti za jezik, književnost in za umetnost. Podatki, pridobljeni iz procesa izvajanja – vključno z dokazi o praksah v razredu in s povratnimi informacijami sedmih osnovnošolskih učiteljev, ki smo jih zbrali prek vprašalnikov, diskusij v fokusnih skupinah in refleksivnih dnevnikov –, so bili analizirani za obravnavo raziskovalnih vprašanj. Ugotovitve poudarjajo učinkovite elemente metodologije načrtovanja pouka, ponujajo priporočila za strokovni razvoj učiteljev ter poudarjajo potencial medpredmetnega, kulturno odzivnega poučevanja pri spodbujanju veščin računalniškega mišljenja prek pristopa računalništva brez računalnika pri pouku jezika, književnosti in umetnosti na osnovnošolski ravni.

Ključne besede: računalniško mišljenje, kulturna odzivnost, načrtovanje izobraževanja, medpredmetno poučevanje, pristop računalništvo brez računalnika

Introduction

The digital transformation of the economy and society influences every dimension of human activity, rendering the cultivation of citizens' digital competence through appropriate educational practices an urgent necessity. Future citizens must be adequately prepared to comprehend the complexities of the modern world and to engage actively in its ongoing digital evolution. In response to this demand, the European Union has established official policies aimed at enhancing digital competence (ECJRC, 2022) and promoting computer science education – referred to in this context as informatics education (ECDEAP, 2020) – to ensure that citizens are equipped to contribute meaningfully to the digital transformation of contemporary society.

The provision of equitable and high-quality computer science education varies significantly across education systems. Approaches range from the inclusion of discrete informatics subjects in basic education to international, large-scale initiatives involving voluntary participation, such as the *Hour of Code* and the *Bebras Challenge*, which seek to mitigate the absence of formal informatics courses at the primary and lower secondary levels (Fesakis et al., 2018). Given the constraints of available instructional time, increasing attention has been directed towards the integration of informatics concepts within the curricula of other subjects, both with and without the use of computers, through the unplugged approach. As well as optimising instructional time, such integration exploits the pedagogical benefits of the "integrated approach" (Neumann et al., 2021), fostering students' active engagement in meaningful learning, promoting deeper conceptual understanding, and encouraging interdisciplinary connections across diverse knowledge domains.

Computational thinking (CT) has been internationally recognised as a conceptual framework for integrating informatics within various school subjects (Fesakis et al., 2018; NRC, 2010; Wing, 2006, 2011). It is considered a cornerstone of digital competence, encompassing the ability to solve problems through the utilisation of informatics principles, methods and tools such as abstraction, generalisation, pattern recognition, algorithmic design, problem decomposition, data representation, simulation and automation, experimentation and play, debugging, persistence and continuation of work, collaboration-teamwork, etc. (Bocconi et al., 2022; Fesakis et al., 2018). CT can be effectively applied not only in disciplines closely related to informatics, such as mathematics and the natural sciences, but also in the humanities, social sciences and arts, reflecting the pervasive influence of digital technology across all fields. Moreover, as a fundamental practice of informatics that supports the solution of real-world problems, CT can be integrated into nearly every school subject, both in plugged and unplugged forms. Successful implementation, however, largely depends on the preparation and professional development of teachers tasked with facilitating such integration (Fesakis & Prantsoudi, 2019).

Unplugged activities mitigate concerns related to limited access to technological equipment by allowing learners to engage in kinesthetic, hands-on experiences that emphasise core informatics concepts without the distractions or technical demands associated with programming environments and software tools (Webb et al., 2017). When employed with younger students, unplugged activities have been found to enhance perceptual and conceptual understanding more effectively than plugged activities (Sung et al., 2017; Hu et al., 2024). Concurrently, the development of intercultural competence has also emerged as a critical educational objective, given the increasingly diverse and international composition of modern classrooms (Kavenuke & Kihwele, 2025; Portera, 2020).

The present study draws upon the outcomes of an international Erasmus+ project designed to advance the development of CT as a key twenty-first-century skill within primary education. The project involved the design and implementation of culturally responsive educational scenarios that integrate CT into language/literature and arts (visual arts and music) subjects without the use of digital technology – that is, through unplugged methods – drawing inspiration from the cultural heritage of the participating countries. The findings provide valuable insights into the educational potential of CT integration within a culturally responsive and interdisciplinary teaching framework.

The integrated approach to education

The integrated, or embedded, approach to education entails the combination of distinct scientific fields within the learning process to provide students with a more holistic, connected and contextually meaningful educational experience. This stands in contrast to the traditional, single-theme/single-discipline instructional model characterised by discrete and isolated teaching from each scientific field (Drake & Burns, 2004). Integration in education can take several forms, most notably interdisciplinary, multidisciplinary and transdisciplinary approaches (Choi & Pak, 2006). The interdisciplinary approach (Mulder, 2012) leverages conceptual and methodological connections between disciplines, the multidisciplinary approach involves examining a topic through the separate yet complementary perspectives of various fields, while the transdisciplinary approach dissolves the boundaries between scientific fields and often involves knowledge co-creation with stakeholders outside academia (Klein, 2013). The integrated approach offers substantial educational benefits (Jones, 2010), as it supports deeper learning through the development of a holistic understanding of complex systems, while also facilitating the synthesis of knowledge across domains, enabling students to perceive relationships between diverse concepts and disciplines.

As a fundamental practice within informatics involving the application of computer science concepts to diverse problem-solving contexts, CT can be effectively incorporated into almost all areas of compulsory education (Neumann et al., 2021; Weintrop et al., 2016). Such integration may occur through interdisciplinary, multidisciplinary or transdisciplinary strategies, depending on the degree to which the involved disciplines maintain distinct conceptual boundaries (Drake & Burns, 2004). Within the framework of the present project, CT was integrated into language/literature and arts courses in primary education, mainly through multidisciplinary and interdisciplinary methods, while further extensions to additional subjects and grade levels were also proposed. Although the unplugged nature of the implementation posed additional pedagogical challenges, it also enriched the creative and experiential dimensions of the learning process.

The rationale for integrating CT across subject areas is particularly strong, as even in educational contexts where discrete informatics courses are available, integrated lessons promote a more cohesive understanding of knowledge, allowing students to develop more durable and transferable cognitive schemas. The cultivation of CT competence inherently aligns with the principles of integration, as CT itself embodies the capacity to creatively and effectively apply informatics concepts across multiple domains. This holistic perspective served as the guiding principle for the present study.

Culturally responsive education

Culturally responsive teaching situates academic knowledge and skill development within the lived experiences of students, thereby fostering personal relevance, increased engagement and more effective learning (Gay, 2018). It constitutes a pedagogical framework in which instruction is adapted to reflect teachers' understanding (Mazzuki, 2024) and students' diverse cultural identities, capabilities and resources, often referred to as asset-based pedagogies. Such approaches utilise students' cultural backgrounds, customs, perspectives and lived experiences as instructional tools, positioning knowledge at the core of the learning process while empowering students from all social groups to become autonomous, critical and lifelong learners. Empirical studies demonstrate that culturally responsive pedagogies enhance students' active participation, motivation, conceptual understanding, self-efficacy and overall academic performance, both quantitatively and qualitatively (Will & Najarro, 2022).

In the context of the present project, culturally responsive lesson plans (LPs) were designed around fairy tales, myths, visual artworks and musical compositions, integrating elements of each participating country's cultural heritage. With respect to CT, the LPs were informed by the Computer Science Teachers Association (CSTA) Standards (2023), which emphasise equity and inclusion through pedagogical frameworks that align with the principles of culturally relevant/responsive pedagogy (CSTA, 2023).

A comprehensive account of culturally responsive CT educational design methodology developed and applied within the project is available at https://inctcorps.pau.edu.tr/.

Computational thinking with the integrated, unplugged approach

Across European education systems, CT is implemented through diverse instructional models, as a cross-curricular concept, as a distinct component of computer-related courses, or through the integration of informatics concepts into other subject areas such as science, literature and the arts (Bocconi et al., 2016, 2022). Consequently, pedagogical approaches to teaching CT vary according to how it is introduced, as well as the specific dimensions and practices emphasised in each educational context (Mannila et al., 2014). Previous research has highlighted the potential of the interdisciplinary integration of CT into subjects including mathematics and science (Weintrop et al., 2016), as well as arts and dance (Leonard et al., 2021). The pedagogical strategies and tools proposed for this purpose are equally diverse, encompassing methods that employ software and computer programming (Sengupta et al., 2013; Werner et al., 2012), technological devices (Atmatzidou & Demetriadis, 2015; Gardeli & Vosinakis, 2019; Leonard et al., 2016), or combinations of programming and traditional social or physical games (Lee et al., 2014).

Despite the range of digital tools proposed for CT instruction, the use of technology is not a prerequisite. CT can also be effectively taught through unplugged activities, which do not rely on computing devices (Bell, 2021). The unplugged approach facilitates the integration of CT across multiple subjects while promoting experiential, hands-on learning and conceptual understanding. In recent years, unplugged activities have been incorporated into official informatics curricula (Caeli & Yadav, 2020), often within the framework of integrated educational scenarios. These scenarios, grounded in constructivist learning theory, aim to support the teaching and learning of foundational computer science and CT concepts without requiring digital technologies or programming skills.

The playful and kinesthetic nature of unplugged and embodied learning activities fosters dynamic engagement with CT concepts, enabling learners, especially young children, to internalise and express CT principles through physical and creative means (Hu et al., 2024). The overarching goal of unplugged teaching is to broaden students' perspectives on CT and to nurture their intrinsic motivation to apply computational strategies in addressing interdisciplinary, real-world problems relevant to their interests. This approach is rooted in the understanding that computer science, on its own, may not inherently attract students' interest; rather, engagement and meaningful learning occur when activities align with students' perceptions of enjoyment, creativity and personal relevance (Bell, 2021).

Furthermore, unplugged activities have proven valuable in teacher professional development, offering educators accessible, inclusive tools for introducing CT concepts without technological constraints (Bell & Vahrenhold, 2018). Within the present research, the LPs were designed following the unplugged approach to facilitate the interdisciplinary integration of CT into language/literature and arts education at the primary school level.

Research problem and research questions

A review of the existing literature revealed an absence of prior research that combines cultural responsiveness with the unplugged approach to the integration of CT into language/literature and arts lessons in primary education. The present article addresses this gap by examining the implementation of such an approach within the framework of an international educational project and analysing its application in the Greek primary education context. The study aims to provide insights and empirical evidence in response to the following research questions:

1. Are teachers willing and adequately prepared to integrate culturally responsive and computational thinking elements into their daily teaching practices?
2. Can the culturally responsive, unplugged integration of computational thinking into language/literature and arts lessons be both effective and engaging for students?

3, Which aspects of the educational design employed in this research contribute to the success of the proposed approach?

The subsequent sections present the methodology and results of the study, provide answers to the above research questions, discuss the key findings, and propose directions for future research and development.

Method

Participants and research material

The study was conducted within the framework of an Erasmus+ KA220 project, involving partners from Turkey, Slovenia, Greece and Romania. The project's overarching objective was to promote the culturally responsive integration of CT into language/literature and arts lessons through the unplugged approach.

The Greek component of the study involved seven primary school teachers (five general education and two music education teachers; six female and one male) from five public primary schools. Each participating teacher selected two or three LPs from a database of 52 LPs developed by the project consortium. In total, 17 distinct LPs were implemented –12 in language/literature and 5 in arts (visual arts and music) – across Grades 1 to 4, with class sizes ranging from 20 to 25 students. Each LP had a duration of one to three sessions of 45 minutes each. Overall, data were collected from 17 LP implementations, 7 teachers, 155 students aged 6–10 years, and approximately 30 hours of classroom implementations.

Instruments

All of the LPs were designed to promote the development of CT skills while incorporating cultural elements such as tales, stories, myths and legends, folk songs, paintings, recipes, musical instruments, local features (mosaics, labyrinths), or traditional skills (weaving or singing). Each LP supported cross-curricular, multidisciplinary or interdisciplinary approaches and addressed a wide range of CT concepts and practices, including algorithmic thinking, decomposition, pattern recognition, abstraction and debugging. Each LP initially introduces the cultural element and then draws from language/literature and arts national curricula goals. In light of the cultural element, students are engaged in relevant activities to cultivate CT.

The LPs were developed following a standardised five-section template: Section A reports the LP's identity data (title, authors, country of origin, target group, duration, and school subject); Section B describes the aim and the intended learning outcomes, divided into subject-specific, CT-related and culturally responsive (CR) learning goals;

Section C describes in detail the teaching and learning process, including teaching, reinforcement and assessment activities; Section D provides additional information for teachers and proposed extensions; and Section E provides the educational materials. The complete collection of LPs is publicly available on the project's website: https://inctcorps.pau.edu.tr/.

Data collection involved multiple instruments such as a pre-implementation questionnaire completed by teachers to record their initial perspectives and readiness. Reflection and feedback reports were submitted by teachers after implementing each LP. Student feedback forms and completed worksheets provided additional qualitative data. A two-hour focus group discussion was held with all of the participating teachers following the implementation.

Research design

Prior to implementation, all of the teachers participated in a five-hour online training seminar conducted by the research team. The seminar introduced the project's theoretical foundations, familiarised the participants with the educational materials, and provided guidelines for implementation and data collection. Following the training, the teachers were given two weeks to review the theoretical background and select LPs for implementation.

During the implementation phase, the teachers implemented the LPs in their classrooms, collected student work, and documented their experiences through written reflection and feedback reports. Upon completion, all of the teachers participated in a comprehensive focus group session to discuss the process, challenges and perceived outcomes.

The researchers conducted a mixed-methods analysis, integrating qualitative and quantitative data from the various instruments to examine the implementation process, evaluate the teacher and student responses, and address the study's research questions.

The following sections present an analysis of the results, the answers to the research questions, and a discussion of the findings in light of the existing literature.

Results

Teachers' readiness to integrate CR and CT in their teaching

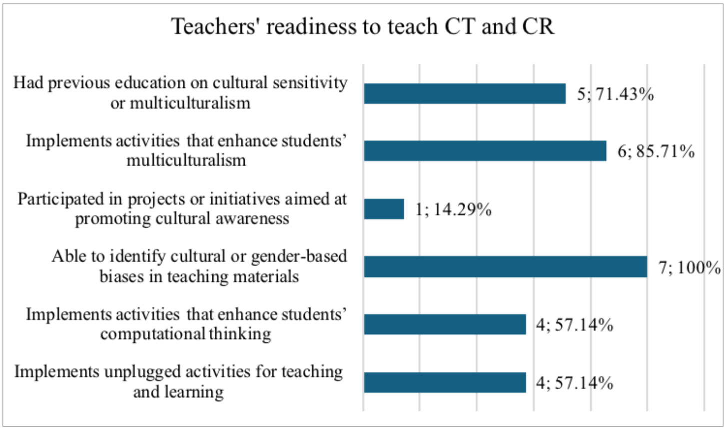
Most of the participants (5/7; 71.43%) reported having previously received some form of preparation related to cultural sensitivity or multicultural education. However, they emphasised that this preparation did not originate from their pre-service teacher training but rather stemmed from personal initiatives and professional interests. Examples included participation in seminars focused on teaching students with refugee or immigrant backgrounds, and attendance at specialised courses during postgraduate studies.

In only one case (1; 14.28%) did a teacher have prior involvement in projects or initiatives specifically designed to promote cultural awareness. Despite this limited formal experience, nearly all of the teachers (6/7; 85.71%) stated that they actively integrate multicultural awareness activities into their everyday teaching practice. Furthermore, all of the participants (7/7; 100%) expressed confidence in their ability to identify cultural or gender-based biases within educational materials, indicating a strong awareness of issues related to diversity and inclusion.

Regarding CT, more than half of the teachers (4/7; 57.14%) reported prior experience teaching CT-related concepts. When asked about their methods for developing problem-solving skills, the teachers described a variety of active learning strategies, including work in groups, case studies, projects, puzzles, treasure hunt, handmade constructions, games, STEM and web tools. They also mentioned fostering critical thinking, creativity and initiative, emphasising the importance of teaching students to follow structured problem-solving steps. Activities such as quizzes, role-playing, concept mapping, observation-comparison games and cooperative learning were cited as effective tools for cultivating analytical and empathetic thinking. The teachers further noted that discussion and guided reflection play key roles in achieving meaningful educational outcomes.

Approximately half of the participants (4/7; 57.14%) had prior experience in integrated lesson plans or unplugged activities that combine multiple subject areas for CT instruction, primarily within physics, mathematics and environmental education.

Figure 1
Teachers' readiness to teach CT and CR



Prior to the implementation phase, the teachers were asked to assess their familiarity with the main concepts underpinning the project. The results indicated that the participants perceived themselves as less familiar with CT and unplugged CT methodologies, while expressing greater familiarity with CR education and integrated curricular approaches.

Following their participation in the five-hour training seminar on CT, CR education, and the use of the LPs, the teachers provided highly positive evaluations of the experience. They described the training using terms such as "helpful", "accurate", "direct", "interesting", "clear", "specific", "enabling" and "supportive". These responses suggest that the training effectively addressed the teachers' knowledge gaps and initial concerns, particularly by helping them recognise CT-related elements already present in their existing instructional practices. The teachers emphasised that the training materials were "clear and easy to use", "interesting" and "understandable". This clarity allowed them to connect theoretical principles with practical applications, thus increasing their confidence in adopting new teaching methods.

After the training, the teachers self-assessed their confidence in implementing integrated, culturally responsive, unplugged CT lesson plans at an average level of 3.3 out of 5 on a Likert scale (1 = not confident to 5 = very confident). This moderate-to-high level of confidence indicates a positive shift in self-efficacy, suggesting that the professional development session contributed meaningfully to their readiness for implementation.

The teachers also expressed optimism about the training's potential to enhance creativity in their lessons and to broaden students' perspectives. One participant notably remarked that the training could serve as "a field of inspiration for new goals, and a basis for further development of existing ones", reflecting an emergent sense of professional growth and innovation. Table 1 presents the teachers' answers to questions before the training, on a 5-point Likert scale (1 = not familiar to 5 = very familiar).

Table 1

Teachers' readiness assessment.

	Means (*N* = 7)
Familiarity with the projects' concepts:	
Computational Thinking	2.7
Unplugged CT Activities	2.6
Culturally Responsive Education	3.6
Integrated Lesson Planning	3.4
Overall effectiveness of teacher training	4
Confidence about implementing the LPs	3.3

Following the implementation of the LPs, the teachers expressed a strong interest in receiving additional training on both CT and CR education. While they evaluated the educational approach employed in the project positively, they emphasised the importance of more extensive theoretical grounding and continuous professional support to enhance their capacity to integrate these concepts effectively into their everyday teaching practice. Some excerpts from the questionnaires and focus group discussions reflect the teachers' perspectives and evolving attitudes after their participation in the project:

T1: *"The LPs really make sense when one understands the theoretical framework, and I suggest that other colleagues who would like to do something similar should study it also."*

T2: *"Participating in this project has helped me to get more familiar with CT concepts."*

T3: *"I am looking forward to read and learn more about integrated CT and I feel there is a lot more that I have to learn."*

T4: *"I really liked it as an idea and educational practice. However, I wish to further cultivate this new method, so that I can be more informed and transmit it more correctly to my students."*

T5: *"I find teaching integrated computational thinking to be an extremely interesting and productive field. I would like to deal much more with the theoretical framework."*

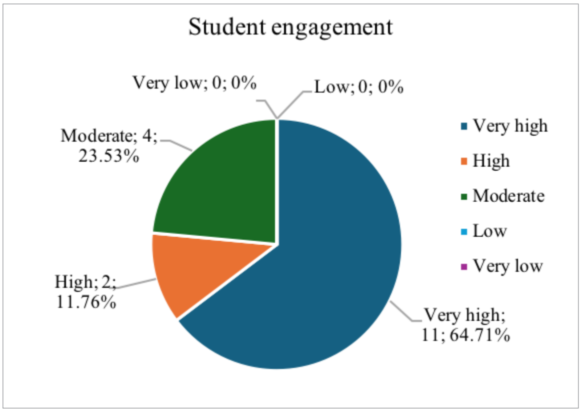
T6: *"It surprised me how much computational thinking is present in many things we do in our daily lives. Also, that computational thinking is taught through school lessons without us realizing it."*

T7: *"…but mainly it made me realize that computational thinking existed in my teaching to a greater extent than I thought."*

Effectiveness of the CR unplugged approach to CT integration

According to the teachers' responses (Figure 2), student engagement during the implementation of the LPs was consistently high. No cases of "low" or "very low" engagement were reported, and the teachers unanimously noted that the students participated with enthusiasm and excitement. In a few instances where engagement during the initial tale or myth introduction phase was moderate, the teachers observed a significant increase in interest once the students began participating in hands-on, unplugged activities.

Figure 2
Students' level of engagement during the implementation of the LPs



The teachers' qualitative comments and interview excerpts provide further evidence of this high level of engagement and its underlying causes (Table 2). The integration of myths, folktales and cultural elements from different countries played a key role in capturing the students' attention and fostering cultural responsiveness. These culturally embedded components not only made the lessons more appealing but also enhanced the students' cultural awareness and appreciation of diversity.

Table 2

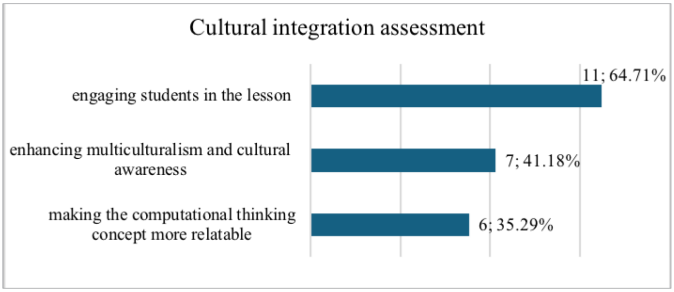
Student engagement evidence

Concept	Evidence
Student engagement	T6: *"Students were listening carefully to the teacher reading the story… answered questions… they collaborated within their groups to complete the activities…"* T1: *"The students were asking questions and they all participated with excitement in the activities."* T5: *"Children's participation in the analysis of the fairy tale was moderate. Then, with the introduction of the worksheet and the presentation of the rhythms, the children's participation increased."*
Reasons for student engagement	T4: *"The students were familiar with the fairytale as they knew it but in the Greek version which has a few differences and similarities."* T7: *"The activities were connected to the heroes, and they increased students' interest."*

The teachers highlighted the fact that the inclusion of cultural content contributed to student engagement in 11 LP implementations (11/17; 64.71%), partially promoted multiculturalism and cultural awareness in 7 cases (7/17; 41.18%), and made CT concepts more relatable in 6 cases (6/17; 35.29%), as illustrated in Figure 3.

Figure 3

Assessment of cultural integration

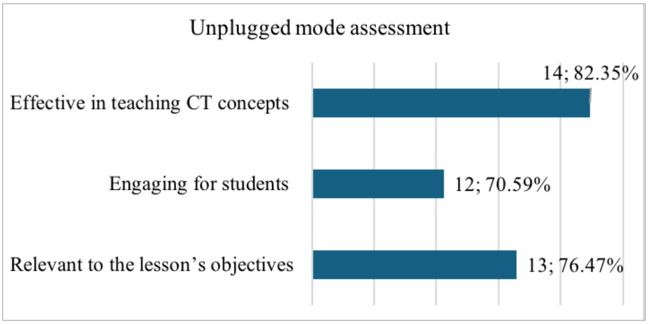


In order to explain student engagement, the teachers mentioned the students' familiarity with the topic, and the engaging and culturally appropriate activities. The students were reported to have enjoyed the fairy tale and connected with the heroes, while their engagement was reinforced by clear instructions and interesting activities promoting collaboration. However, multiculturalism and cultural awareness were low rated and should be further investigated.

The unplugged mode of the activities was also highly rated as effective in teaching CT concepts (14/17; 82.35%), engaging for students (12/17; 70.59%) and relevant to the lesson's objectives (13/17; 76.47%), as shown in Figure 4.

Figure 4

Assessment of the unplugged mode of the activities



The students were reported to have enjoyed working in pairs or teams through unplugged activities, discovering CT concepts and practices such as perseverance and collaboration. Language and arts lessons offered a new and distinctive context in which students were encouraged to think computationally. At the same time, the teachers indicated that learning objectives related to the arts and language were achieved in 14 cases (14/17; 82.35%), while CT learning goals were met in 16 cases (16/17; 94.12%), demonstrating the strong effectiveness of the LPs. The implementation process was described as highly successful, with no significant difficulties reported by the teachers. Any necessary adaptations, such as adjustments to the duration or the format of the activities (oral or written), were managed effectively according to the needs of each class. Overall, the students appeared to integrate unplugged CT activities smoothly through fairy tales and myths. They were able to partially associate CT with the narratives and, with teacher guidance, identify other situations in which they apply CT unknowingly, such as "following recipes, playing videogames, dressing, brushing teeth, making origami, assembling objects, or choosing a route from home to school", as noted by their teachers. The students also expressed enjoyment in creating and executing pseudocode and exploring how music boxes are programmed. Some of the students were particularly enthusiastic about this new way of thinking and showed eagerness to continue working on it, while others were initially more sceptical and only recognised the connection between technology and CT after teacher intervention, at which point they became more engaged and interested in learning more about CT and its applications. Selected excerpts from the students' reflective writings capture their evolving understanding and excitement:

S6: *"Helped me discover ways to solve my differences with my classmates when arguing during the school break."*

S5: *"… I created a small musical instrument with the help of my teacher."*

S3: *"I used computational thinking when I tried to compose my own piece of music with the metallophone. I used the code with the table and dots."*

S4: *"In my daily life there are many aspects of what we learned in class – repetitive situations (loops), problem solving, etc."*

S5: *"I use CT sometimes when difficult situations happen to me. In such cases I try to be calm, analyse the situation, think about similar cases in the past and try to find a solution."*

S6: *"… I liked that we talked about music boxes and programming. I wish I could build something like this in the future."*

Educational design of the CR unplugged approach of CT integration

The overall experience was positive and appeared to engage both students and teachers. The integration of multicultural elements within the LPs enhanced student involvement, while the inclusion of tales and myths provided a safe and meaningful context in which learners could emotionally connect with the heroes. Moreover, the unplugged approach not only increased interest and motivation among participants but also facilitated the implementation process by eliminating potential barriers related to technological equipment and digital literacy.

T3: " *An Italian student, who usually did not participate, started participating voluntarily because of the connection he found with the myth of Jason. Familiar educational material activates students."*

T5: *"I am excited by the connection of CT with music. I want to work more on this field."*

Cultural elements such as traditional recipes and folk songs, along with tangible educational materials like Lego and tangrams, were identified by the teachers as particularly effective components of the LPs. They noted that these elements contributed to enhancing student engagement and facilitating conceptual understanding. The integration of myths was also regarded as highly interesting and pedagogically valuable, as it provided a meaningful narrative framework for linking cultural content with learning objectives, although CT objectives were not highly connected to cultural awareness by the teachers. The reasons for this need to be investigated. However, the teachers emphasised the necessity of language adaptation and editorial adjustments to ensure that the myths correspond appropriately to the students' age level and linguistic competence.

T7: *"In the Romanian scenario, an activity of comparing the fairy tale with the corresponding Greek one emerged and the children's participation became very active and essential."*

T6: *"In the LP with the magical pipe, the use of metallophones and the composition with their own notation activated children."*

Interdisciplinary elements were employed by the teachers to support the implementation of the LPs in the classroom. In relation to the individual subjects, the teachers noted that the combination of myths and CT contributed to the enhancement of the students' language learning, as it encouraged comprehension, sequencing and narrative reasoning. They also emphasised the inherent connection between music and CT, observing that musical structure, rhythm and pattern recognition align naturally with key computational concepts and practices.

T1: *"We worked on the recognition of structural elements of texts."*

T7: *"They found it quite interesting as this interdisciplinarity in teaching helped them develop their critical thinking."*

T5: *"The playing of music and the creation of music involve elements of CT so it is a normal relationship. If we highlight it, it helps in learning music. If interdisciplinary commonalities are emphasized in LPs, then the cause is served."*

The teachers recognised the cultural responsiveness of the LPs and their capacity to include students from diverse backgrounds. Learners from different cultural and social groups, such as Roma students or those of various religious affiliations, were reported to have participated equally and actively in the implementation of the LPs. According to the teachers' observations, all of the students found the activities engaging and relevant, indicating that the culturally responsive design successfully promoted inclusion and equal participation in the learning process.

T6: *"Contact with the different helped students broaden their horizons and acquire critical skills."*

T1: *"Through fairy tales, they met other cultures and learned about the value of respecting diversity."*

T7: " *Maybe we could bring information from their group, e.g., Roma myths."*

The students' levels of enthusiasm and understanding were observed to evolve during and after the implementation of the LPs. While one student disengaged after facing difficulties, most found the lessons engaging and showed positive behavioural shifts towards collaboration, persistence and active participation.

T6: *"A student with dyslexia gave up on the Pixelart LP. Another student who usually does not work in groups liked the princess who saved the prince and actively participated."*

T4: *"When they had to construct something themselves, they were more excited than answering by writing on the worksheets."*

T1: *"Moreover, they were excited by the idea of an algorithm, an important idea for solving problems."*

The teachers emphasised challenges related to time management and recommended that the LPs be made more flexible to allow easier adaptation. Drawing on their experience, they proposed adjustments such as strengthening the connection between CT and myths, selecting or modifying activities, and replacing written tasks with oral ones. They also advised avoiding direct instruction of CT and suggested including additional cultural groups (e.g., Roma, immigrant communities).

Overall, the teachers noted that only long-term implementations can reveal the true impact of this approach on students' CT skills and cultural awareness. They found it difficult to assess measurable CT skill development but agreed on the importance of continued engagement in such activities to foster CT growth.

T7: "*... the effect is long-term evaluable. If there is continuation, CT will be developed. Cultural diversity requires a combination of many parameters to have a definitive result. The LPs are a positive contribution but what we need is continuity in the interventions.*"

Discussion

The results indicate a generally positive experience and reveal important insights regarding teacher preparation, student engagement and the educational impact of the culturally responsive, unplugged integration of CT in subject fields. The findings highlight both the potential of the approach and the continuing need for systematic teacher training in CT and cultural responsiveness.

Evidence suggests that teachers lack adequate pre-service preparation in cultural awareness, which contributes to cautious attitudes and uncertainty towards inclusive education, an issue similarly noted by Mazzuki (2024). Their readiness to teach cultural responsiveness appears to derive primarily from personal motivation and professional experience rather than formal education. Participation in initiatives promoting cultural awareness was minimal, and the teachers' sense of readiness may be attributed to instinct and accumulated teaching experience. Nevertheless, the importance of strengthening intercultural knowledge to prepare teachers for culturally diverse classrooms has been emphasised in prior research (Kavenuke & Kihwele, 2025), and policies supporting this direction remain essential.

Following the implementation of the LPs, the participating teachers expressed a strong demand for further training, as well as for structured educational materials and curricula. Although they reported familiarity with concepts such as culturally responsive education and integrated lesson planning, their confidence in implementing culturally responsive unplugged CT lessons was moderate. They rated the training they attended highly, reflecting both its effectiveness and above all their need for additional support in this area (Will & Najarro, 2022).

The teachers' responses demonstrated limited confidence and cautiousness regarding CT concepts and practices, which is consistent with earlier findings (Fesakis & Prantsoudi, 2019). While many of the teachers already used practices associated with CT, such as problem decomposition or algorithmic thinking, they often did so unconsciously. The realisation that such practices were already part of their teaching seemed to raise their awareness, but it also highlighted their insecurity and the need for further professional development.

Both the teachers and the students responded positively to the overall learning experience. The teachers described creative and enjoyable teaching moments, while the students were reported to have been highly engaged and actively involved throughout both the storytelling and activity phases. The students recalled their favourite heroes and activities, emphasising how the cultural context created a sense of connection and emotional engagement. Moreover, with teacher guidance, the students were able to relate CT to real-life experiences such as following recipes, playing games or organising daily routines, thus demonstrating the potential for transferring CT concepts beyond the classroom.

The teachers acknowledged the added value of cultural integration, noting that multicultural elements enhanced student participation and engagement

(Gay, 2018). However, while they recognised the motivational role of cultural elements, they did not always perceive a strong conceptual link between these and CT learning outcomes, probably due to their limited understanding of CT. Cultural responsiveness was seen primarily as a means of fostering inclusion rather than as an integral component of computational learning. The unplugged approach further contributed to student engagement by removing technological barriers and reducing the need for specialised skills or infrastructure.

Several aspects of the educational design emerged as critical to the project's success. Activities connected to familiar situations and well-known heroes sustained the students' interest, while cultural references from different countries promoted multicultural awareness and made CT concepts more relatable (Bocconi et al., 2022; Mannila et al., 2014). The use of tangible educational materials and the unplugged format increased accessibility and equity (Hu et al., 2024; Sung et al., 2017). Moreover, the interdisciplinary nature of the approach linked CT with language/literature and the arts, offering a creative and cognitively stimulating context that fostered engagement and learning in both academic and cultural domains (Žnidaršič, 2022).

The participating teachers suggested improvements concerning time management, activity format (oral, written or visual), inclusion of more cultural groups (e.g., immigrants, refugees, Roma), and longer intervention periods, emphasising that sustained application is necessary in order to observe measurable progress in CT skills and cultural awareness.

Overall, the results demonstrate that student engagement was the most immediate and pronounced outcome of the intervention, clearly surpassing observable gains in CT skills or cultural awareness. The students' enthusiasm and participation were strong indicators of the approach's motivational power and inclusiveness. While CT skills and cultural understanding were fostered to some degree, their development was less evident and harder to assess within the short implementation period. The teachers appear eager yet insufficiently prepared to integrate CT and cultural responsiveness fully, underscoring the need for ongoing professional development. Nonetheless, the overall effectiveness of the LPs and the positive feedback from both students and teachers affirm the potential of the integrated, culturally responsive, unplugged approach as a sustainable model for fostering engagement, inclusivity and the gradual cultivation of CT competence in primary education.

Conclusions

Based on the findings of this research, the culturally responsive, unplugged integration of CT into language/literature and arts lessons proved to be both effective and engaging for students and teachers. The results demonstrate that this educational design can be feasibly implemented in real classroom settings to support the cultivation of CT skills while simultaneously promoting cultural awareness and inclusion. Teachers appeared willing and able to adopt the proposed approach in their daily practice; however, they also expressed a need for further support and training to acquire a deeper understanding of CT concepts and pedagogical applications. Such support could be systematically provided through pre-service and in-service professional development programmes, as well as through the development of relevant curricula and instructional materials designed to scaffold CT integration. Future research should therefore explore teachers' specific training needs, focusing on effective strategies for developing their CT competence and confidence in implementing integrated, culturally responsive approaches.

The study also concludes that the culturally responsive unplugged approach constitutes an appealing and effective pedagogical model for cultivating CT skills in primary education. By combining cultural narratives with hands-on, technology-free activities, this approach successfully enhanced students' engagement, motivation and sense of connection to the learning content. These findings suggest that a methodology of this kind can serve as a powerful vehicle for promoting CT integration across disciplines. Future studies could expand on this work by increasing the sample size, involving a broader range of teachers, students and lesson plans, and conducting long-term interventions to assess the sustained effects of this method. Additionally, the use of validated assessment instruments would enable more precise evaluation of CT skill development and its potential influence on students' future academic, social and professional orientations.

Key educational design features contributing to the success of the approach include the interdisciplinary integration of CT across multiple subjects and the use of the unplugged methodology. This combination enabled the achievement of diverse learning objectives while optimising instructional time and resources and reducing inequities related to technological access or prior knowledge. Building on these strengths, future research could focus on reviewing, designing and evaluating curricula and learning materials that incorporate CT skills into other subject areas, leveraging cultural content and the unplugged format to ensure inclusivity and engagement.

Finally, it is recognised that computational thinking is a complex and multi-dimensional construct, requiring systematic, long-term and well-designed interventions to be meaningfully developed. This study represents a contribution towards that broader goal by offering empirical evidence and pedagogical insights that support the integration of CT, cultural responsiveness and unplugged learning as complementary dimensions of effective, equitable and future-oriented education.

Ethical statement

The research study was carried out following ethical standards for pedagogical research and was approved by the University of the Aegean Research Committee, Greece.

Disclosure statement

The authors have no conflict of interest to declare.

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References

Atmatzidou, S., & Demetriadis, S. (2016). Advancing students’ computational thinking skills through educational robotics: A study on age and gender relevant differences. *Robotics and Autonomous Systems*, *75*(Part B), 661–670. https://doi.org/10.1016/j.robot.2015.10.008

Bell, T. (2021). CS unplugged or coding classes? *Communications of the ACM*, *64*(5), 25–27.

Bell, T., & Vahrenhold, J. (2018). CS Unplugged – How is it used, and does it work? In H. J. Böckenhauer, D. Komm, & W. Unger (Eds.), *Adventures Between Lower Bounds and Higher Altitudes. Lecture notes in computer science* (pp. 497–521). Springer. https://doi.org/10.1007/978-3-319-98355-4_29

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A. & Engelhardt, K. (2016). *Developing computational thinking in compulsory education: Implications for policy and practice*. Publications Office of the European Union. https://doi.org/10.2791/792158

Bocconi, S., Chioccariello, A., Kampylis, P., Dagienė, V., Wastiau, P., Engelhardt, K., Earp, J., Horvath, M.A., Jasutė, E., Malagoli, C., Masiulionytė-Dagienė, V., & Stupurienė, G. (2022). *Reviewing computational thinking in compulsory education*. Publications Office of the European Union. https://doi.org/10.2760/126955

Caeli, E. N., & Yadav, A. (2020). Unplugged approaches to computational thinking: A historical perspective. *TechTrends*, *64*(1), 29–36.

Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and investigative medicine, 29*(6), 351–364.

Computer Science Teachers Association. (2023, June 5). *Inclusive teaching pedagogies.* https://csteachers.org/inclusive-teaching-pedagogies

Drake, S. M., & Burns, R. C. (2004). *Meeting standards through integrated curriculum.* ASCD.

European Commission. (2020). *Digital Education Action Plan 2021–2027: Resetting education and training for the digital age*. https://eurlex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0624

European Commission Joint Research Centre. (2022). Vuorikari, R., Kluzer, S., & Punie, Y. *DigComp 2.2, The Digital Competence framework for citizens: With new examples of knowledge, skills and attitudes.* https://data.europa.eu/doi/10.2760/115376

Fesakis, G., Komis, V., Mavroudi, E., & Prantsoudi, S. (2018). Exploring the scope and the conceptualization of computational thinking at the K-12 classroom level curriculum. *Computational thinking in the STEM disciplines: Foundations and research highlights* (pp. 181–212). Springer. https://doi.org/10.1007/978-3-319-93566-9_10

Fesakis, G., & Prantsoudi, S. (2019). Computer science teachers' perceptions, beliefs and attitudes on computational thinking in Greece. *Informatics in Education, 18*(2), 227–258. https://doi.org/10.15388/infedu.2019.11

Fesakis G., Prantsoudi S., Koutsomanoli-Filippaki D., Özçınar, H., Tugba-Ozturk, H., Serbec, I., & Paros D. N. (2022). *Guideline for teaching integrated and culturally responsive computational thinking skills for primary students* (1st ed.). INCTCORPS Project Report. https://inctcorps.pau.edu.tr/

Gardeli, A., & Vosinakis, S. (2019). ARQuest: A tangible augmented reality approach to developing computational thinking skills. In F. Liarokapis, M. Klein, I. Haubner, K. Höbart, G. Weinlinger, S. von Mammen, A. Vourvopoulos, I. Kico, & M. Žuži (Eds.), *Proceedings of the 11th International Conference on Virtual Worlds and Games for Serious Applications (VS-Games)* (pp. 1–8). IEEE. https://doi.org/10.1109/VS-Games.2019.8864603

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Hu, W., Huang, R., & Li, Y. (2024). Young children's experience in unplugged activities about computational thinking: From an embodied cognition perspective. *Early Childhood Education Journal*, *52*(4), 769–782.

Jones, C. (2010). Interdisciplinary approach: Advantages, disadvantages, and the future benefits of interdisciplinary studies. *Essai, 26*(7), 76–81.

Kavenuke, P. S., & Kihwele, G. E. (2025). Intercultural competence, a necessity in 21st century classrooms: Are teacher educators in Tanzania interculturally competent? *Center for Educational Policy Studies Journal*, *15*(1), 201–224. https://doi.org/10.26529/cepsj.1524

Klein, J. T. (2013). The transdisciplinary moment(um). *Integral Review*, *9*(2), 189–199.

Lee, I., Martin, F., & Apone, K. (2014). Integrating computational thinking across the K–8 curriculum. *ACM Inroads*, *5*(4), 64–71. https://doi.org/10.1145/2684721.2684736

Leonard, A. E., Daily, S. B., Jörg, S., & Babu, S. V. (2021). Coding moves: Design and research of teaching computational thinking through dance choreography and virtual interactions. *Journal of Research on Technology in Education, 53*(2), 159–177. https://doi.org/10.1080/15391523.2020.1760754

Leonard, J., Buss, A., Gamboa, R., Mitchell, M., Fashola, O. S., Hubert, T., & Almughyirah, S. (2016). Using robotics and game design to enhance children's self-efficacy, STEM Attitudes, and computational thinking skills. *Journal of Science Education and Technology*, *25*(6), 860–876. https://doi.org/10.1007/s10956-016-9628-2

Mannila, L., Dagienė, V., Demo, B., Grgurina, N., Mirolo, C., Rolandsson, L., & Settle, A. (2014). Computational thinking in K-9 education. In A. Clear, & R. Lister (Eds.), *Proceedings of the Working Group Reports of the 2014 on Innovation & Technology in Computer Science Education Conference* (pp. 1–29). ACM. https://doi.org/10.1145/2713609.2713610

Mazzuki, B. D. (2024). Preparing teachers for inclusive education: Pre-service teachers' knowledge, perceptions and experiences of inclusive pedagogy from teaching practice. *Center for Educational Policy Studies Journal,* Article 1807. https://doi.org/10.26529/cepsj.1807

Mulder, M. (2012). Interdisciplinarity and education: Towards principles of pedagogical practice. *The Journal of Agricultural Education and Extension, 18*(5)*,* 437–442. https://doi.org/10.1080/1389224X.2012.710467

National Research Council (NRC), Division on Engineering, Physical Sciences, Computer Science, Telecommunications Board, & Committee for the Workshops on Computational Thinking. (2010). *Report of a workshop on the scope and nature of computational thinking*. National Academies Press.

Neumann, M. D., Dion, L., & Snapp, R. (2021). *Teaching computational thinking: An integrative approach for middle and high school learning*. MIT Press. https://doi.org/10.7551/mitpress/11209.001.0001

Portera, A. (2020). Intercultural competence in education to foster European identity. *Journal of Educational Sciences, 40*(2), 14–27. https://doi.org/10.35923/jes.2019.2.02

Sengupta, P., Kinnebrew, J. S., Basu, S., Biswas, G., & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies*, *18*(2), 351–380. https://doi.org/10.1007/s10639-012-9240-x

Sung, W., Ahn, J., & Black, J. B. (2017). Introducing computational thinking to young learners: Practicing computational perspectives through embodiment in mathematics education. *Technology Knowledge and Learning*, *22*(3), 443–463. https://doi.org/10.1007/s10758-017-9328-x

Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). Computer science in K-12 school curricula of the 2lst century: Why, what and when? *Education and Information Technologies*, *22*(2), 445–468. https://doi.org/10.1007/s10639-016-9493-x

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology*, *25*(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5

Werner, L., Denner, J., Campe, S., & Kawamoto, D. C. (2012). The fairy performance assessment. In L. S. King, D. R. Musicant, T. Camp, & P Tymann (Eds.), *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education* (pp. 215–220). ACM. https://doi.org/10.1145/2157136.2157200

Will, M., & Najarro, I. (2022). What is culturally responsive teaching. *Education Week*, *41*(33), 16–18. https://www.edweek.org/teaching-learning/culturally-responsive-teaching-culturally-responsive-pedagogy/2022/04

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Wing, J. M. (2011). Research notebook: Computational thinking – What and why. *The Link Magazine*, *6*, 20–23. https://www.cs.cmu.edu/link/research-notebook-computational-thinking-what-and-why

Žnidaršič, J. (2022). Interdisciplinary interaction between music education and history: Shaping the musical preferences in classical music of the 20th century. *Center for Educational Policy Studies Journal*, *12*(2), 197–216. https://doi.org/10.26529/cepsj.976

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The Importance of the School Magazine as an Extra-Curricular Activity in Facilitating Students' Cross-Curricular Skills and Competences

Melita Lemut Bajec[1]

The paper discusses the school magazine as an important extracurricular activity. We first define the characteristics of school magazines, pointing to aims, content focus, types of texts and the organisation of editorial boards. The fact that school magazines present an important platform for young people to formulate their opinions, challenge societal norms and values, pursue their artistic aspirations, and acquire knowledge, skills and competences, as well as form group identity, is emphasised. The objective of the research was to identify how the theoretical underpinnings of the school magazine as a clash of genres are reflected in the selected corpus of 103 issues of the school magazine *Izvir*, which has been in circulation since 1967. Particular interest is focused on the content, the types of texts, the presence of the zeitgeist and the edition notice. The research is in the form of a case study, applying thematic network analysis. The results show that the researched corpus covers diverse content, relating mainly to curricular and extracurricular activities, embraced in informative and interpretative journalistic texts, entertaining features and a literary section. The extent of politically oriented content engaging with issues that mark the period 1979–1985 is exceptional. The edition notice shows a significant improvement from the first issues, which lacked much of the required data, to the present perfected issues. Lastly, the magazines mirror the zeitgeist, transitioning from socialist and communist ideology to democracy. All in all, school magazines are an important educational pillar, adding to the formation of young people's minds, but also encouraging teachers to question their roles, didactic methods and approaches. They also play a role in the formation of the school's recognition in the local community.

Keywords: edition notice, extra-curricular activity, skills and competences, school magazine, content, types of texts, zeitgeist

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Pomen šolskega glasila kot obšolske dejavnosti pri razvoju prečnih veščin in zmožnosti

Melita Lemut Bajec

Članek obravnava šolsko glasilo kot pomembno obšolsko dejavnost. Najprej opredelimo značilnosti šolskega glasila. Pogledamo cilje, ki jim šolska glasila sledijo, vsebino, besedilne vrste, ki se jih ustvarjalci glasil poslužujejo, in delovanje uredništev šolskih glasil. Poudarimo, da so šolska glasila pomembna platforma, ki mladim omogoča, da izrazijo svoje mnenje, so kritični do družbenih norm in vrednot, zasledujejo svoje umetniške ambicije, pridobivajo številno znanje, veščine in zmožnosti ter prek njih tudi izražajo pripadnost šoli. Z raziskavo smo želeli ugotoviti, kako se značilnosti šolskega glasila kot hibridnega medija sporočanja odražajo v izbranem korpusu 103 številk šolskega glasila *Izvir*, ki izhaja od leta 1967. Posebno pozornost smo namenili vsebinam, besedilnim vrstam, prisotnosti duha časa in kolofonu. V raziskavi je bila uporabljena študija primera, pri čemer smo se poslužili analize tematskih mrež. Izsledki so pokazali, da preučevani korpus pokriva raznolike vsebine, ki se nanašajo predvsem na šolske in obšolske dejavnosti, zajete v informativna in interpretativna publicistična besedila, zabavne vsebine in v literarno ustvarjanje. Presenetljiv je obseg političnoangažiranega pisanja, ki je v preučevanem korpusu svoj vrhunec dosegel med letoma 1979 in 1985. Analiza kolofona kaže, da je glasilo napredovalo od prvih številk, ki niso vsebovale vseh potrebnih podatkov, do današnjih dovršenih izdaj. Navsezadnje glasila odražajo duh časa, ki sega od socialistične in komunistične ideologije do demokracije. Šolska glasila so torej pomembna vzgojna in izobraževalna dejavnost, ki prispeva k oblikovanju mladih, omogoča preizpraševanje učiteljeve vloge in uporabe sodobnih didaktičnih pristopov ter prispeva k prepoznavnosti šole v lokalni skupnosti.

Ključne besede: kolofon, obšolska dejavnost, veščine in zmožnosti, šolsko glasilo, vsebina, besedilne vrste, duh časa

Introduction

The production of a school magazine is an important extracurricular activity and is perceived as indispensable in many schools (Mohor, 2008). It differs from other types of periodicals in its aims, characteristics, focus, organisation and distribution range (Prostináková Hossová & Švecová, 2019). As a clash of genres, the school magazine encompasses texts displaying linguistic and functional similarities within a standard set of guidelines that include tone, style, imagery, symbolism and emotion, and take into account text, audience, subject and context (Ljung, 2000). These texts seek to fulfil the social action of interpreting and responding effectively; they also serve as sites for social actions, cultural critique and change, as well as answering questions of how and why texts are produced as cultural artefacts (Bawarshi, 2000; Caudill, 2007; Hoffman, 2002; Miller, 1984, p. 151). The school magazine as a clash of genres is fragile in the sense that it needs to respond to a dynamic, evolving, interdisciplinary world through reflection and assessment of current events (Shavkatovna, 2021).

Characterised by a complex and interconnected activity system involving numerous stakeholders, the school magazine is often conditioned by the enthusiasm and knowledge of individual teachers and students (Prostináková Hossová & Švecová, 2019) who are dedicated to reporting about diverse topics, from curricular and extracurricular activities to topics beyond the school setting (Bowen, 2015), within diverse informative and interpretative journalistic texts (Mohor & Saksida, 2003, p. 41). However, it can also bring in more relaxing topics, as well as providing a platform for students' first literary and artistic attempts (Prostináková Hossová & Švecová, 2019). It is therefore safe to claim that the school magazine represents a platform that allows young people to formulate their opinions and critically reflect upon current problems, thus educating them in the vein of democracy and free speech, as well as helping them to develop creativity (Prostinákova Hossová, 2016, pp. 326–335; Prostináková Hossová & Švecová, 2019). With the literary dimension, it pursues cultural and aesthetic goals, while shaping young minds into critical readers and media consumers (Mohor & Saksida, 2003). Through the creation of a school magazine, students acquire knowledge of specific journalistic genres and develop cross-curricular complementary skills (Ferguson & Page, 2021), such as communicative, analytical, cooperative and ICT skills. By acquiring functional and organisational skills, students also learn journalism principles (Caudill, 2007) and thus prepare for "effective self-realisation in today's dynamic, information and mediatised society" (Kačinová, 2018, p. 39).

Students try their hand as novice journalists, writers, editors, designers, photographers, reporters, artists, poets, etc., and hone their skills, ideas and talents (Caudill, 2007; Mohor & Saksida, 2003; Mohor, 2008). They also get an opportunity to reflect on the politics of selection, representation and reception (Melbye & Tassoni, 2006), thus acquiring real-world experience and an insight into the publishing industry, which is driven by deadlines. The social nature of the genre ensures that each member depends on all of the others for success; therefore, the whole process must be entrusted to the hands of a capable, motivated and driven editor-in-chief, i.e., a student who takes responsibility for the entire process, from concept and choice of topics, to design, photography, organisation, production and editing (Caudill, 2007). The editor-in-chief should also make sure that a wide range of topics is covered, and that as many students as possible are included and given instruction on how to undertake thorough research, conduct interviews, write captions, take pictures, insert the data into a template, and take care of marketing, advertising, distribution, etc. (Prostináková Hossová & Švecová, 2019). In addition, the editor-in-chief should be aware of copyright and trademark infringement, libel, privacy rights, etc., and should ensure that the magazine offers a fair and balanced view of the school and is more than just a set of records and PR tools (Caudill, 2007).

The organisation of work in school magazines is influenced by several factors. The first is continuous generational exchange and unsteady membership numbers (Prostináková Hossová & Švecová, 2019), typically decreasing towards the end of the process due to voluntary participation and workload (Caudill, 2007). The second factor is active teacher/student collaboration; teachers must be present and supervise the process, helping with the proofreading while being careful not to interfere too much (Rigler, 2022; Prostináková Hossová & Švecová, 2019). Although students are typically the main decision-makers regarding the topics to be written about and published, teachers nonetheless often contribute with their own writings (Caudill, 2007; Prostináková Hossová & Švecová, 2019).

The creation and production process of the school magazine also presents an opportunity for educators to try out more flexible didactic methods and approaches, such as learning-by-doing, project-based, research-based, inquiry-based and problem-based learning, and thus develop a plethora of cross-curricular interdisciplinary skills much needed for students' future life (Prostináková Hossová & Švecová, 2019). It is also a way for the school to present itself to the general public and to develop closer links with the community in which it is embedded. As such, it is an ideal base for reflection, analysis and sharing of good practices (Kobolt & Žižak, 2013). As a piece of material culture, the school magazine can also be used as data to interpret past and present human activity (Hoffman, 2002).

If journalists are to be considered mirrors of society then journalism should genuinely reflect the community in which it is produced and not protect the image of this community (Bowen, 2015). Following this principle, it is no surprise that the school magazine reflects the zeitgeist[2]: it either reports on various historical, political or ideological movements, issues and views (Coyer et al., 2007) or is very much under their influence (e.g., the writings produced during the Yugoslav[3] era) (Mohor, 2008, p. 65). Overall, a school magazine being written for and by students of a specific school preserves images, stories and facts from each year for one specific group of people, linked by age and geographic community (Caudill, 2007). It also contributes to the sense of belonging (Lueck, 2017, p. 383), as it tends to empower by presenting positive images (Caudill, 2007).

The fact that school magazines have a rich tradition within the Slovenian educational setting is also worth emphasising. Dating back to the mid-nineteenth century, with magazines such as *Vaje* (1823), *Pesme za pokušno* (1832–1835), *Zvezek pesmi* (1833), *Vesna Daničice* (1848, 1851, 1852), *Lepa Vida* (1922), *Sprotuletna vijolica* (1846), *Vedež* (1848–1850), *Vrtec* (1871–1994) and *Angelček* (1887–1935), the early school magazines fulfilled the same goals as those of today: they created a platform for young people to sharpen, try out and demonstrate their artistic and editorial skills. This is how authors such as Simon Jenko (1835–1869), Fran Levstik (1831–1887), Matija Valjavec (1831–1897) and Srečko Kosovel (1904–1926) started their careers (Mohor, 2005; Prijatelj, 1995, pp. 236–241). At this point, it should be noted that, at the same time, young Slovenian female writers, such as Josipina Urbančič Turnograjska (1833–1854), Luiza Pesjak (1828–1898) and Lea Fatur (1865–1943), were also beginning to master their voice through poems, fairy tales, short stories, etc. (Blažić, 2018). To the best of our knowledge, however, they did not engage in the creation of school magazines of the early period in the way that their male counterparts did.

Having established the theoretical underpinnings, the study aims to research how the concept of the school magazine is manifested in a selected corpus of school magazines. To this end, four research questions were formulated:

(1) What kind of content prevails in the researched corpus?

2 Zeitgeist, a German word meaning "the spirit of the time", was first used by the German philosopher Georg Wilhelm Friedrich Hegel in his *Phenomenology of Spirit* in 1807. Zeitgeist encompasses the cultural, intellectual, ethical, philosophical and political climate that defines and reflects the spirit of an era and presents a platform for its thoughtful analysis and evaluation (Klikauer, 2016, p. 25).

3 The Yugoslav era refers to the times of the existence of the Socialist Federal Republic of Yugoslavia.

(2) What types of texts are used to embrace the content?
(3) How is the zeitgeist evident?
(4) What information does the edition notice reveal?

Method

The following is qualitative research that employs thematic network analysis as a method that seeks to "unearth the themes salient in a text at different levels" (Attride-Stirling, 2001, pp. 390–394).

Sample

The sample comprises 103 issues of the school magazine *Izvir* published at the Veno Pilon Secondary School in Ajdovščina. The study covers the period between 1967/68 (when the first issue was published) and 2021/2022. However, it is important to note that the school magazine continues to be published to this very day. Geared towards students, teachers and the local community, its mission is to encourage creativity among the young and disseminate information. It is published periodically, the language of communication being mainly Slovenian. The whole corpus is available at several locations: at the Archive of the Veno Pilon Secondary School in Ajdovščina and at the National and University Library of the Republic of Slovenia (NUK), while issues from 1967/68 to 2011/12 are also part of the Digital Library of Slovenia (dLib). Additionally, it is registered in COBISS (the Slovenian Library Information System that links libraries into a national library information system). The author of the present research decided to make use of the issues from the school's archive for several reasons: first, the digitalised collection finishes with the 2011/2012 school year; second, it is incomplete (a few issues of the first editions have only recently been discovered); and thirdly, due to paper and ink deterioration, some of the issues are difficult to read even in the paper format, which makes them almost indecipherable in digital form.

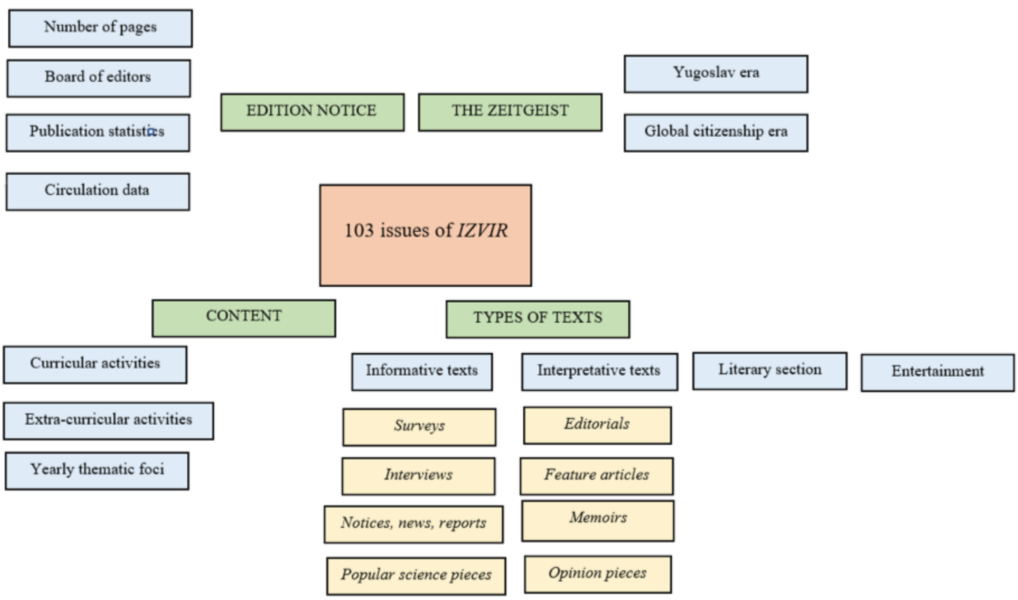
Instrument

We decided to apply a thematic network, a web-like map (Figure 1) that helped us understand the analysed corpus on both the explicit and implicit levels (Attride-Stirling, 2001, p. 388).

Research design

Based on the theoretical underpinnings and our research questions, a set of predefined categories was devised, which later emerged as global (overarching) themes. However, during the breaking-up process, the first basic (fundamental) themes and later organising (more abstract) themes unfolded. The organisation of the themes was executed by taking into account the intrinsic similarities they shared. After the thematic network was established, we formed a summary of each theme, made deductions and linked them with the relevant theory. Lastly, we looked at the thematic network, the research questions and the theoretical framework comprehensively and inferred conclusions from the patterns that emerged in the exploration of the texts, as well as exposing underlying questions.

Figure 1
Thematic network of the most salient themes found in the corpus



Results

The following section presents the results of the qualitative analysis, which yielded 4 global themes, 13 organising themes and 8 basic themes.

Content

The global theme 'content' splits into three organising themes: curricular activities, extracurricular activities and yearly thematic foci. The recurring basic themes among the first two organising themes are: excursions and field trips, culture, culture days and other culture-related events, project days, school clubs, competitions, achievements and awards, people important for the school, the issue of the (in)activity of young people, love for one's country, etc. These basic themes align with the yearly thematic focus. Some of the more popular ones relate to:

- artists of local, national and international importance (e.g., a special issue of 1970/71 and the issue of 1994/95 published in memory of Veno Pilon, the second issue of 1992/93 dedicated to the writer Danilo Lokar, the 2003/2004 issue dedicated to Srečko Kosovel, etc.);
- important political personas (e.g., the 1979/1980 issues dedicated to Josip Broz-Tito and Edvard Kardelj, respectively);
- commemoration of political events important for the founding of the nation (e.g., the third issue of 1983/84 dedicated to the 40th anniversary of the first Slovenian government);
- the engagement of the young in political bodies (e.g., the third issue of 1976/77 dedicated to the Communist Union);
- the promotion of political campaigns (e.g., the 1979/80 issue dedicated to NNNP[4]);
- the school's jubilee years (e.g., the 2001 and 2022 issues commemorating 50 and 70 years of the school, respectively).

A humour-themed issue of the school magazine entitled *Bukvice za shirane* (Booklets for the undernourished, 1982/83) is unique for being full of humorous nonsense literary contributions. In 2011/2012, a corpus of sheet music was documented as an issue of the school magazine created under the thematic focus 'seasons of the year'. From 2013, more abstract themes are addressed, such

4 NNNP – an acronym signifying a nationwide political mobilisation campaign in which the Yugoslav authorities informed people about worst-case scenarios, telling them what to do in the event of a natural disaster, a war or a nuclear, biological or chemical attack, with the aim of ensuring defence (Rojc, 2016).

as values (2013), identity and belonging (2014), love (2015), friendship and solidarity (2016), respect (2017), peace (2019), etc.

To sum up, like most school magazines, *Izvir* offers a rich insight into the life of the school, its students, its personnel and the values to which its creators adhered (Caudill, 2007; Mohor & Saksida, 2003; Prostináková Hossová & Švecová, 2019). Particularly noteworthy, however, is the extent of politically oriented content and thematic foci that characterised the issues in the period 1979–1985.

Types of texts

The representation of the global theme of 'types of texts' is based on Mohor and Saksida (2003). It splits into four organising themes and nine basic themes. The categorisation of writings into different types of texts was not always clear-cut, as some of the texts shared characteristics of the adjacent categories. In such cases, the criterion was to determine the dominant category and proceed in that manner.

Informative journalistic texts

As one of the organising themes, informative journalistic texts aim to inform and report objectively. They comprise five basic themes: notices, news and reports, popular science pieces, surveys, and interviews.

Notices, news and reports

As analytical descriptions of events (Shavkatovna, 2021), notices, news and reports represent the most popular type of journalistic texts in the researched corpus. Students make use of them to report on the *when, where, what, why* and *who* of the current topic of interest. Some issues should be highlighted for their informative, factual and distinctly political touch (1976/77, 1; 1976/77, 4; 1977/78, 5; 1983/84, 4). In them, we read reports of the activities undertaken by politically oriented youth organisations and clubs (e.g., the Marxist School Club, and the UN School Club). These texts were written in line with the guidelines of the booklet *ABC7: Informing in Schools*, which encouraged building community spirit (Mihelin, 1979, p. 3) in a way that was typical of socialist and communist times.

Popular science pieces

Popular science pieces aim to inform an audience of non-experts of the latest developments in the field of science. Designed to report scientific information in an interesting way, they have an important role in shaping people's views of academic research (Fu & Hyland, 2014), as they seek to convince readers of the importance of the content and scientific progress (Hyland, 2010). Ten issues contain articles that were classified as popular science pieces. The authors of these articles deal with topics such as relativity theory, memory and learning techniques, snake venom, domestication of birds and some other wildlife, rocket propulsion, juvenile delinquency, the sea as a source of food, the issue of vaccination, etc. These topics are dealt with in an objective, factual, technical and comprehensive way, indicating the complexity with the necessary jargon vocabulary. Sometimes these writings are equipped with charts and images to illustrate the findings, but only one, in a 2021 issue, is equipped with references. In some cases, the pieces are serialised into several parts.

It is worth noting that popular science pieces have a tradition dating back to the very beginnings of the formation of the school magazine as a genre in Slovenia. A group of educated and engaged students known as *vajevci* (1854–1855)[5] aimed to present novel ideas and concepts to disseminate research and provide readers with new findings. Some of these students later became acknowledged experts in their fields of expertise, e.g., Fran Erjavec on fauna and Ivan Tušek on flora (Pogačnik, 1968, p. 15; Prijatelj, 1995, pp. 236–241). Stemming from this, it might be concluded that the authors of the articles identified in the present study as popular science pieces might have aspired to enter the world of science or academia.

Surveys

Surveys aim to gather information from a group of people by using a set of pre-prepared questions usually in the form of a questionnaire. The surveyor collects data on behaviours, knowledge, attitudes and opinions that they need for further activities (Dale, 2006). The surveys published in *Izvir* follow much in this vein. They were prepared, conducted and reported by students 14 times between 1967 and 2001, after which they no longer appeared. Written in a youthful, entertaining manner, with the use of exclamation marks, rhetorical questions, subjective criticisms, biased interpretations, and ironic and funny comments, they give an insight into the school climate and events of interest to the students. Even if strict factuality is not the main concern of these articles

5 The school magazine *Vaje* (1854–1855) represented an alternative to the rigidity of the school system of the time. The founding members of *Vaje* – Vaclav Bril, Simon Jenko, Valentin Mandelc, Ivan Tušek, Fran Erjavec, Valentin Zarnik and Martin Povše – were individuals with extremely broad interests, who were knowledgeable about general socio-political problems, which is why no other student association has achieved the same level of importance in the development of Slovenian literature (Mohor & Saksida, 2003; Pogačnik, 1968, p. 10; Prijatelj, 1995, pp. 236–241).

and little contextual information is provided, not to mention the questionable research methodology and small sample size, these texts were nonetheless meaningful to the students, as they themselves were the participants of the surveys. Surveys were conducted on the following topics: the popularity of the school magazine, culture, happiness, smoking habits, the grading system, leisure activities, sexuality, the teaching profession, the level of acquaintance among the students, local artists, and life in the dormitory.

Interviews

An interview as a type of text appears throughout the researched corpus. It is the result of a purposeful questioning of a person with the aim of obtaining certain information (Shavkatovna, 2021), but it excludes discussion and the interviewer's opinion (Natsvlishvili, 2013). Interviews in the researched corpus follow the characteristics of the journalistic interview: they reflect reality, they are presented in the form of questions and answers, and they are topical, relevant and interesting. The interviewees are present and former students, teachers of the school, political figures or music groups. The interviews aim to highlight the individual's areas of strength (e.g., a student footballer), present a particular profile of the teaching profession, recall school experience, gather information about well-known local artists, etc. Until 2013, interviews were conducted by students, and after that also by teachers-editors.

Interpretative journalistic texts

Interpretative journalistic texts represent the second organising theme and are further split into four basic themes: editorials, feature articles, opinion pieces and memoirs. As the word interpretative suggests, these articles go beyond mere factual reporting and allow for the author's subjectivity.

Editorials

Editorials are a distinctive form of journalism, occupying a special place in the magazine and representing the voice of the institution rather than that of an individual. They have a characteristic style and form of expression, and they aim to influence (Firmstone, 2019). This is true of the editorials of the researched corpus, as well. However, it should be stressed that not all editions have editorials. Moreover, editorials are often not signed with the editor's name. Nonetheless, it can be deduced that by 2001, editorials had been written by the student-editor-in-chief or a student board of editors. A distinctive feature of students' editorials is their constant call for more articles, which they approached in different ways: by kindly encouraging students to participate, by moralising about the importance of being active, by pleading for articles, by appealing to the conscience of other students, or by thanking them for their response. Editorials also reveal how work proceeded among the members of the editorial office, which comprised a very energetic, devoted and passionate group of students, among whom crises were nonetheless not unknown. All in all, student editorials reveal the very challenging task that students were faced with and the ways they solved it and succeeded in creating an issue. From 2013, editorials were written by a teacher editor-in-chief, who typically presents the content intertwined in the yearly thematic foci.

Feature articles

Feature articles are narrative texts that portray people and milieus with a personal and subjective touch (Steensen, 2009). Articles in this category aim to illustrate, maybe even inspire, but do not provide critique as opinion pieces do. Feature articles of the analysed corpus deal with the presentation of local businesses, sports and music, personalities, school-related topics, important milestones in the history of the school, and the presentation of research and development projects, while a few of them present oriented education.[6] However, the most frequently represented articles in this category are texts on political organisations and ideas, the majority of which were published between 1969 and 1985. Some examples of articles of this nature are: *On the work and mission of the Yugoslav people's army* (1976/77, 2, 2-22), *Partisan sanitation in the Primorska region* (1978/79, 3), *Self-protection of the people in war and in the case of disasters* (1979/80), *The first slovenian government in Ajdovščina* (1984/85, 3), etc.

Opinion pieces

Another category is opinion pieces. Driven by facts and based on research, they are written as more complex, erudite, artistically valuable, stylistically complex essays, often without a very rigid structure (Rončáková & Môcová, 2020). As a type of journalistic commentary, they are persuasive, personal and subjective; they aim to convince readers of the importance of a topic and recruit them to the perspective of the writer, who establishes a stance early on in the piece and provides sufficient arguments with which s/he seeks to overcome alternative viewpoints (Fu & Hyland, 2014; Hanoli, 2020). This category of articles is made up of young people's critical – sometimes even daring – reflections

6 Oriented education was an ideologically founded project effective in the period 1980–1996 in Slovenian secondary and tertiary education. It pursued the idea of egalitarianism and human resource management for the needs of the future labour market. It failed on account of not being in line with market trends and left a huge deficit in the number of educated people (Kramberger, 1999).

on topical issues or events (such as the issue of the inactivity and passivity of youth), historical events, the current school and the social system. A passage from an article entitled *Highlights from the youth conference* (*Izvir*, 1977/78, p. 2) is presented here as an example. In it an anonymous student critically addressed the teacher's expectations:

> *Well, I remember Professor S.'s remark that we are only interested in money. I don't know why, but it seems to me that people with monthly salaries often find it very difficult to understand that students sometimes need to scrap and save. Society pays for our education, but not fully. There are still expenses like bus fares, lunches, prom trips, proms, membership fees, contributions for broken chairs, compulsory film screenings, theatre, English, French, maths, physics, science notebooks and magazines, books, pencils, field trips, etc.*

It is noticeable that young people engaged in this genre with at least one article in all of the years preceding 2003, after which opinion pieces are no longer present.

Memoirs

Another representative subgenre of literary nonfiction is memoirs. As Kirby and Kirby (2010) point out, memoirs provide accounts of real events or experiences in artful narratives. They are characterised by a distinguishable first-person voice, with the author posing rhetorical questions and/or injecting uncertainties and ruminations into their factual texts. In this way, they create detailed word pictures for their readers and send them on memory journeys of their own. Memoirs aim not only to remember or describe, but also to inspire and educate. This is true of the memoirs present in the corpus, as well. They are written by teachers and former students, who recall their high school days or prominent personalities (e.g., Veno Pilon, Evgeny Bavčar, Boris Pahor). Typical of anniversary editions, these writings are stylistically well written, nostalgic and emotionally charged.

Entertainment

The next organising theme is entertainment, which includes diverse basic themes, from crosswords, horoscopes, jokes and witticisms, to cartoons, caricatures, comic strips and other visual images that allow for greater freedom, spontaneity and authenticity (Maidment, 2017). In our case, entertaining features relate to the school environment. Crosswords are present in 10 issues, comic strips in 19 and horoscopes appear 7 times. Whereas crosswords, horoscopes and comic strips appear throughout the circulation, humour is present in the periods 1967–1970 and 1984–2008, and completely absent from 1971 to 1983 and from 2008 to the present. From 1984 to 1994, there was quite a lot of humour at the teachers' expense, with students making use of jokes, witticisms and mocking rejoinders. The students' aim may have been to test their boundaries (Meeus & Mahieu, 2009), or humour may have been a coping strategy to deal with their feelings (Chateau-Smith, 2016).

Literary section

Another in the organising themes is the literary section, which further splits into three basic themes: prose, poetry and drama. In our case, all 103 issues of the corpus feature fiction in all three forms. Ten issues were entirely fiction-based and mostly published on the occasion of the Slovenian Culture Day, e.g., the first issue of the 1983/84 edition and the 1985/86 edition, the second issue of 1984/85, etc., while one was dedicated to the annual gathering of aspiring young authors.

Edition notice

The global theme 'edition notice' splits into four organising themes: circulation data, publication statistics, board of editors and number of pages. The research shows that the corpus has all of these characteristics only after 2013, while the magazines from 1967–1977 are mostly equipped only with the names of students and the mentor.

The publication statistics show that from 1967/68 to 1986/87, the magazines were on average published four times a year, although some school years proved to be even more fruitful (five issues were published in 1977/78 and six in 1979/80). From 1987/88, there is only one issue per year. Although some issues lack page numbers, it can be concluded that the first issues amounted to approximately 20 pages per issue and persisted at this number until the year 2000, when the anthological issue boasted 284 pages. After 2013, the magazines amount to 70–90 pages on average per issue. Circulation data first appeared in 1987/88, when 150 copies of the issue were printed. The number of copies increased over time and peaked in 2013 with 900 copies, after which an average of 700 copies per issue are published. The first issues were made with the use of cyclostyle,[7] often by the students themselves. Later, the creators made use

7 Cyclostyle is a manual stencil duplicator that was commonly used in the early to mid-twentieth century. By creating a matrix, multiple copies could be extracted through a process of pressing ink through the matrix onto paper.

of photocopiers, and it seems that the magazine was outsourced to a printing house to complete the publication process for the first time in the 1990/91 school year. In some cases, especially at the beginning of the magazine's circulation, the identity of the mentor remains unclear, and not all of the articles are equipped with the author's name. The only piece of information that is always given is the board of editors with the editor-in-chief. Until the early 2000s, the school magazines were created collaboratively by at least 7 and up to 17 students under the leadership of a student editor-in-chief and tutored by a teacher-mentor. In 2013, the school magazines were transferred to the teachers' leadership and they became the editors-in-chief.

The zeitgeist

The global theme 'the zeitgeist' splits into two organising themes: the Yugoslav era and the global citizenship era. Both of these themes later split into several minor basic ones.

Having thoroughly researched the entire corpus, it is evident that the ideology of the Yugoslav socio-political system heavily influenced students' writings from 1967 to 1991, peaking between 1979 and 1985. There are many articles related to the socio-political ideology, for example:

> *Everyone should be aware that we live in a socialist Yugoslavia. The working class came to power in our country, but at the same time as it was fighting for power, it was fighting for something more important – for self-management,[8] for the right of all members of society to decide directly for themselves on all social matters. Self-management is the basis of our socio-political system and social order in our country; it is the aim and the result of the workers' movement.* (*Izvir*, 1976/77, p. 6).

Students were encouraged to write about historical events important for the formation of Yugoslavia. A lot was written about the collaboration with the representatives of the Yugoslav National Army, about young people's participation in workers' brigades,[9] about the idea of the worker's self-management contribution,

8 Self-management is a distinctive feature of the Yugoslav system that refers to a comprehensive socioeconomic system characterised by collective ownership of production resources and by socioeconomic relations that ensure that decisions are taken by the workforce and the wider local community first, and then by the top governing bodies that gradually lose their authoritarian power (Vodušek Starič, 1983, p. 9).

9 The Youth Work Brigades (Slo. *mladinske delovne brigade*) were organised groups that operated in post-war Yugoslavia. They worked according to a military scheme and were organised on a (conditionally) voluntary basis with the aim of improving the economy and strengthening the political unity of the Yugoslav youth, and of nations and nationalities, while pursuing cultural and educational objectives.

and about referenda[10]. A passage from an article entitled *Misli iz naših nalog* (*Izvir*, 1976/77, 15) is presented here as an example. In it an anonymous student writes:

> *We are preparing for a referendum for the construction of a new school centre, for the renovation of schools in the municipality of Ajdovščina. We will help with our contributions, with our work. We will build together. …*

Numerous articles are connected with the concept of communism and the Union of Communists, for example:

> *It is true that communists have always given up something, but above all they have given up their laurels and resting on their laurels. They have always been committed to fraternity and unity, to the workers' problems and finding their solutions, and, more recently, to the pursuit of a policy of non-alignment* (*Izvir*, 1976/77, 2).

Young people write about their entry into political organisations, such as the Union of Communists or the Union of Socialist Youth of Slovenia, and their participation in Marxist and United Nations Organisation clubs; they report conclusions formed at local, regional and national youth political conferences. Through interviews conducted with factory workers and presentations of local factories, value is given to the importance of the workforce.

Certain editions were enriched with political slogans such as "Tito's way is our way!" (*Izvir* TITO, 1980, p. 3) or "To be a communist is to be on the front line of the struggle for progress, for a happier future" (*Izvir* TITO, 1980, p. 4). A characteristic feature of this type of writing is a strong emotional note, e.g., "Our holiday, in our month, with our dearest leader – Tito. Can we ask for more?" (*Izvir*, 1967/68, p. 1). Leading figures (Tito, Kardelj) and political bodies (the Yugoslav People's Army) were idealised and portrayed in a highly biased way, e.g., "Yugoslavia has never had such a hero in its history, nor can it have one in the future" (*Izvir* TITO, 1980, p. 4).

We would like to present a poem dedicated to Tito, which we classified as a case of engaged socio-political writing within the genre of political eulogy (Dolgan, 1989). It was published on the occasion of Tito's death (*Izvir* TITO, 1980, p. 1). In light of the other articles in this issue, the poem written by an anonymous student helped endorse the cult of Tito's personality by promoting feelings of admiration, love, yearning and devotion, mixed with sentiments of sadness.

May our deeds speak of our love for you!

10 The worker's self-management contribution (Slo. *samoprispevek*) was a levy of a few percent of the salary, which had to be voted on in a referendum. It was used to co-finance the construction of community-oriented projects (Piškurić, 2017, 99).

Today, Comrade Tito, I am sending you a poem,
a poem my brothers are already sharing far and wide,
it is full of strength and faith, Comrade Tito –
of the love and yearning that countless young hearts hold for you!

Today I yearn, oh so much, I yearn
to shake your heroic hand,
to admire Thy face, sculpted amidst the storms,
Thy caring eyes, their dawn-like glow

and whisper words both long and tender
that our spring shall never falter, not even in the face of adversity,
but rather rise even more blooming and gentle!

Hear me, Comrade, you soaring falcon,
hear how the earth conceives its warm love
and how new life from her soul sprouts -
gentle as blossoms, pure as the dawn!

Today, Comrade Tito, I'm sending you a poem,
a poem my brothers are already sharing far and wide,
a poem full of faith and zeal!
May our deeds speak of our love for you!

In the anthological issue of the corpus, a former student recalls her teenage artistic endeavours (*Izvir*, 2000, p. 8), saying: "One day, when the teacher was discussing the selection of my poems for publication, she hastily put one of them in her bag. At the time, of course, I didn't know why. But thinking about it today, I should be grateful to her, because the poem was politically controversial for the time." The following thoughts of a long-time mentor (Slamič, 2000, p. 56) are in much the same vein: "Some of the poems were overtly critical; we could not publish them because the life of the student and the mentor would have become complicated." One wonders how many unspoken similar cases there must have been where a mentor decided to withdraw an article to avoid negative consequences.

After 1985, the issues became distinctly more creative and experimental in expression and visual layout. The question arises as to the extent to which this turn is linked with the death of Josip Broz-Tito, the beginnings of the collapse of the Yugoslav political system and the consequent loosening of censorship, or whether it may simply be the case of more daring generations that did not care about social and political directives. Upon thorough investigation, one thing is nonetheless clear: criticism of the social and political system – albeit not extensive criticism – first emerged only after 1991.[11] It can therefore be assumed that until that time, only articles written in line with political directives could be published.

On the other hand, issues published after the year 2000 promote the idea of European and global citizenship, as evident from articles on Comenius and Erasmus student exchanges. After 2017, there is a greater presence of articles on cross-generational cooperation, active citizenship and sustainable development, i.e., themes that are relevant in today's era. Part of the 2021 issue is dedicated to articles written by parents, who assess the school, compare it with their own experience, and express their gratitude.

Discussion and conclusion

As an important extracurricular activity, the traditionally oriented school magazine aims to inform, analyse, comment, educate, advertise, entertain, etc., and as such is an artefact of the world at large (Mihelin, 1979; Mohor, 2005, p. 28; Mohor & Saksida, 2003, p. 65). Production of a school magazine includes students, who take a central role in its creation, and teachers, who refrain from the traditional roles of ultimate know-how and instead take on the roles of facilitators and mentors who can try out alternative didactic methods and approaches to achieve the final product. The school magazine is also a way for the school to place itself within its community.

The article presents a case study that aimed to analyse all 103 issues of the school magazine *Izvir* in the period 1967–2022. A comprehensive analysis of the content, the types of texts, the zeitgeist and the edition notice was conducted and placed within a theoretical framework. The findings show that the researched corpus covers a wide range of topics primarily concerning the school's curricular and extracurricular activities and related to the yearly thematic foci. One phenomenon that needs to be pointed out is the number of politically oriented themes present in the magazines published under the Yugoslav regime. The school magazine is, therefore, an excellent illustration of how the zeitgeist permeated and reflected young people's writings. To be more specific, it demonstrates the influence and intrusion of the socio-political system into the educational setting with the clear promotion of the political and

11 The year of Slovenian independence.

economic ideology of the time, which encouraged active engagement of the young in political affiliations. The writings have elements of nationalism and patriotism that reinforce the cult of personality. To follow in this vein, it might even be deduced that the magazine provided a platform for political education, as values and principles of the political system of the time are so clearly emphasised. Another finding that should be highlighted is the presence of censorship, as mentioned in retrospect in the anthological issue of 2000 in reference to the Yugoslav era.

The research also demonstrates the richness of various types of texts, which form four broad categories (informative journalistic texts, interpretative journalistic texts, entertainment, and a literary section) that are further divided into subcategories. It is therefore safe to hypothesise that the corpus satisfied the various tastes of its readers. In terms of the edition notice, the corpus is not always thoroughly and accurately equipped with the required data, although it does improve as time progresses and was perfected when teachers became editors-in-chief. However, the very engagement of teachers as the ultimate leaders in the creation of the school magazine poses several questions: Are young people today lacking incentives to be bold and daring in their actions, and thereby unable to create their own publication as in the golden years of the magazine's beginnings? Do the students avoid the task because of their general passivity, or are they disinterested because school magazines may no longer be their preferred avenue to express their creativity on the grounds of alternative and more appealing and creative outlets (e.g., memes)? Or are the roots of this phenomenon to be attributed to teachers, the school climate and the leadership of the school?

Looking at the findings, numerous other questions emerge, which we believe would be worth investigating in future studies, for example: Do humour and critique correlate with the zeitgeist that censors, restricts, permits or perhaps even encourages their usage, or could it be a specific feature of the school that discourages ridicule? Might it even be argued that young people today have no opinion of their own? To find comprehensive answers, but also to give the above findings more value, we would suggest extending the research and comparing this corpus with a similar one elsewhere in Slovenia or on the ex-Yugoslav territory.

We nonetheless believe that the results obtained are relevant for schools that engage in the publication of their school magazines on several levels. Firstly, the researched corpus – with its continuity, the number of participating students and teachers, and the circulation data – is an example of good practice. Secondly, as an important extracurricular activity, the school magazine serves as a useful didactic tool in facilitating students' skills and competences. Thirdly, school magazines provide a platform for educators to reflect upon their roles and the efficiency of their didactic methods. Lastly, they also add to the formation of the school's recognition in the local community, while helping to define and strengthen the identity and sense of belonging among its members. To sum up, based on the obtained insights into the benefits of school magazines as a pedagogical and community-building tool, educators elsewhere can introduce reasonable changes to their publication process and thus enhance the quality of their work.

Author's note

The whole collection of school magazines Izvir was taken under thorough investigation with the articles listed below chosen to provide in-text evidence and justifications. To protect the writers' anonymity, all student articles are listed as anonymously written.

Izvir. (1967–2022). [*A collection of school magazines*]. *Izvir* – Glasilo Srednje šole Veno Pilon Ajdovščina. Arhiv Srednje šole Veno Pilon Ajdovščina.

- Misli iz naših nalog [Thoughts from our assignments]. (1976/77). *Izvir*, *1*, 15.
- Utrinki iz mladinske konference [Highlights from the youth conference]. (1977/78). *Izvir*, *1*, 2.
- Ob dnevu mladosti [On Youth Day]. (1967/68). *Izvir*, *3*, 1.
- *Izvir*[12] – obstaja reka z rednim pretokom [*Izvir* – A river with a constant flow]. (2000). *Izvir*, *1*, 8.
- Slamič, I. (2000). *Izvir*, izviren izvir [*Izvir* – An Original Source]. *Izvir*, *1*, 56.
- Decembrski DA [A December YES]. (1976/77). *Izvir*, *1*, 6.
- TITO. (1980). *Izvir TITO*, *6*, 1–4.
- Naša sedanjost je rezultat revolucionarnosti KP in osebnosti, ki jo vodi. [Our present is the result of the revolutionary character of the communist party and the personality who leads it]. (1976/77). *Izvir*, *3*, 2.

Ethical statement

The research did not involve human and animal subjects. The reviews on which it was based aggregated studies that had already received ethical approval. Consequently, no additional ethical approval was necessary.

12 The name of the school magazine *Izvir* means a spring, the origin of a river.

Disclosure statement

The authors have no conflict of interest to declare.

References

Attride-Stirling, J. (2001). Thematic networks: An analytic tool for qualitative research. *Qualitative Research*, *1*(3), 385–405. https://doi.org/10.1177/146879410100100307

Bawarshi, A. (2000). The genre function. *College English*, *62*(3), 335. https://doi.org/10.2307/378935

Blažić, M. M. (2018). Slovenska pravljičarka Josipina Turnograjska v evropskem prostoru: Primerjalna analiza Rožmanove Lenčice [The Slovenian storyteller Josipina Turnograjska in the European space: A comparative analysis of Rožman's Lenčice]. In M. Delavec Touhami, & F. Križnar (Eds.), *Josipina Urbančič Turnograjska: Kdor dušno živi, ne umrje* [Josipina Urbančič Turnograjska: Whoever lives in spirit, does not die!] (1st ed., pp. 69–81). KD Josipine Turnograjske.

Bowen, J. (2015). *The role of student media.* https://jeasprc.org/the-role-of-student-media/

Caudill, M. A. (2007). *Yearbooks as a genre. A case study*. Clemson University.

Coyer, K., Dowmunt, T., & Fountain, A. (2007). *The alternative media handbook*. Routledge.

Dale, A. (2006). Quality issues with survey research. *International Journal of Social Research Methodology, 9*(2), 143–158. https://doi.org/10.1080/13645570600595330

Dolgan, M. (1989). Slavljenci in njih slavilci [The celebrated one and those who celebrate them]. In M. Dolgan (Ed.), *Slovenska muza pred prestolom: Antologija slovenske slavilne državniške poezije* [The Slovenian muse before the throne: An anthology of Slovenian political eulogy] (1st ed., pp. 253–258). Univerzitetna konferenca ZSMS: Knjižnica revolucionarne teorije.

Ferguson, K., & Page, M. (2021). Bridging the brick divide: Graphic design and writing collaboration in undergraduate student magazine production. *Journal of Creative Writing Studies*, *6*(1), 16.

Firmstone, J. (2019). Editorial journalism and newspapers' editorial opinions. In J. Firmstone (Ed.), *Oxford Research Encyclopedia of Communication* (pp. 1–2). Oxford University Press. https://doi.org/10.1093/acrefore/9780190228613.013.803

Fu, X., & Hyland, K. (2014). Interaction in two journalistic genres: A study of interactional metadiscourse. *English Text Construction*, *7*(1), 122–144. https://doi.org/10.1075/etc.7.1.05fu

Hanoli, V. (2020, October 31). *Literary journalism as a clash of genres between journalistic literature and fiction* [Conference presentation abstract]. In E. Hajrizi (Ed.), The conference book of abstracts (p. 424). UBT International Conference, University for Business and Technology, Lipjan, Kosovo. https://knowledgecenter.ubt-uni.net/conference/

Hoffman, L. M. (2002). Why high schools don't change: What students and their yearbooks tell us. *The High School Journal*, *86*(2), 22–37.

Hyland, K. (2010). Constructing proximity: Relating to readers in popular and professional science. *Journal of English for Academic Purposes*, *9*(2), 116–127. https://doi.org/10.1016/j.jeap.2010.02.003

Kačinová, V. (2018). Media competence as a cross-curricular competence communication today.

Communication Today, *9*(1), 42–44.

Kirby, D., & Kirby, D. (2010). Contemporary memoir. A 21st-century genre ideal for teens. *English Journal*, *99*(4), 22–29.

Klikauer, T. (2016). Modern corporations and Hegel's ethical corporation. In T. Klikauer (Ed.), *Hegel's moral corporation* (pp. 25–47). Palgrave Macmillan UK. https://doi.org/10.1057/9781137547408_2

Kobolt, A., & Žižak, A. (2013). Editorial. *Center for Educational Policy Studies Journal*, *3*(2), 5–8. https://doi.org/10.26529/cepsj.3.2

Kramberger, A. (1999). *Poklici, trg dela in politika: Poklicni problem socialne države, empirični primeri iz Slovenije* [Occupations, the labour market and politics: The employment issue in the welfare state, empirical examples from Slovenia]. Faculty of Social Sciences, University of Ljubljana.

Ljung, M. (2000). Newspaper genres and newspaper English. In F. Ungerer (Ed.), *English media texts – past and present: Language and textual structure* (Vol. 80, pp. 131–150). John Benjamins Publishing Company. https://doi.org/10.1075/pbns.80.10lju

Lueck, A. J. (2017). Classbook sense: Genre and girls, school yearbooks in the early-twentieth-century American high school. *College English*, *79*(4), 382–406.

Maidment, B. (2017). The gallery of comicalities: Graphic humour, wood-engraving, and the development of the comic magazine, 1820–1841. *Victorian Periodicals Review*, *50*(1), 214–227.

Meeus, W., & Mahieu, P. (2009). You can see the funny side, can't you? Pupil humour with the teacher as target. *Educational Studies*, *35*(5), 553–560. https://doi.org/10.1080/03055690902880224

Melbye, E., & Tassoni, J. P. (2006). The student literary magazine on a two-year campus: Where politics of place meet politics of literary representation. *Pedagogy*, *6*(2), 289–308.

Mihelin, S. (1979). *ABC 7. Informiranje v šolah* [Informing in schools]. RK ZSMS.

Miller, C. R. (1984). Genre as social action. *Quarterly Journal of Speech*, *70*(2), 151–167. https://doi.org/10.1080/00335638409383686

Mohor, M. (2005). "Iz moje katedrale rujete opeke …" Dijaški list *Plamenica* in začetki avantgardističnega gibanja OHO ["From my cathedral you're rusting bricks ..." The school magazine *Plamenica* and the beginnings of the avant-garde movement OHO]. *Dialogi*, *41*(2–4), 22–51.

Mohor, M. (2008). *Glasovi mladih: Slovenska šolska glasila in njihovo mentorstvo* [Voices of the young: Slovenian school magazines and their mentoring]. Republic of Slovenia Public Fund for Cultural Activities.

Natsvlishvili, P. (2013). For the genesis of interview as a genre. *European Scientific Journal*, *2*, 382–387.

Piškurić, J. (2017). Hiše, vrtci, šole, ceste. Gradnja hiš v Občini Ljubljana Vič-Rudnik [Houses, kindergartens, schools, roads. Construction of houses in the Municipality of Ljubljana Vič-Rudnik]. *Kronika: časopis za slovensko krajevno zgodovino*, *65*(1), 95–108.

Pogačnik, J. (1968). *Vaje. Faksimile* [Exercises. Facsimile]. Mladinska knjiga.

Prijatelj, I. (1995). 1848–1895. In A. Ocvirk (Ed.), *Slovenska kulturnopolitična in slovstvena zgodovina* (Vol. 1) [Slovenian culture, politics and language-related history (Vol. 1)] (pp. 236–241). Državna založba Slovenije.

Prostinákova Hossová, M. (2016). The use of new media and ICT as a tool for development of pupils' media literacy. In D. Petranová, J. Matúš, & D. Mendelová (Eds.), *Marketing identity – Brands we love* (pp. 326–335). Faculty of Mass Media Communication, University of Ss. Cyril and Methodius in Trnava.

Prostináková Hossová, M., & Švecová, M. (2019). Challenges and limits of current school magazine production-case study. *Media Literacy and Academic Research*, *2*(2), 34–51.

Rigler, B. (2022). *35. Roševi dnevi 2022* [35th Roš' Days]. Republic of Slovenia Public Fund for Cultural Activities. https://www.jskd.si/literatura/natecaji_literatura/rosevi_dnevi/2022/uvod_rosevi_22.htm

Rojc, P. (2016). *NNNP Nič nas ne sme presenetiti* [Nothing should surprise us]. KAMRA. https://www.kamra.si/album-slovenije/nnnp-nic-nas-ne-sme-presenetiti/

Rončáková, T., & Môcová, L. (2020). New journalistic genres in social weeklies: A statistical probe. *Informatologia*, *53*(1–2), 92–100. https://doi.org/10.32914/i.53.1-2.6

Shavkatovna, S. N. (2021). Specific features of journalism genres. *Eurasian Research Bulletin*, *3*, 13–18.

Steensen, S. (2009). Online feature journalism: A clash of discourses. *Journalism Practice*, *3*(1), 13–29. https://doi.org/10.1080/17512780802560716

Vodušek Starič, J. (1983). *Začetki samoupravljanja v Sloveniji: 1949-1953* [The beginnings of self-management in Slovenia]. Obzorja. http://hdl.handle.net/11686/996

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Emancipation or Instrumentalisation in Erasmus+ Mobility: A Literature Review

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European education tools and policies show growing social concerns for inclusion while embracing standardised approaches that may put diversity at risk. The Erasmus+ programme is a tool that aims for cultural awareness and European citizenship while promoting a linkage with the needs of the globalised labour market, starting with the higher education field. Given the programme's expansion to other education fields, namely school education, adult education, and vocational education and training, it remains uncertain how such an extension influences scientific research about Erasmus+ mobility and the relative position assumed therein by each field. Taking emancipatory and instrumental perspectives as a reference, the present study aimed to ascertain which concepts drive the published research about Erasmus+ mobility, mapping their position in the different education fields embraced by the programme. To do so, a literature review was conducted covering articles published between 2014 and 2022. The data analysed through content analysis showed that concepts driving emancipatory and instrumental perspectives are present in the selected articles, although approaches that are not directly linkable to either perspective prevail. The data also show that higher education remains the hegemonic field in Erasmus+ mobility research, indicating that studies focused on the programme's effects occur mainly in this education field. These findings highlight the importance of in-depth knowledge about the programme's effects on school education, adult education, and vocational education and training.

Keywords: literature review, Erasmus mobility, emancipatory education, Europeanisation

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Emancipacija ali instrumentalizacija v mobilnosti Erasmus+: pregled literature

José Carlos Bronze, Carlinda Leite in Angélica Monteiro

Evropska izobraževalna orodja in politike kažejo vse večjo družbeno skrb za inkluzijo, hkrati pa sprejemajo standardizirane pristope, ki lahko ogrozijo raznolikost. Program Erasmus+ je orodje, ki si prizadeva za kulturno ozaveščenost in evropsko državljanstvo ter hkrati spodbuja povezavo s potrebami globaliziranega trga dela, začenši s področjem visokošolskega izobraževanja. Glede na razširitev programa na druga področja izobraževanja, in sicer šolsko izobraževanje, izobraževanje odraslih ter poklicno izobraževanje in usposabljanje, še vedno ni jasno, kako takšna razširitev vpliva na znanstvene raziskave o mobilnosti Erasmus+ in na relativni položaj, ki ga na njih zavzemajo posamezna področja. Namen te študije je bil na podlagi emancipatorne in instrumentalne perspektive ugotoviti, kateri koncepti spodbujajo objavljene raziskave o mobilnosti Erasmus+, in opredeliti njihov položaj na različnih področjih izobraževanja, ki jih zajema program. V ta namen je bil opravljen pregled literature, ki je zajemal članke, objavljene med letoma 2014 in 2022. Podatki, analizirani z vsebinsko analizo, so pokazali, da so v izbranih člankih prisotni koncepti, ki spodbujajo emancipatorno in instrumentalno perspektivo, čeprav prevladujejo pristopi, ki jih ni mogoče neposredno povezati z nobeno izmed perspektiv. Podatki tudi kažejo, da visoko šolstvo ostaja prevladujoče področje v raziskavah mobilnosti Erasmus+ in da se torej študije, osredinjene na učinke programa, izvajajo predvsem na tem področju izobraževanja. Te ugotovitve poudarjajo pomembnost poglobljenega znanja o učinkih programa na šolsko izobraževanje, izobraževanje odraslih ter na poklicno izobraževanje in usposabljanje.

Ključne besede: pregled literature, mobilnost Erasmus, emancipatorno izobraževanje, evropeizacija

Introduction

After nearly three decades devoted to promoting international student mobility, and after having engaged millions of students in mobility activities, it is important to know the effects of the Erasmus programme. Since 2014, this programme has adopted the designation Erasmus+ (E+) and implemented a framework that has expanded its most successful features to additional education fields. Beyond higher education, adding the "+" symbol to the programme name rendered it an extended framework in terms of conceptualisation, operationalisation possibilities and the domains covered.

Among other distinguishing features of the programme's funding cycle initiated in 2014, compared to previous funding cycles, it underwent a transition to encompass four fields of education and training within a single instrument – higher education, school education, adult education, and vocational education and training (VET) – as well as incorporating the cross-cutting domains of youth and sports. Through these reforms, the foundational role of the programme as an instrument of Europeanisation in education has been fortified, while it also serves as a reference for an amplified connection between education and the labour market (European Commission, 2021).

Being the major European tool promoting and funding the international mobility of youngsters, E+ actively promotes intercultural encounters within an enlarged region of more than 30 countries, encompassing dozens of languages and different cultural habits. Based on two premises of the programme – intercultural promotion and the connection between education and the labour market – two perspectives of education are derived and used in the present study. On the one hand, it is through the emancipatory perspective that individuals are empowered as full members of society, become aware of their rights and duties, and consolidate their human dignity on equal terms (Habermas, 2012). In a society of individuals (Elias, 2001), such emancipation implies interaction and social interdependence as promotors of social justice (Fleurbaey, 2020). The present study brings *soft skills*, *digital literacy*, and *active and European citizenship* into the emancipatory perspective. On the other hand, it is through the instrumental perspective that individuals are *instructed* to comply with labour market requirements in order to succeed in professional settings within a globalised world (Habets et al., 2020; Winchester & Bailey, 2012). This study brings *hard skills*, *the labour market* and *Europeanisation tools and policies* into the instrumental perspective. The Europeanisation of education (Lawn & Grek, 2012) relies on the process of standardisation inherent to the European Union's common policies in education, reconfiguring approaches, curricula, pedagogies and professional identities, of which the Bologna Process in higher education is a powerful example (The Bologna Declaration of 19 June 1999, 1999; Huisman & Van der Wende, 2004; Symeonidis, 2018).

Concerning the labour market's relationship with education, the strongest link between the four education fields of E+ is given by *vocational education and training*. Its goals and outcomes rely on the connection between education and the labour market, either at initial or continuing VET. Initial VET (iVET) commonly occurs in articulation with secondary school systems, aiming to provide *students* with an initial qualification for a given occupation before they start their working life. Continuing VET (cVET) typically occurs during professional life, aiming to upskill *workers* and promote their professional development (Cedefop, 2023). An example of iVET is the case of vocational education courses applied in the school system, leading to double certification: a school diploma *and* a professional qualification. This happens in some countries, such as Portugal (Cedefop, 2021b) and Germany (Peters, 2021), with the aim of facilitating the transition from school to work. An example of cVET is the case of workers attending a VET course to improve their professional performance, or unemployed people attending a VET course to acquire new skills to increase their employment possibilities (Mara et al., 2022).

In initial VET, mainly targeting youngsters of upper secondary or post-secondary school aged around 15–18 years, this direct relationship might overshadow other results, particularly those related to the role of education as a catalyst for social mobility and social justice (Apple, 2012; Belavi & Murillo, 2016; Biesta, 2017; Fritsch & Leite, 2019; Gutmann, 1999; Leite & Sampaio, 2020; Sampaio & Leite, 2021), feeding an emancipatory perspective that goes beyond mere market-driven instrumentalisation (González-Faraco et al., 2019). This framework creates the need for in-depth knowledge about the effects of E+ in the VET field, particularly related to promoting individual and social dimensions able to drive the emancipatory perspective (Avis, 2018).

Studies show that *adult education* involves an emancipatory (Boyadjieva & Ilieva-Trichkova, 2021) and an instrumental perspective (Ioannou, 2023). However, while following aims of equal opportunities for adults lacking basic education and supporting socioeconomic mobility, the tendency of adult education is mainly emancipatory, as revealed by the Council Resolution on a New European Agenda for Adult Learning 2021–2030 (Council of the European Union, 2021). The priority areas of the agenda evidence this tendency by focusing on emancipatory dimensions, inferred from their "special attention on vulnerable groups", "quality, equity, inclusion and success", and "green and digital transitions" (priority areas numbers 3, 4 and 5).

The *school education* field, particularly in its goal of universal access to school and quality education for all children, as declared in Sustainable Development Goal Number 4 (United Nations, 2015), also embraces a prior emancipatory perspective following the aims of equity and inclusion.

Higher education is mainly connected to the emancipatory perspective, not only supporting the maintenance of sociocultural and economic elites (Ball et al., 2006; Bourdieu, 1984), as the aspirations of upward social mobility of underprivileged classes and individuals (Gale & Parker, 2015).

The focus of the present study is ascertaining which concepts prevail in the published research about E+ mobility, mapping tendencies in the four education fields outlined above, and determining the relevance of each field within E+ mobility-related research. The emancipatory trend is anchored in the programme's priorities defined for the period 2021–2027: "inclusion and diversity", "digital transformation", and "participation in democratic life, common values and civic engagement" (European Commission, 2021). Simultaneously, an instrumental dimension is found within the perspective of the Europeanisation of education, of which the programme is a cornerstone, as well as in the focus on and mobilisation of the needs of the labour market.

The present article has five sections. A theoretical framework follows this introductory section, outlining the authors' main concepts and theoretical lines. The third section describes the methodological approach and steps, followed by a presentation and discussion of the results. Finally, the concluding section focuses on the main outcomes and suggests further research.

Theoretical framework

In August 2023, the Fifth Newsletter of the European School Education Platform celebrated the European Year of Skills (European Parliament & Council of the European Union, 2023) by stating the importance of skilled and prepared young professionals, especially when facing digital and green transitions. The document pointed to the relevance of VET and its teachers in moving towards inclusive education, ensuring that students from disadvantageous contexts and backgrounds are included, while stressing the importance of apprenticeships and work-based learning to achieve this goal. This approach is particularly interesting because it included several aspects and priorities of the E+ programme presented in simple and short information that was widely disseminated. While consolidating a prior turning point of higher education in 2014 exclusivity under the "Erasmus" umbrella, it aligned VET with concepts appealing to an emancipatory dimension beyond its inherent instrumental perspectives, which are also present, driven by the labour market's needs.

Soft skills, digital literacy and active citizenship

The "skills" dimension brings immediate concerns, as it feeds divisive debates, namely the divide between "knowledge and skills" (Costa & Couvaneiro, 2019; Rasmussen et al., 2022; Young, 2015) and the divide between "hard and soft" skills (Lamri & Lubart, 2023) and their corresponding role in education. This assumes particular relevance when equated and conceptualised within the two different perspectives: emancipatory and instrumental. Whereas hard skills, or technical skills, are more consensually allocated to the instrumental perspective of knowledge and its formal application in a work-based context, *soft skills* are more challenging to define both in conceptual (Matteson et al., 2016) and teleological terms (Pinto et al., 2023; Succi & Canovi, 2020; Tsirkas et al., 2020). Given their characterisation as "skills", which implies the operationalisation of given knowledge, soft skills are often taken to conform to the ambitions of the labour market: "Soft skills help learners to become more employable and give them more chances to succeed in different competitive situations" (Elmoutanna & Motii, 2022), in this sense becoming "instrumental". Many studies consider soft skills an increasingly necessary condition for good professional performance (Aryani et al., 2021; Cimatti, 2016; Meeks, 2017).

While not undermining their value to the labour market, the present study proposes allocating soft skills to what we consider to be a wider dimension simultaneously active upstream and downstream of the labour market's instrumental perspective: emancipation. While implying economic independence – for instance, when referring to the emancipation of women, Sen (2000, p. 181) points out two conditions, "literacy" and "employment", the latter implying financial subsistence – emancipation also implies autonomy. Indeed, notions such as "autonomy", "critical thinking", "creativity" and "empathy", among other soft skills, are decisive in the construction and experience of freedom and self-determination, a theory that intertwines autonomy with relatedness and competencies (Ryan & Deci, 2020; Sartori et al., 2022). Such a relation is transversal to the multiplicity of soft skills. It even overcomes difficulties in their conceptualisation, evoking them as simultaneously involving intrapersonal and interpersonal factors, in line with the inseparability of the individual and social dimensions advocated by Elias (2001).

Beyond the individual approach concerning self-empowerment and self-development, the social dimension of soft skills makes them relevant, if not a necessary condition, to tolerance, social cohesion, social peace and social justice. The capacity for intercultural relationships, recognised as a soft skill within the sphere of communication and empathy, is an example (Messelink et al., 2015), showing how, despite being called "skills" and being widely redeemable by the "labour market" as the "competences of the 21st century" (Cobo, 2013; Dean & East, 2019; Hilton, 2008), soft skills are a necessary condition for emancipation.

In line with these ideas, we followed an operationalisation of soft skills, falling within an emancipatory setting that moves beyond self-interest towards social relationships, since individuals operate their soft skills through their "agency" (Biesta & Tedder, 2007; Jerome & Starkey, 2022) and their "active citizenship" (Enchikova et al., 2021; Golubeva et al., 2018). Since the study is focused on the E+ programme, "active citizenship" has been combined with "European Union citizenship" (EU citizenship), forming the second category of analysis within the emancipatory perspective. "EU citizenship" is a concept that goes beyond the legal dimension of citizenship, not only because it is supranational and, consequently, limited to the legal dimension of the member state that grants it, but mainly because it is delineated by moral dimensions embodied in the Treaty on European Union (European Union, 2016). This conception can be inferred from values such as "respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities [...] pluralism, non-discrimination, tolerance, justice, solidarity and equality between women and men" (European Union, 2016, p. 17).

In addition, aligning soft skills, such as critical thinking, with EU citizenship and *digital literacy* as an emerging and crucial dimension of emancipation elicits this last item as the third axis of our emancipatory analysis. Although the field does not directly address the emancipatory perspective, VET is required to participate in this context. Sartori et al. (2022) state:

> The contemporary setup of VET contexts underlines (a) the need for VET teachers and trainers to equip students with critical thinking skills and media literacy as well as (b) the lack of formal training paths on the identified topics, thus supporting teachers and trainers in empowering students to become the future generation of EU citizens. (p. 7)

The authors advocate using the capacity of VET teachers for "agency" to promote the emancipatory dimensions based on soft skills such as critical thinking, but also based on digital literacy, in order to increase students' empowerment as EU citizens. Taking it as a dimension contributing to the emancipatory perspective in education, our approach requires considering a broader conceptualisation of "digital literacy" by associating it with the other dimensions in use, such as soft skills and EU citizenship, in a sense to which Pfaff-Rüdiger and Riesmeyer (2016) explicitly allude to when they state that they "propose defining [digital] skills primarily by their necessity for social development (e.g., critical thinking, social, or moral skills)" (p. 169).

The authors point out different features of digital literacy as an intrapersonal process combining knowledge and practice, where soft skills (autonomy, creativity and emotional skills) bidirectionally relate to motivation and social development. Accordingly, digital literacy influences, shapes or even determines social relationships at different levels, turning its absence into an increased risk factor for self-development and social inclusion (Monteiro et al., 2022). As stated by Gutiérrez Ángel et al. (2022, p. 1): "Nowadays, [the term digital competence] refers to a set of technical-processual, cognitive, and socioemotional skills needed to live, learn, and work in a digital society". Aligned with this, the OECD project *Future of Education and Skills 2030* has, since its early positions, emphasised the concept of "the learner's agency", placing "motivation" and "digital and data literacy" (OECD, 2018, p. 4) as the required factors to feed learners' current and future capacity for "agency". The OECD approach combines soft skills, active citizenship and digital literacy within the emancipatory perspective of education, stating: "Education can equip learners with the agency, the competencies and the sense of purpose to shape their own lives and contribute to the lives of others" (p. 22).

Hard skills, the labour market, and Europeanisation tools and policies

The instrumental perspective of education appears more directly explicable, as it is rooted in an approach marked by specific supranational agendas, namely the labour market's needs and Europeanisation.

Hard skills constitute a subset within the labour market, referring to the ability to manipulate equipment, data and software (Laker & Powell, 2011), inter alia, in a technical approach to knowledge application. Falling within operationalisation and quantification (Kumar et al., 2022), hard skills conform to an instrumental approach to education aligned with the labour market that risks commodifying people as merely "human capital". Some authors, such as Klees (2016) and Zajda (2020), are critical of the "theory of the human capital" precisely due to such a commodifying risk for individuals. Other authors, such as Brown (2016) and Gobby and Niesche (2019), point to parallel effects on institutions themselves, such as the school "corporatisation" effect and its potential increase in social segregation.

Following these categories of *labour market* and *hard skills*, *Europeanisation* brings a more complex categorial set, partly due to its links with the emancipatory category of EU citizenship. On the one hand, since EU citizenship is based on Europeanisation and its instruments and policies, it cannot be realised without them. On the other hand, Europeanisation is based on the convention of each EU Member State's acceptance of and subjection to a European standard, otherwise the "European project" is jeopardised. Taking the example of EU fundamental rights, as emancipatory as such a dimension is, Gill-Pedro (2019) states: "[…] if member states were allowed to assess the validity of EU law by reference to their own national fundamental rights standards, then the uniform applicability of EU law throughout the territory of the Union would be destroyed – there would be no EU law as such" (p. 71).

This idea can be applied to other dimensions of the European project. Paradoxically, the decision to take the Europeanisation tools and policies as an instrumentally driven category relies on its standardising character, which necessarily weakens diversity, but also on its commodifying nature, which is grounded on economistic concepts, despite its progressively emancipatory tendencies: "[Europeanisation is also seen] as a marketable commodity, as an economic and employment policy and as a policy for the creation of 'Europe'" (Antunes, 2020, p. 300).

While distinguishing between the emancipatory perspective and the instrumental perspective based on categories addressed exclusively to one or the other, this foundation also establishes relationships between the two perspectives. On this basis, the theoretical framework was designed to learn more about research focused on international mobility, including research in the fields recently integrated into a single programme: school education, adult education and VET.

Methods

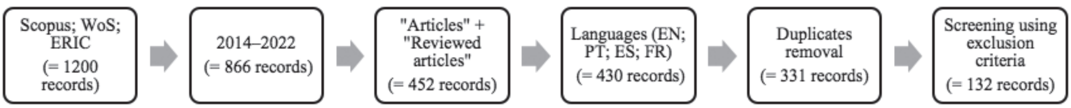
The methodology followed in the study was a literature review based on the stages of defining the search scope, data selection, data analysis, and presentation and discussion of findings (Gessler & Siemer, 2020). This exercise constitutes a background study (Templier & Paré, 2015) that aims to support further research about the effects of international mobility in the education fields embraced by the E+ programme, particularly the less-studied fields. The analysis was undertaken by recognising the tendencies towards the emancipatory perspective of education driven by self-empowerment and social relations, the instrumental perspective driven by the labour market and Europeanisation agendas, or other perspectives. The emancipatory and instrumental perspectives are sought using the established categories for the analysis, while other perspectives are sought through emerging categories that do not straightforwardly articulate either of the previous two perspectives.

The search was conducted in the Scopus, Web of Science (WoS) and ERIC (Educational Resources Information Center) databases, considering their substantial collection of high-impact journals and peer-reviewed articles, as well as their significant representativeness in the field of education. The Boolean search was limited to basic expressions aimed at encompassing the broadest possible range of studies, which would then be subjected to particular inclusion/exclusion and screening criteria according to the study objectives. The research question driving the procedure aimed to ascertain which concepts are deployed in studies on Erasmus+ mobility and to identify the main concerns driving such research. The aim was to find all of the peer-reviewed papers in relevant scientific databases focused on E+ mobility, to gain insights about their main concepts, and to identify gaps, thus preparing the ground for further research.

The search equation used was "Erasmus AND mobility", applied to "Article title", "Abstract" and "Keywords" in Scopus and WoS, and to "full search (peer-reviewed only)" in ERIC, the assumption being that any publication focused on E+ mobility would necessarily use these terms. Additional search criteria were also general, thus allowing for as many results as possible. These criteria were based on time, type of document and language. The time limitations applied excluded studies conducted before 2014, when the current version of Erasmus started to apply, thus setting the timeframe to 2014–2022. The type of document was set to "article" or "peer-reviewed article", and the type of source was set to "journal" in order to target high-quality, peer-reviewed publications. Where applicable (Scopus and WoS), languages were set to those within the research team's knowledge.

The results were subjected to a first screening procedure using the web application Rayyan (https://www.rayyan.ai) to eliminate repeated documents. At this point, exclusion criteria were defined and applied to the remaining original articles to eliminate studies that fell outside the research scope and objectives. The exclusion criteria aimed to refine the quality and nature of the results retrieved, namely the relationship to E+ and the context in which the relationship had been determined. The results were screened using an in-depth analysis of the titles, abstracts and keywords, eliminating those in which at least one of the exclusion criteria was observed. In some cases, rejection was determined by the immediate finding of more than one exclusion criterion. The following criteria were applied: (i) the paper does not concern E+ mobility; (ii) it is not focused on E+ mobility, nor does it establish relationships between mobility and its participants; (iii) it is not based on empirical studies; (iv) it is not exclusively focused on the E+ programme countries; (v) it concerns a study that falls outside the exclusive 2014–2022 timeframe; (vi) it is not focused on a specific E+ education field; or (vii) it is not a peer-reviewed article published in a scientific journal. The procedure resulted in 132 documents selected for further analysis, as summarised in Figure 1:

Figure 1
Search and screening flowchart



The review aimed to identify which concepts are reflected in the current research and how they portray a particular perspective. Accordingly, the 132 documents obtained were subjected to a second analysis to identify the education perspective underlying the main concepts being mobilised: emancipatory, instrumental or other. Considering a possible conceptualisation of these trends, specific categories of concepts were defined for each one. These categories were then searched in the documents, registered and analysed through content analysis using NVivo release 1.7.1. Each document was allocated to only one category of the perspectives under analysis, based on the text's primary focus. In addition to the emancipatory and instrumental perspectives, the category of "both perspectives" was used for situations in which concepts belonging to each perspective received equal focus. In contrast, the category of "other perspectives" was used in cases where the prevailing concepts did not address either approach. Additional concepts or results assuming relevance in the studies and not directly allocated to the classification in use, such as "gender differences", were also registered in the applicable cases. These are presented below, as they provide additional insights into the conducted studies.

In addition, the content analysis allowed the identification of the education field that was the focus of each study: higher education, school education, adult education, and VET. The fields were ranked in reverse order of relevance to previous research in order to focus attention on fields that were less studied because they were less known. An in-depth analysis of the papers dedicated to the less-studied education fields was then conducted, and the results were presented in order to gain detailed knowledge about the non-hegemonic fields. This exercise allowed the identification of the main focus and perspectives in place as well as those remaining understudied or less known. This may capture further research interests in E+ mobility, generating knowledge about the programme, its different fields, and possible relational dimensions.

Results and discussion

Concerning the relevance given to different education fields in Erasmus+ mobility, the findings show that, of the 132 records, a significant majority of 127 (96%) are related to higher education. Of the remaining five papers, three are related to school education, one to adult education and one to VET. This result may be related to the historical weight of higher education in the Erasmus programme for almost three decades, thus attracting substantial research interest. This effect is so relevant that, in many cases, the education field is not mentioned in the paper's title, abstract or keywords, thus requiring confirmation by an analysis of the full text. The E+ programme's success and inherent wider visibility continue to be associated with its foundation field, which also justifies the symbolic addition of the "+" symbol to its name in 2014, when it became associated with other education fields and additional domains. This format has been running for nearly a decade and its second programming period lasts until 2027, thus consolidating the association of the "Erasmus" designation to all fields. The former designations of funding programmes in other fields (de Olagüe-Smithson, 2019; Pépin, 2006) have become obsolete and are less and less used.

Regarding the second aim, related to the perspectives in place, each study was allocated exclusively to one case based on its central conceptual focus: emancipatory, instrumental, both, or other. The results emphasise concepts and approaches related to the emancipatory perspective, representing approximately 36% (47 records) of the total results, with only approximately 8% (11 records) addressing the instrumental perspective. While some studies address both perspectives (14 records, 11% of the total), the majority (60 records, representing around 45%) do not present a specific tendency towards the perspectives conceptualised in the present study.

Table 1 presents the main concepts found in studies on higher education, distributed by the education perspective.

Table 1

The education perspective and main concepts driving research on E+ mobility in higher education

Emancipatory (44 records)
– Intercultural ability (awareness, competence, development, needs, interaction, etc.) (21) – Active citizenship; global citizenship; EU citizenship self-awareness; positive views about the EU (9) – Soft skills (5) – Social media; e-learning; digital skills; online exchanges; online mobility (4) – Participants' emotions; human development; self-development (5)
Instrumental (11 records)
– Employability expectations; career ambitions; career development; salary prospect; labour market outcomes (6) – Setting a common European entity; improving Europeanism; EU integration policies (3) – Hard skills (2)
Both (12 records)
– Intercultural awareness/employment and career development (6) – Socioemotional, personal development and well-being/employability, professional life (4) – Politics of difference/consumerist approaches (1) – Voluntarist attitudes towards the labour market (1)
Other (60 records)
– Mobility features, drivers and barriers; Erasmus+ improvement (39) – Language improvement (11) – Inequalities shaping mobility (5) – Destination choice; Erasmus+ and tourism (4) – Environmental impacts (1)

The findings show that the primary concerns in the retrieved studies about Erasmus+ in higher education are mainly related to the characterisation of mobility, trying to show its main drivers and barriers in order to improve the programme's design and outcomes for institutions and participants (39 records). The second prevalent concern is about the effect of mobility on raising intercultural awareness (21 records). The concern with foreign language improvement by itself (without addressing a specific perspective) is also addressed to some extent (11 records). However, additional concerns not implying an educational perspective are also present, such as inequalities shaping access to mobility and drivers for the selection of destination, including tourism and environment-related concerns.

In addition to the concepts determining the central perspective found in the higher education records, additional concepts were also identified in order to avoid losing sight of other dimensions, despite their lower relevance to the study. Since the focus of these concepts is not central in the analysed studies, they were not considered in establishing the approach's central perspective, as presented in Table 1. Concepts playing secondary roles were: Erasmus+ programme knowledge and improvement (found in 21 papers); foreign language improvement (16); mobility outcomes (11); mobility and tourism (10); labour market and employability (8); EU tools & policies (7); digital literacy (7); gender issues (5); informal education (3); social, economic and disability-based inequality (3); and EU citizenship (3).

In addition to higher education, other education fields were found in the retrieved records, albeit with significantly lower frequency. Since the database searches and subsequent screening processes were intentionally broad so as not to limit the sectorial results, it can be concluded that the disparity found reflects an effectively lower incidence of studies in these fields. This effect may be rooted in the previously described historical prominence of higher education in the programme. Still, other reasons may apply, requiring dedicated further study.

Table 2 summarises the findings for school education, adult education and VET, presenting examples of the central concepts on which the allocation to the education perspective was based.

Table 2

The education perspective and main concepts driving the retrieved papers on E+ mobility in school education, adult education and VET

School Education (3 records)	Adult Education (1 record)	VET (1 record)
	Emancipatory (3 records)	
Intercultural awareness; learner autonomy; social setting and agency; impact on students' beliefs and values; critical thinking; sociocultural values; (2 records: Normann (2021); Yüzlü (2022))	Active citizenship; fighting ageism; intergenerational, digital, and international relationships and communication; developing digital literacy; personal and social skills and learning to learn (1 record: Baños–Martínez (2022))	–
	Instrumental	
–	–	–
	Both (2 records)	
Intercultural awareness/ professional development (1 record: Gozpinar (2018)	–	Intrapersonal and interpersonal dimensions/ labour market responsiveness and liaison with industry (1 record: de Paor (2018)
	Other	
–	–	–

The findings show the emancipatory perspective in evidence for these education fields. While three studies embrace this perspective rather exclusively (two in school education and one in adult education), two other studies also show the instrumental perspective and are thus registered in the category "both". These include one study in school education and a single study in VET. In addition to the mobility of students, these papers include the mobility of teachers and administrators, which accounts for the professional development concerns in evidence. This means that, from the students' perspective, they are retained within the scope of a significant emancipatory approach.

The single VET paper, which considers teachers' perspectives and concerns over their professional development, presents a particular situation that warrants further comment. As mentioned in the introduction, compared to the other fields, VET intrinsically addresses an intertwined combination of the two perspectives under analysis, as it may combine a school diploma and a professional diploma (Cedefop, 2021a) conferred at an early age (in initial VET, the process starts in the early teenage years). The paper is in line with this and, as the only VET case retrieved in the study, it confirms the significantly low weight of empirical studies on E+ mobility in this field. The analysis shows that the capacity of teachers/trainers for "agency" as a determinant factor shaping students' international mobility is in evidence (for additional insights on the "teachers' agency" concept, see, for instance, Biesta (2017); Biesta & Tedder (2007); Priestley et al. (2013, 2015a, 2015b)).

Engaging in international mobility brings additional challenges for young VET students, who are often minors, compared to higher education students. Such challenges are commonly associated with fear of the unknown or lack of confidence in using a foreign language. Using teachers as role models for students and youngsters is essential in order to gain confidence for the necessary but feared steps ahead. Geagea and MacCallum referred to this supportive mechanism in their study about the access, mobilisation and activation of capital, in this case related to navigating higher education: "The positive, supportive and engaging environment built by the mentors and role models helped students to build their confidence to explore and attempt unfamiliar and challenging tasks" (2020, p. 806). In line with this, Kmiotek-Meier et al. also refer to the importance of those who can act as gatekeepers conditioning mobility, particularly in VET, reinforcing the importance of teachers' agency in such a setting: "young people depend on institutional procedures; for example, the information flow via gatekeepers (e.g. teachers, tutors, support)" (2019, p. 38).

Conclusion

Aiming to identify the main trends guiding researchers in conceptual approaches to Erasmus+ mobility and mapping their distribution across the different educational fields of the programme, the findings of the present study point to the diversity of conceptual approaches and the prevalence of higher education in recent and earlier research. Despite the integration in the programme of all fields and levels of education for almost a decade, higher education has prevailed as a focus of recent research on Erasmus+ mobility. Compared to school education, adult education, and vocational education and training, the number and diversity of studies in higher education constitute a significant corpus of knowledge about Erasmus+ mobility.

In the case of higher education, which accounts for 96% of the retrieved studies, the concepts addressed and the educational perspectives covered are broad and allow linkages of Erasmus+ mobility to an emancipatory perspective based on social skills, EU citizenship and digital literacy, or an instrumental approach based on technical skills, labour market needs, and Europeanisation tools and policies. In some studies, both perspectives coexist; however, the prevailing situation, "other perspectives", is consistent with different approaches that do not focus on either of these perspectives. Apart from these "other perspectives", which are commonly focused on technical aspects of the programme, the results focusing on mobility participants indicate a prevalence of the emancipatory perspective. This indicates that Erasmus+ mobility is considered and sought as a potential tool to generate emancipatory effects related to intercultural ability, active citizenship, social skills, digital literacy and human emotions, in this order of relevance according to the collected data. Furthermore, some studies on the instrumental perspective corroborate the idea that the programme can produce effects that conform to labour market requirements and the standardisation of educational outcomes; however, these are not the main concerns of researchers.

In the case of the remaining education fields, the small number of studies retrieved indicates their lower relevance in research about E+ mobility, limiting the identification and assumption that a particular trend prevails. This scarcity poses challenges, namely determining whether there are common effects of E+ mobility in different education fields or, on the contrary, whether the specificities of each field prevail, given that mobility assumes different forms across fields. This significant knowledge gap on the programme's effects risks perpetuating lower visibility of E+, but also risks preventing further evidence-based adjustments of the programme and institutional policy enactment within these fields of education compared to higher education. The knowledge obtained from higher education research and findings may feed hypotheses to search and test on the remaining fields, particularly addressing the effects of mobility and barriers present across them. In line with this aim, the programme's design and the specific education systems of participating countries are likely to emerge since, contrary to higher education relying on the effects of the Bologna

Process, other fields do not rely on a standardised process facilitating mobility, despite existing efforts in the case of VET through the Copenhagen Process (The Copenhagen Declaration, 2002).

The present study cannot determine the reasons behind the lower prevalence of studies in education fields other than higher education, which may be due to the connection of higher education to the history of E+, unbalanced figures of mobility across fields, or other factors. Seeking more consistent conclusions demands further empirical research in order to gain substantial additional knowledge. This limitation may be overcome within school education and adult education, but above all within VET, as it is the field that most directly liaises with both of the education perspectives addressed. Moreover, further connections can be established between VET and higher education, namely the mobility of young participants (not school pupils or adult learners) and the Bologna Process versus the Copenhagen Process. This will be achieved through empirical research in VET schools that are significantly active in E+.

Ethical statement

The research did not involve human and animal subjects. The reviews on which it was based aggregated studies that had already received ethical approval. Consequently, no additional ethical approval was necessary.

Disclosure statement

The authors have no conflict of interest to declare.

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References

Antunes, F. (2020). Europeanisation and adult education: Between political centrality and fragility. *Studies in Continuing Education*, *42*(3), 298–315. https://doi.org/10.1080/0158037X.2019.1615425

Apple, M. W. (2012). *Can education change society?* Routledge.

Aryani, F., Wirawan, H., Saman, A., Samad, S., & Jufri, M. (2021). From high school to workplace:

Investigating the effects of soft skills on career engagement through the role of psychological capital in different age groups. *Education + Training*, *63*(9), 1326–1345. https://doi.org/10.1108/ET-03-2021-0087

Avis, J. (2018). Crossing boundaries: VeT, the labour market and social justice. *International Journal for Research in Vocational Education and Training*, *5*(3), 178–190. https://doi.org/10.13152/IJRVET.5.3.2

Ball, S. J., Reay, D., & David, M. (2006). 'Ethnic choosing': Minority ethnic students, social class and higher education choice. In S. J. Ball (Ed.), *Education policy and social class – The selected works of Stephen J. Ball* (pp. 215–236). Routledge.

Baños-Martínez, V. (2022). Articulation of an Erasmus+ project for senior university students. *Human Review. International Humanities Review / Revista Internacional de Humanidades*, *11*. https://doi.org/10.37467/revhuman.v11.4169

Belavi, G., & Murillo, F. J. (2016). Education, democracy and social justice. *Revista Internacional de Educacion para la Justicia Social*, *5*(1), 13–34. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85173711469&partnerID=40&md5=deda596c0de399c9b74b6b0f87ff43ab

Biesta, G. (2017). Don't be fooled by ignorant schoolmasters: On the role of the teacher in emancipatory education. *Policy Futures in Education*, *15*(1), 52–73.

Biesta, G., & Tedder, M. (2007). Agency and learning in the lifecourse: Towards an ecological perspective. *Studies in the Education of Adults*, *39*(2), 132–149.

Bourdieu, P. (1984). *Distinction: A social critique of the judgement of taste*. Routledge.

Boyadjieva, P., & Ilieva-Trichkova, P. (2021). *Adult education as empowerment: Re-imagining lifelong learning through the capability approach, recognition theory and common goods perspective*. Springer Nature.

Brown, W. (2016). Sacrificial citizenship: Neoliberalism, human capital, and austerity politics. *Constellations*, *23*(1), 3–14. https://doi.org/10.1111/1467-8675.12166

Cedefop. (2021a). *Spotlight on VET, 2020 compilation: Vocational education and training systems in Europe*. Publications Office. https://doi.org/doi/10.2801/667443

Cedefop. (2021b). *Vocational education and training in Portugal – Short description.* Publications Office. https://doi.org/doi/10.2801/251891

Cedefop. (2023). *The future of vocational education and training in Europe. Volume 4, Delivering lifelong learning: The changing relationship between IVET and CVET.* Publications Office. https://doi.org/doi/10.2801/726631

Cimatti, B. (2016). Definition, development, assessment of soft skills and their role for the quality of organizations and enterprises. *International Journal for quality research*, *10*(1), 97.

Cobo, C. (2013). Skills for innovation: Envisioning an education that prepares for the changing world. *Curriculum Journal*, *24*(1), 67–85.

Costa, J., & Couvaneiro, J. (2019). *Conhecimentos vs. competências: uma dicotomia disparatada na educação* [Knowledge versus skills: A nonsense dichotomy in education]. Guerra & Paz.

Council of the European Union. (2021). Council Resolution on a new European agenda for adult learning 2021–2030. *Official Journal of the European Union, 14 December*, *2021/C 504/02*. Council of the European Union.

Dean, S. A., & East, J. I. (2019). Soft skills needed for the 21st century workforce. *International Journal of Applied Management and Technology*, *18*(1), 17–32. https://doi.org/10.5590/IJAMT.2019.18.1.02

de Olagüe-Smithson, C. (2019). European VET mobility. In C. de Olagüe-Smithson (Ed.), *Analysing Erasmus+ vocational education and training funding in Europe* (pp. 23–32). Springer. https://doi.org/10.1007/978-3-030-16211-5_2

de Paor, C. (2018). Supporting change in VET: Teachers' professional development and ECVET learner mobility. *Empirical Research in Vocational Education and Training*, *10*(1). https://doi.org/10.1186/s40461-017-0062-3

Elias, N. (2001). *Society of individuals*. Bloomsbury Publishing USA.

Elmoutanna, N., & Motii, N. (2022). Soft skills from university to workplace: A literature review. *International Journal of Accounting, Finance, Auditing, Management and Economics*, *3*(5–1), 187–198.

Enchikova, E., Neves, T., Beilman, M., Banaji, S., Pavpoulos, V., & Ferreira, P. D. (2021). Active citizenship-participatory patterns of European youth. *Journal of Social Science Education*, *20*(1), 4–29. https://doi.org/10.4119/jsse-3146

European Commission. (2021). *Erasmus+ programme guide (version 3 (2021): 12/05/2021)*. https://erasmus-plus.ec.europa.eu/erasmus-programme-guide

European Parliament & Council of the European Union. (2023). *Decision 2023/936 of the European Parliament and of the Council of 10 May 2023 on a European Year of Skills*. The European Parliament and The Council of the European Union.

European Union. (2016). Consolidated version of the Treaty on European Union. *Official Journal of the European Union, C 202, 7 June 2016.*

Fleurbaey, M. (2020). Inequalities, social justice and the web of social interactions. *Revue de Philosophie Economique*, *21*(1), 19-63. https://doi.org/10.3917/RPEC.211.0019

Fritsch, R., & Leite, C. (2019). TEIP in the mirror: The Portuguese policy for the promotion of school success oriented to social justice. *Revista e-Curriculum*, *17*(3), 933–962.

Gale, T., & Parker, S. (2015). To aspire: A systematic reflection on understanding aspirations in higher education. *The Australian Educational Researcher*, *42*(2), 139–153. https://doi.org/10.1007/s13384-014-0165-9

Geagea, A., & MacCallum, J. (2020). Conversations with young people: Using a creative arts outreach programme to access, mobilise and activate capital to navigate to higher education. *The Australian Educational Researcher*, *47*(5), 797–814.

Gessler, M., & Siemer, C. (2020). Umbrella review: Methodological review of reviews published in peer-reviewed journals with a substantial focus on vocational education and training research. *International Journal for Research in Vocational Education and Training*, *7*(1), 91–125. https://doi.org/10.13152/IJRVET.7.1.5

Gill-Pedro, E. (2019). Divisible, contingent and parochial? The instrumentality of EU fundamental rights. In S. Rocha-Cunha, M. A. B. Martins, & R. F. Vasques (Eds.), *Os direitos humanos por um fio? - Perspectivas transdisciplinares em torno dos direitos humanos em tempos difíceis* (1st ed., pp. 65–86).

Edições Humus.

Gobby, B., & Niesche, R. (2019). Community empowerment? School autonomy, school boards and depoliticising governance. *The Australian Educational Researcher*, *46*(3), 565–582. https://doi.org/10.1007/s13384-019-00303-9

Golubeva, I., Gómez Parra, M. E., & Espejo Mohedano, R. (2018). What does "active citizenship" mean for Erasmus students? *Intercultural Education*, *29*(1), 40–58.

González-Faraco, J. C., Luzón-Trujillo, A., & Corchuelo-Fernández, C. (2019). Initial vocational education and training in a second chance school in Andalusia (Spain): A case study. *The Australian Educational Researcher*, *46*(5), 827–842. https://doi.org/10.1007/s13384-019-00304-8

Gozpinar, H. (2018). School education projects experiences: Fostering lifelong learning as a person and a professional. *Folia Linguistica Et Litteraria, 21*, 155–175. https://doi.org/10.31902/fll.21.2018.7

Gutiérrez Ángel, N., Mercader Rubio, I., Trigueros Ramos, R., Oropesa Ruiz, N. F., García-Sánchez, J. N., & García Martín, J. (2022). Digital competence, use, actions and time dedicated to digital devices: Repercussions on the interpersonal relationships of Spanish adolescents. *International Journal of Environmental Research and Public Health*, *19*(16), Article 10358.

Gutmann, A. (1999). *Democratic education*. Princeton University Press.

Habermas, J. (2012). *The crisis of the European Union: A response*. Polity.

Habets, O., Stoffers, J., Van der Heijden, B., & Peters, P. (2020). Am I fit for tomorrow's labor market? The effect of graduates' skills development during higher education for the 21st century's labor market. *Sustainability*, *12*(18), Article 7746. https://doi.org/10.3390/su12187746

Hilton, M. (2008). Skills for work in the 21st century: What does the research tell us? *Academy of Management Perspectives*, *22*(4), 63–78.

Huisman, J., & Van der Wende, M. (2004). The EU and Bologna: Are supra- and international initiatives threatening domestic agendas? *European Journal of Education*, *39*(3), 349–357. http://www.jstor.org/stable/1503860

Ioannou, N. (2023). Professional development of adult educators: A European perspective. *International Review of Education*, *69*(3), 379–399. https://doi.org/10.1007/s11159-023-10014-0

Jerome, L., & Starkey, H. (2022). Developing children's agency within a children's rights education framework: 10 propositions. *Education 3–13*, *50*(4), 439–451.

Klees, S. J. (2016). Human capital and rates of return: Brilliant ideas or ideological dead ends? *Comparative Education Review*, *60*(4), 644–672. https://doi.org/10.1086/688063

Kmiotek-Meier, E., Skrobanek, J., Nienaber, B., Vysotskaya, V., Samuk, S., Ardic, T., Pavlova, I., Dabasi-Halázs, Z., Diaz, C., Bissinger, J., Schlimbach, T., & Horvath, K. (2019). Why is it so hard? And for whom? Obstacles to intra-European mobility. *Migration Letters*, *16*(1), 31–44. https://doi.org/10.33182/ml.v16i1.627

Kumar, A., Singh, P. N., Ansari, S. N. A., & Pandey, S. (2022). Importance of soft skills and its improving factors. *World Journal of English Language*, *12*(3), 220–227. https://doi.org/10.5430/wjel.v12n3p220

Laker, D. R., & Powell, J. L. (2011). The differences between hard and soft skills and their relative impact on training transfer. *Human resource development quarterly*, *22*(1), 111–122.

Lamri, J., & Lubart, T. (2023). Reconciling hard skills and soft skills in a common framework: the generic skills component approach. *Journal of Intelligence*, *11*(6), 107. https://www.mdpi.com/2079-3200/11/6/107

Lawn, M., & Grek, S. (2012). *Europeanizing education: Governing a new policy space*. Symposium Books Ltd.

Leite, C., & Sampaio, M. (2020). Self-evaluation and social justice on Portugal's school's evaluation. *Cadernos de Pesquisa*, *50*(177), 660–678.

Mara, L. C., Cascón-Pereira, R., & Brunet Icart, I. (2022). Perceptions of empowerment and motivation as outcomes of a continuing vocational education and training (CVET) programme for adults. *Education and Training*, *64*(3), 433–444. https://doi.org/10.1108/ET-12-2020-0389

Matteson, M. L., Anderson, L., & Boyden, C. (2016). "Soft skills": A phrase in search of meaning. *Portal-Libraries and the Academy*, *16*(1), 71–88. https://doi.org/10.1353/pla.2016.0009

Meeks, G. A. (2017). *Critical soft skills to achieve success in the workplace.* Walden University.

Messelink, H. E., Van Maele, J., & Spencer-Oatey, H. (2015). Intercultural competencies: What students in study and placement mobility should be learning. *Intercultural Education*, *26*(1), 62–72. https://doi.org/10.1080/14675986.2015.993555

Monteiro, A., Guedes Teixeira, E., Leite, C., Barros, R., Fernandes, P., & Soares, F. (2022). Education towards literacy and digital citizenship of young people: Beyond "being online". *Revista Conhecimento Online*, *2*, 89–107. https://doi.org/10.25112/rco.v2.2991

Normann, A. (2021). Secondary school students' perceptions of language-learning experiences from participation in short Erasmus+ mobilities with non-native speakers of English. *Language Learning Journal*, *49*(6), 753–764. https://doi.org/10.1080/09571736.2020.1726993

OECD. (2018). *The future of education and skills - Education 2030 - The future we want*. OECD.

Pépin, L. (2006). *The history of European cooperation in education and training Europe in the making - an example*. European Commission – Office for Official Publications of the European Communities.

Peters, S. (2021). Market conditions of international VET providers: A comparative analysis of Australia, UK, USA, and Germany. *Empirical Research in Vocational Education and Training*, *13*(1), 23. https://doi.org/10.1186/s40461-021-00128-w

Pfaff-Rüdiger, S., & Riesmeyer, C. (2016). Moved into action. Media literacy as social process. *Journal of Children and Media*, *10*(2), 164–172. https://doi.org/10.1080/17482798.2015.1127838

Pinto, H. R., Gouveia, L. B., & Trigo, M. (2023). Assessment of the Evaluation of Technical and Soft Skills in a Professional Training Course: Pilot Study to Analyze the Efficiency of the Instruments and Results. In A. Mesquita, A. Abreu, J. V. Carvalho, & C. H. P. de Mello (Eds.), *Perspectives and Trends in Education and Technology – Selected Papers from ICITED 2022* (pp. 165–173). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-6585-2

Priestley, M., Biesta, G., & Robinson, S. (2013). Teachers as 'agents of change' teacher agency and emerging models of curriculum. In M. Priestley, & G. Biesta (Eds.), *Reinventing the curriculum for the 21st century: New trends in curriculum policy and practice* (pp. 186–206). Bloomsbury Academic.

Priestley, M., Biesta, G., & Robinson, S. (2015a). The role of beliefs in teacher agency. *Teachers and Teaching*, *21*(6), 624–640.

Priestley, M., Biesta, G., & Robinson, S. (2015b). Teacher agency: What is it and why does it matter? In R. Kneyber & J. Evers (Eds.), *Flip the system: Changing education from the ground up* (pp. 134–148). Routledge.

Rasmussen, J., Rasch-Christensen, A., & Qvortrup, L. (2022). Knowledge or competencies? A controversial question in contemporary curriculum debates. *European Educational Research Journal*, *21*(6), 1009–1022. https://doi.org/10.1177/14749041211023338

Ryan, Richard M., & Deci, Edward L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, Article 101860. https://doi.org/https://doi.org/10.1016/j.cedpsych.2020.101860

Sampaio, M., & Leite, C. (2021). Relationships between the assessment of school quality and social justice. *Educational Research*, *63*(1), 133–146.

Sartori, R., Tommasi, F., Ceschi, A., Falser, M., Genero, S., & Belotto, S. (2022). Enhancing critical thinking skills and media literacy in initial vocational education and training via self-nudging: The contribution of NERDVET project. *Frontiers in Psychology*, *13*, Article 935673. https://doi.org/10.3389/fpsyg.2022.935673

Sen, A. (2000). *Development as freedom* (1st ed.). Anchor Books.

Succi, C., & Canovi, M. (2020). Soft skills to enhance graduate employability: Comparing students and employers' perceptions. *Studies in Higher Education*, *45*(9), 1834–1847. https://doi.org/10.1080/03075079.2019.1585420

Symeonidis, V. (2018). Revisiting the European teacher education area: The transformation of teacher education policies and practices in Europe. *Center for Educational Policy Studies Journal, 8*(3), 13–34. https://doi.org/10.26529/cepsj.509

Templier, M., & Paré, G. (2015). A framework for guiding and evaluating literature reviews. *Communications of the Association for Information Systems*, *37*(1), 6.

The Bologna Declaration of 19 June 1999. (1999). *The European higher education area. The Bologna Declaration of 19 June 1999.* Joint Declaration of the European Ministers of Education.

The Copenhagen Declaration. (2002). *Declaration of the European Ministers of Vocational Education and Training, and the European Commission, convened in Copenhagen on 29 and 30 November 2002, on enhanced European cooperation in vocational education and training.* Declaration of the European Ministers of Vocational Education and Training, and the European Commission. https://www.cedefop.europa.eu/files/copenahagen_declaration_en.pdf

Tsirkas, K., Chytiri, A. P., & Bouranta, N. (2020). The gap in soft skills perceptions: A dyadic analysis. *Education and Training*, *62*(4), 357–377. https://doi.org/10.1108/ET-03-2019-0060

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* In U. G. Assembly (Ed.), *A/RES/70/1*. United Nations.

Winchester, N., & Bailey, N. (2012). Making sense of 'global' social justice: Claims for justice in a global labour market. *Sociological Research Online*, *17*(4), 7. https://doi.org/10.5153/sro.2777

Young, Michael (2015). What is learning and why does it matter? *European Journal of Education*, *50*(1), 17–20. https://www.jstor.org/stable/26609248

Yüzlü, M. Y. (2022). Embracing ELF through Erasmus+ mobility: A case study. *Asian Englishes*, *26*(1), 124–139. https://doi.org/10.1080/13488678.2022.2132129

Zajda, J. (2020). Globalisation, education and policy reforms. In G. Fan & T. S. Popkewitz (Eds.), *Handbook of education policy studies – Values, governance, globalization, and methodology, Volume 1* (pp. 289–307). Springer.

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Environmental Content as a Part of Science-Oriented Sustainable Development Goals in Grades 6 and 7 of Slovenian Primary School: An Analysis of Science Textbooks

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Slovenian science education in Grades 6 and 7 (11- and 12-year-old students) of primary school focuses on the integration of various science subjects. According to the current Slovenian science curriculum, environmental concepts, as a part of science-oriented sustainable development goals, are an integral part of the subject of science. In 2026, a new science curriculum will be introduced in the education system to provide students and teachers with competences for sustainable development. Consequently, the aim of this study is 1) to analyse old (valid prior to the 2010/2011 school year) and current 6th and 7th-grade Slovenian science curriculum for primary school from an environmental and sustainability perspective, and 2) to investigate textual and pictorial material of four 6th grade and four 7th grade textbooks available for students in the current school year (2023/24) of primary school, that relate to environmental content, as well as their overall structure. The analysis of the textbooks showed that all textbooks explain some environmental topics recommended by the national curriculum. The text is supported by pictorial elements that present phenomena with realistic pictures on the macrolevel. The present study suggests that some environmental content is present in 6th- and 7th-grade science textbooks that are consistent with the learning goals of the curriculum but that a significant amount of sustainability content is missing. For this reason, the curriculum reform currently underway in Slovenia should more clearly include the implementation and thoroughly consider the integration of science-oriented sustainable development goals into the science curriculum in Grades 6 and 7.

Keywords: science curriculum, environmental competences, primary school, science education, sustainable development, textbook analysis

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Okoljske vsebine kot del naravoslovnih ciljev trajnostnega razvoja v 6. in 7. razredu osnovne šole v Sloveniji: analiza naravoslovnih učbenikov

Matej Vošnjak, Neva Rebolj in Iztok Devetak

Naravoslovno izobraževanje v 6. in 7. razredu (učenci v starosti 11 in 12 let) osnovne šole v Sloveniji se osredinja na povezovanje različnih naravoslovnih predmetov. Po veljavnem učnem načrtu za naravoslovje so okoljski pojmi kot del naravoslovnih ciljev trajnostnega razvoja sestavni del predmeta naravoslovje. Leta 2026 bo v slovenski izobraževalni sistem uveden nov učni načrt za naravoslovje, ki bo vseboval tudi kompetence za trajnostni razvoj. Cilja raziskave sta: 1) analizirati stari (veljaven pred šolskim letom 2010/2011) in trenutni slovenski učni načrt za naravoslovje za 6. in 7. razred osnovne šole z okoljskega in s trajnostnega vidika; 2) raziskati besedilno in slikovno gradivo štirih učbenikov za 6. razred in štirih učbenikov za 7. razred osnovne šole, ki so na voljo učencem v tekočem šolskem letu (2023/24) in se nanašajo na okoljske vsebine, ter njihovo celotno strukturo. Analiza učbenikov je pokazala, da vsi učbeniki pojasnjujejo nekatere okoljske teme, ki jih priporoča trenutno veljavni učni načrt. Besedila v učbenikih so podprta s slikovnimi elementi, ki pojave prikazujejo z realističnimi fotografijami na makroravni. Raziskava nakazuje, da je nekaj okoljskih vsebin zajetih v naravoslovnih učbenikih za 6. in 7. razred osnovne šole, ki so skladni z učnimi cilji trenutno veljavnega učnega načrta, vendar manjka precejšnji del vsebin, ki se nanašajo na trajnostni razvoj. Načrtovana reforma učnih načrtov, ki trenutno poteka v Sloveniji, bi morala jasneje implementirati naravoslovne cilje trajnostnega razvoja v učni načrt za naravoslovje v 6. in 7. razredu osnovne šole ter podati smernice, kako te cilje realizirati pri pouku tega predmeta.

Ključne besede: učni načrt za naravoslovje, okoljske kompetence, osnovna šola, naravoslovno izobraževanje, trajnostni razvoj, analiza učbenikov

Introduction

Environmental issues have recently become one of the most emphasised topics as a result of globalisation, the media, and the impact of its consequences on people's daily lives (Laçin Şimşek, 2011). The realisation that environmental problems are related to human beings brings with it the need to raise individuals' awareness of the environment and the negative impact humans have on it. The agenda of the European Union and the United Nations now and in the near future is to create an adequate environment for future generations, focusing on sustainable development and a green transition. Following various guidelines (Bianchi et al., 2022; Mulvik et al., 2021; Rieckmann et al., 2017) to achieve the established goals, the school system worldwide is attempting to adapt to meet these criteria (Freire et al., 2016).

As Jimenez et al. (2017) report, environmental content is one of the most important dimensions of education for sustainable development. Nearly all levels of education, especially science education, promote either sustainable development or education for responsible citizens (Eilks, 2015), so when teaching the concept of sustainability in science education, a link should be made between science and sustainability concepts (Quinn et al., 2015). With the environmental competences acquired through environmental education, students take their place in society as citizens of the future to build a better future in a sustainable way (Erjavšek et al., 2021; Rauch & Steiner, 2013). Roczen (2011) defined environmental competencies as a model that describes the interconnectedness of environmental knowledge in relation to nature and a person's ecological attitudes and behaviour. Environmental competencies and sustainable development competencies are closely intertwined, often complementing each other within the broader framework of sustainable development (Agbedahin, 2019; Kopnina, 2020).

One of the basic educational materials that students need for learning school subjects is textbooks. They are usually the primary source of information and the most important educational resource of information for students' learning (King, 2010; Martin et al., 2011; Stará et al., 2017). Students use textbooks at school, for learning at home, and sometimes cite them as a reference for further work and projects that go beyond the national curriculum of a particular school subject (Gkitzia et al., 2011). In this context, science textbooks with environmental education concepts have great potential for learning about science-based sustainable development goals.

There are many definitions of a textbook, but the legal definition is contained in the Slovenian Regulation of Textbook Approval (*Pravilnik o* *potrjevanju učbenikov*) from 2015 and states:

> The textbook is a basic learning material for achievement of educational aims and standards of knowledge, defined in the curriculum or in the catalogue of knowledge. It supports teaching and learning with didactic-methodical organization of content and adapted illustrations and graphical layout. The content and the structure of the textbook allow for independent learning of the participants of education and the acquisition of different levels and categories of knowledge. The textbook should not require any direct insertion of answers or solutions either written or drawn, save in the case of the textbook, designed for the use in electronic form (further e-textbook), that can allow for the direct insertion. The textbook is tied to the school subject or a topical-didactical set, grade and the level of education. A reader as a compendium of texts chosen in accordance with the aims of curriculum is also a textbook" (*Regulation of textbook approval*, 2015, Art. 2.1).

In order to be approved, the textbook must meet the conditions set out in the regulations cited above and is reviewed by experts from the individual subject areas.

The catalogue of approved textbooks is published by the Ministry of Education of the Republic of Slovenia and is available on the Ministry of Education's website. Many criteria have been published for the creation of textbooks in Slovenia (Devetak & Vogrinc, 2013), stating that a textbook should be comprehensible and transparent, that the pictorial elements should be of high quality, that the content should be in line with the objectives of the educational programme and be well-rounded, that the content should also be in line with the educational goals in the national curriculum of the subjects, that the textual and pictorial material should be scientifically accurate and promote the development of general and specific competences in the respective scientific field.

Ultimately, a textbook should promote active learning, include activities at various levels of knowledge and incorporate aspects of interdisciplinarity (Devetak & Vogrinc, 2013). In Slovenia, it is common for textbooks to be approved for the next school year every year. If there is more than one approved textbook for a subject, teachers are often faced with the dilemma of which textbook to use. They should choose the textbook that will help them the most in the classroom and with which they can achieve the learning objectives. Kalin (2004) presents six basic factors that should influence the choice of teaching materials or textbooks: 1) purpose and objectives of teaching, 2) learning content, 3) teaching methods and approaches, 4) characteristics of the social environment, 5) characteristics of the students and the teacher, and 6) characteristics of the educational material itself. Finally, the textbook is an important element for all participants in the conventional classroom-centred learning environment (King, 2010). In such a conventional classroom-centred learning environment, textbooks enable teachers to achieve the objectives set out in the curriculum and guide them in their teaching (Martínez-Gracia et al., 2006). With the rapid development in information and communication technology and with the transition to online teaching triggered by the Covid-19 pandemic, learning and teaching have inevitably evolved from a traditional, classroom-based, textbook-centred process to a more flexible, e-learning-resource-oriented learning one (Dunn et al., 2022; Lau et al., 2018).

Research has often provided inconclusive results regarding students' preferences for digital textbooks compared to print textbooks and their achievement (Johnston & Salaz, 2019). by Roberts (2021) showed that students were equally successful when using e-textbooks or paper textbooks. Paivio (1991) presented a dual coding theory that explains two ways of taking in information while learning certain content: verbal associations and visual imagery. The visual system deals with the processing of graphic information, while the verbal system deals with the processing of linguistic information. Paivio's theory states that both verbal and visual information are used to represent information (Paivio, 1991; Sternberg, 2003). Based on these assumptions, Paivio suggested that learners have twice the chance of acquiring the information if it is encoded both visually and verbally, as the information is physically presented as a whole. According to this theory, textbooks that promote learning should convey the information to be processed in both textual and pictorial ways.

It is important that the texts in the textbook are written clearly and comprehensibly and that the professional terminology is explained. Reading, writing, and oral communication skills are necessary for students to understand the professional texts in the textbooks (Lemke, 1998; Martínez-Gracia et al., 2006). If they lack these skills, they will have problems understanding the professional texts. Peacock and Gates (2000) have shown that the structure of the text is not so important and does not contribute significantly to the quality of learning. Guidelines for the evaluation of textbook texts should therefore be: 1) the text must be stylistically appropriate (the writing style should be clear and close to everyday life); 2) the material should be didactically adapted to the needs of the target group of students (e.g., adapted to the average cognitive development of students at the respective educational level); 3) the material should contain elements that arouse the students' interest in learning a particular scientific content (e.g., life stories, case studies, problem-solving, adequate pictorial material etc.); 4) the material should promote active learning; and (5) the material should include activities at various cognitive levels of knowledge (stepwise from knowledge to synthesis and evaluation) (Peacock & Gates, 2000; Devetak & Vogrinc, 2013).

An important part of the textbook is also the tasks in or at the end of each chapter, which allow students to consolidate and test their knowledge (Holcar, 2009) and give students personal insight into the knowledge acquired in the chapter.

A textbook without pictorial material is no longer conceivable today. Not only does the pictorial material make textbooks more attractive and dynamic, but it also breaks up the monotony of the text and contributes to the successful transfer of knowledge and, as Dimopoulos et al. (2003) report, to better understanding. The criteria for evaluating the pictorial material in the textbook include some important aspects such as: 1) it should be of high quality; 2) it should contain elements that stimulate students' interest; 3) it should promote the recall of what is already known and stored in students' long-term memory; 4) it should be specifically linked to the text; 5) it should be of different types; 6) the multidisciplinary aspect of the pictorial material should be emphasised; and 7) the pictorial material should complement the activities presented in the textbooks (Stylianidou et al., 2002; Cook, 2008; Devetak & Vogrinc, 2013).

In contrast, Stylianidou et al. (2002) reported that images can often cause additional problems for students in understanding the specific text in a textbook if they are not logically integrated into the text and their sole purpose is to fill the empty space and not to provide additional illustration to the text. However, a cognitive theory of multimedia learning (Mayer, 1997) suggests that the learner goes through three important cognitive processes: 1) selecting: verbal information yields a textbase and visual information yields a picture base; 2) organising, applied to the word base to create a verbally based model of the system being explained and is applied to the picture base to create a visually based model of the system being explained; and 3) integrating: occurs when the learner makes connections between corresponding events (or states or parts) in the verbally based model and the visually based model. These processes should be utilised by the learner when using the textbook. This theory states that it is better to present an explanation in words and pictures together than in words alone, and it extends Paivio's dual coding theory of learning mentioned earlier. Reid et al. (1983) suggest that visual-verbal learning allows students to reconcile the two modes and carefully compare the information available in the picture with the explanation in the text. In a study of six science textbooks, Mayer (1993) concluded that illustrations accounted for 55% of the printed space. Cook (2008) suggested that because a large proportion of science textbooks consist of diverse visual material, more attention needs to be paid to understanding the impact of pictorial material on students learning.

For science textbooks, the pictorial material can be divided into two categories:(1) pictorial materials Type I (realistic, conventional, and hybrid images) and 2) pictorial materials Type II (images that comprise macroscopic, submicroscopic, and symbolic levels of representations of science concepts). Realistic images represent reality (e.g., photos or drawings). Conventional images are graphs, diagrams, maps, molecular structures, and similar, while hybrid images combine realistic and conventional images (Dimopoulos et al., 2003). Macroscopic images represent experimental phenomena or other natural phenomena at the sensory level, while submicroscopic images visualise the particulate level, such as atoms, ions, and molecules. Symbolic images present symbolic chemical language (e.g., symbols of elements, chemical formulas, chemical equations, mathematical equations, etc.) (Johnstone, 1982; Devetak et al., 2010).

In modern textbooks, the pictorial and textual material presented in textbooks could be upgraded in e-textbooks. The development from traditional textbooks to e-textbooks has opened new dimensions in the presentation of learning materials. The integration of various multimedia elements, such as videos, animations, and simulations of natural processes, not only enhances the visual and textual components but also contributes significantly to the overall value of the students' learning experience and promotes their digital literacy (Shalgimbekova et al., 2023).

Environmental contents in science textbooks and science curriculum

Environmental topics became increasingly important in the second half of the 20th century, mainly due to global environmental content (Bromley et al., 2011). Therefore, environmental education has started to be included in school curricula and textbooks.

In Slovenia, two major revisions of primary school curricula have been conducted in the previous three decades. The primary school curriculum was first adopted in 1998 (old curricula) by the Expert Council for General Education of the Republic of Slovenia in accordance with the curriculum guidelines prepared by the National Curriculum Council in 1996. In the period between 2007 and 2011, the second and last major curriculum renewal took place, which was completed in 2011 (current curricula). One of the focuses of this study is also to analyse the above-mentioned curriculum for science education in Grades 6 and 7 of primary school.

European Commission funding for post-pandemic recovery represented an opportunity for Slovenia to renew national curricula across the education chain. Slovenia, therefore, committed to renewing its education system and the national curriculum in primary and secondary schools in 2021 as part of the Recovery and Resilience Plan (RRP). The aim of the renewal of educational programs is to provide students and teachers with competences that are important for coping with current and future challenges (digital competences, competences for sustainable development, mechanisms for caring for (mental and physical) health and entrepreneurial competences) in order to strengthen the resilience of the education system. This began in 2022 with the adoption of the starting points for the renewal of the main program documents and is expected to continue until its completion in 2026 when new curricula will also be introduced into the education system for science and other subjects. For these reasons, the analysis of the two previous curricula is presented here from an environmental and sustainability perspective.

While students learn about forests, inland waters, oceans, and similar., they are also exposed to environmental content that focuses on the human impact on these ecosystems. The question, however, is how this content is taught and, more importantly, how much time and in what way environmental topics are integrated into the classroom as suggested in textbooks and curricula. As part of the RRP, the new science curriculum to be introduced in the 2026/27 school year will include sustainable development and green and resilient transition competences, among others.

The environmental content in the curriculum is often designed as cross-curricular activities, which means that teachers should incorporate it into a variety of subjects, curricular and extra-curricular activities, and science days. Environmental education should be integrated into the whole educational process, as this is the only way it can lead to the development of students' environmental competences and the formation of an environmentally aware citizen. Although the content that can stimulate the development of specific environmental skills in students can be found in textbooks and curricula, research (Lane & Wilke, 1994; Wade & Eland, 1995; Ernst, 2007, 2009; Rebolj & Devetak, 2012) shows that problems arise when teaching environmental content. One of them is the lack of knowledge about environmental content among teachers and the lack of time to prepare for teaching environmental content. Other obstacles include lack of training or opportunities for continuous professional development, lack of technical support, safety concerns, responsibility for teaching outside the classroom, lack of financial resources, lack of interest and support from local partners, and lack of support from parents (Rebolj & Devetak, 2012; Yurtsever & Angın, 2022).

Purpose of the study and research questions

Authors of the educational material should consider the criteria for quality material and, following them, prepare the textual and supporting pictorial elements appropriately. According to the above literature review, it can be assumed that only properly presented content in the textbook can help develop students' understanding of environmental concepts with fewer misconceptions. Devetak et al. (2010) conducted an analysis of Slovenian science and chemistry textbooks regarding selected chemistry concepts (Grades 1-9), but no attempt was made to analyse the textbooks from the perspective of environmental concepts in Grades 6 and 7. Therefore, this study focused on the most commonly used science textbooks in Slovenian primary schools for these grades and the curriculum for science in Grades 6 and 7.

The aim of this study is to examine how environmental concepts are presented to 11- and 12-year-old students in Slovenian science textbooks for Grades 6 and 7 of primary school from a textual and pictorial perspective. In addition, the aim was to examine how the science curriculum changes from the environmental competences perspective from the old to the current one. The textual material was analysed to determine what didactic elements are included in the textbooks and how environmental issues are presented in the textual part of the textbook. The analysis of the pictorial material was also included to gain insight into what type of pictorial material appears in the textbooks and what types of pictorial material are most frequently presented.

Particular attention was paid to the quality and clarity of the pictorial material and whether they were correctly placed on the page of the textbook so that they complemented the text and enabled students to better understand the material. In addition, to what extent is pictorial material in the different textbooks dealing with environmental content, and the consequences of reckless environmental behaviour were investigated.

According to the research problem, the following research questions were stated: 1) What are the differences between the learning objectives of the old and the current science curriculum in terms of environmental concepts and 2) What are the general and environmental characteristics of the textual and pictorial materials in the selected science textbooks in Grades 6 and 7 of primary school.

Method

The present study is based on a quantitative research approach; a descriptive, non-experimental educational research method was used. The criteria were developed on the basis of literature that presents criteria for the textbook analysis (Devetak & Vogrinc, 2013) and adapts them for Slovenian science textbooks/curricula. The criteria were used to analyse and compare the old and current 6th- and 7th-grade Slovenian science curricula for primary schools and to analyse and compare 6th- and 7th-grade science textbooks in Slovenian primary schools.

Sample

Four science textbooks for the 6th grade and four science textbooks for the 7th grade of primary school were analysed (Tables 1 and 2). Only textbooks available for students in the current school year (2023/24) and from a publisher that only issues textbooks for Grades 6 and 7 were analysed. In addition, the old curriculum (valid before the 2010/2011 school year) and the current curriculum (which replaced the old curriculum in the 2011/2012 school year and is still available for students in the current school year) for science in Grades 6 and 7 of primary school were analysed.

Table 1
The list of analysed sixth-grade science textbooks

Textbook authors	Original textbook title (translated textbook title)	Publisher	Publication year	Abbreviation
Šorgo, A., Glažar, A. S., & Slavinec, M.	Aktivno v naravoslovje 1 (Active in the science 1)	DZS	2012	DZS/6
Bačič, T., Vilfan, M., Strgulc Krajšek, S., Dolenc Koce, J., & Krajšek, V.	Spoznavamo naravo 6 (We learn about the nature 6)	Narava d.o.o.	2012	NA/6
Torkar, G., Devetak, I., & Kovič, M.	Dotik narave 6 (Touch of Nature 6)	Rokus Klett	2012	R/6
Dermastia, M., Denac, D., Goričan, Š., Repnik, R., Urbančič, M. & Vidic, T.	Jaz pa vem, kako rožice cveto... (But I know how flowers bloom...)	Modrijan	2012	M/6

Table 2
The list of analysed seventh-grade science textbooks

Textbook authors	Original textbook title (translated textbook title)	Publisher	Publication year	Abbreviation
Šorgo, A., Čeh, B., & Slavinec, M.	Aktivno v naravoslovje 2 (Active in the science 2)	DZS	2013	DZS/7
Bačič, T., Vilhar, B., Vilfan, M., Strgulc Krajšek, S., Fišer, C., Bevk, D., & Tkavc, R.	Spoznavamo naravo 7 (We learn about the nature 7)	Narava d.o.o.	2014	NA/7
Devatak, I., Rozman, L., Sopotnik, M., & Susman, K.	Dotik narave 7 (Touch of Nature 7)	Rokus Klett	2013	R/7
Tome, S., Ravnjak, B., Glažar, S. A. & Repnik, R.	Ste jo videli že, srno? (Have you seen her yet, doe?)	Modrijan	2016	M/7

Instrument

The documents (textbooks and national curriculum) were analysed using the rubric developed for the purposes of this study and by adapting some of the criteria developed for textbooks, pictorial and textual materials (Devetak et al., 2010; Devetak & Vogrinc, 2013).

The rubric for the general and textual analysis contains basic information about textbooks, such as the number of pages, the number of chapters, and the number of pages in each chapter. Regarding textual analysis, specific didactic elements of the textbook were examined, such as explanations, instructions for experiments, summaries, explanations of new concepts, the activities in the workbook, introductory motivation, and tasks between the text and at the end of each chapter. The rubric for the textbooks' pictorial analysis sections was divided into two parts: 1) pictorial material Type I and 2) pictorial material Type II. Type I includes realistic images (drawings) and conventional images (graphs, diagrams, sketches, schematics, maps, and other presentations). Type II includes macroscopic-level images (drawings or photographs depicting a phenomenon or process, e.g., an experiment), submicroscopic images, and symbolic images. All the pictorial and textual material was also analysed in terms of environmental content, taking into account the framework of topics included in the national curriculum.

Research design

According to the rubrics developed for the general, textual, and pictorial elements in the textbooks, which follow the framework of the environmental content presented in the national science curriculum, the coding process was carried out by two independent persons. To ensure high reliability of the categorisation, two researchers (the two authors of this article) independently evaluated the textbooks using the coding table, resulting in an overall reliability of 96%. Both evaluations were then compared at the points where differences occurred, and after consideration, the more appropriate evaluation was chosen.

Results

The first part of the results shows the comparison between the old and the current national science curriculum in terms of environmental concepts, followed by general data for a comparison between textbooks (Tables 3 and 4). The second part of the results presents the analysis of the textbooks in terms of environmental content.

Environmental contents in the science curriculum (old and current)

The old science curriculum for the 6th and 7th grades of primary school was valid until 2011 when the then-responsible ministry (Ministry of Education and Sports) renewed the science curriculum. The number of lessons (one lesson is 45 minutes) for science in each grade remained the same, so students attended 70 lessons of science in Grade 6 and 105 lessons of science in Grade 7 throughout the school year: a total of 175 lessons of science in two school years. The old and current curricula differ in the scope of content (see Table 3). The old curriculum included a definition of the subject describing its place in primary education, the philosophy and nature of the subject, and the general and operational objectives presented. It also included activities, content, concepts and cross-curricular links, specific didactical recommendations, and the general proposals for knowledge assessment (i.e., a knowledge catalogue indicating the basic and minimum knowledge standards). The current curriculum also contains a definition of the subject, the general objectives, the operational objectives, and the content describing the science procedures and skills, as well as the thematic sets. It includes a section on the knowledge standards, which also describes the science procedures and skills and the thematic sets and makes some assessment suggestions for teachers. At the very end of the curriculum is the *Didactic Recommendations* section, which suggests teaching methods and approaches, guidelines for planning and implementing student activities, individualisation and differentiation, aspects, and cross-curricular links for each specific topic.

The old 6th-grade science curriculum is much more clearly organised and defines the topics of the subject more precisely than the current one, which only covers more general topics and allows teachers to choose more specific contextual approaches to teach the concepts (e.g., environmental topics).

Nevertheless, the presentation of environmental content in both curricula is rather scarce or non-existent. In the sixth grade, students learn how they can contribute to the protection of the environment through appropriate behaviour, become aware of the significant influence of each individual on the environment, learn that the mining and processing of energy and other natural resources affect the environment, learn about the importance of efficient energy use, learn about the problems of scarcity and overuse of natural resources, water, raw materials and fuels, and become aware of the need to use these resources sparingly. In the seventh grade, students learn about the effects and consequences of fertilisation and the use of pesticides in agriculture on the pollution of groundwater, learn that the concentration of pollutants in water, air and soil can increase due to natural causes and human activities, which has a negative impact on organisms, learn about the main causes of pollution of water, groundwater, air and soil, learn about the main pollutants and the consequences of their effects on organisms and the environment, as well as the possibilities and measures to reduce and prevent pollution. They also learn about the effects of different types of transportation and communication on the environment and the causes of the increase in emissions and the associated global warming, which is reflected in climate change and terrestrial and aquatic ecosystems.

In the old science curriculum for 6th grade, there are no learning objectives that relate directly to environmental content. Some teaching and learning suggestions for teachers that relate to environmental content can be found in the chapter *Didactic Recommendations*. The current curriculum contains the chapter Human Impact on the Environment with eight learning objectives directly related to environmental content. This corresponds to 8.6% of all learning objectives in the 6th grade (Table 3).

Table 3

Comparison between the old and current 6th-grade science curriculum in terms of topics and learning objectives related to environmental content and objectives for the topics defined by the national science curriculum

	The content section or learning topic	Environmental/ all objectives
Old curriculum	Living and non-living nature	0/7
	Substances	0/12
	Garden	0/18
	Hedges, lawns, and parks (optional educational topic)	0/10
	Greenhouse (optional educational topic)	0/10
	Field	0/19
	Orchard (optional educational topic)	0/15
	Vineyard (optional educational topic)	0/10
	Meadow	0/7
	Flow and energy	0/22
	Colours	0/18
Percentage of learning objectives associated with environmental content		0/148 (0%)
Current curriculum	Substances	0/14
	Energy	0/11
	Living nature	0/60
	Human impact on the environment	8/8
Percentage of learning objectives associated with environmental content		8/93 (8.6%)

The old 7th-grade science curriculum is much more precisely defined in terms of specific topics than the current one (Table 4). In contrast to the 6th-grade science curriculum, both the old and the current 7th-grade curriculum contain learning objectives that are directly related to environmental content. In the old curriculum, there are four (3.7%) learning objectives in different subject areas, while in the current curriculum, eleven learning objectives appear in the *Human Impact on the Environment* section, which accounts for 11% of all learning objectives in the 7th grade. In the old curriculum, there was also a section on didactic recommendations in which some environmentally relevant content could be found but which must be included by the teachers in the relevant topics.

Table 4

Comparison between the old and current 7th-grade science curricula in terms of content sections/learning topics and learning objectives related to environmental content and all objectives for the topics defined in the national science curriculum

	The content section or learning topic	Environmental/ all objectives
Old curriculum	Substances, their properties, and changes	0/4
	Pure substances and mixtures	0/4
	Air	1/5
	Forest	0/26
	Sound	0/8
	Light	0/15
	Wave motion	0/7
	Water	1/4
	Inland waters	1/22
	Sea	1/13
Percentage of learning objectives associated with environmental content		4/108 (3.7%)
Current curriculum	Substances	0/21
	Energy	0/21
	Live nature	0/47
	Human impact on the environment	11/11
Percentage of learning objectives associated with environmental content		11/100 (11%)

Environmental content of textbooks

The structure of the 6th-grade textbooks published by different publishers varies considerably (Table 5). On average, the textbooks have 116 pages. The textbooks also have a different number of chapters. The textbook DZS/6 has the most chapters (9) and a maximum number of pages. The M/6 textbook has the fewest chapters (4 chapters), but the chapters are the longest on average (23 pages per chapter on average), and they present a broader range of concepts covering a given topic. The textbooks contain chapters with very different headings. The textbooks also differ in the number of pages per chapter. On average, the textbook NA/6 has the fewest pages per chapter (15 pages).

Table 5

Number of pages, number of chapters and chapter headings in analysed 6th-grade textbooks

Textbook	The number of pages	The number of chapters	Chapter heading/the number of pages
DZS/6	144	9	1. Substances/16; 2. Rocks and mould/18;3. Energy/24; 4. Cell and organism/12; 5. Structure and function of a plant/24; 6. Growth, development, and reproduction of plants/14; 7. Plant sorting/10; 8. Plants and environment/18; 9. Man and environment/11
NA/6	116	8	1. Everything is built from substances, living and non-living nature/10; 2. Stream and energy /10; 3. Living creatures are composed of cells /10; 4. Different parts of the body perform a variety of tasks /20; 5. Organisms reproduction /12; 6. Organisms have names/12; 7. Organisms were clamped into the environment /22; 8. Man exploits nature /13
R/6	109	5	1. Since the formation rock to plant life /26; 2. From sun to the food/14; 3. Everything is made from substances/22; 4. From life of plants/20; 5. Ecosystems and Environmental Protection /19
M/6	91	4	1. Autumn/22; 2. Winter/26; 3. Spring/24; 4. Summer/19

Textbooks for 7th grade have an average of 169 pages. The textbooks also differ in the number of chapters, the headings, and the number of pages in each chapter. The textbook DZS/7 has the highest number of chapters (11 chapters). Other textbooks, R/7 and M/7 with 4 and NA/7 with 5 chapters, present science concepts very broadly in their chapters with more general headings. The chapters also differ in terms of the number of pages. The textbook NA/7 has the highest average number of pages per chapter (43 pages per chapter), followed by the textbook M/7 (36 pages per chapter) and the textbook R/7 (35 pages per chapter). The textbook with the lowest average number of pages per chapter is DZS/7 (16 pages per chapter).

Table 6

Number of pages, number of chapters and chapter headings in analysed 7th-grade textbooks

Textbook	The number of pages	The number of chapters	Chapter heading/the number of pages
DZS/7	176	11	1. Substances/34; 2. Light in colours/18; 3. Sound and waves /16; 4. Viruses, bacteria and fungi /16; 5. Animals, construction types and classification of animals /16; 6. Digestion, respiration, excretion and transfer of substances in the body /12; 7. Support, protection and movement /12; 8. Control and Detection /10; 9. Reproduction, growth and development of animals /12; 10. Structure and function of ecosystems /14; 11. Human and environment/13
R/7	141	4	1. The diversity of nature /38; 2. Organisms related to the environment /32; 3. What is happening in organisms? /36; 4. Human impacts on nature /27
NA/7	215	5	1. Substances/26; 2. Waves/42; 3. Animals/62; 4. Structure and function of animal protozoans, fungi and bacteria /20; 5. Structure and function of ecosystems /58
M/7	142	4	1. Autumn/48; 2. Winter/46; 3. Spring/30; 4. Summer/11

Regarding the pictorial material in the 6th-grade textbooks, textbook M/6 contains the fewest pictorial material of Type I and Type II (377 images), while most pictorial material of Type I and Type II can be found in textbook R/6 (450) (Table 7). Most pictorial material comprises realistic images, followed by conventional images, macroscopic images, and sub-microscopic images of science phenomena. There are no symbolic images in any of the 6th-grade textbooks examined. The textbook M/6 contains the highest percentage of realistic images related to environmental content (2.4%), followed by textbooks DZS/6 (2.3%) and NA/6 (1.2%). The lowest proportion of realistic images associated with environmental content is found in the textbook R/6 (0.6%). Conventional images associated with environmental content are only found in the textbook DZS/6 (1.5%). None of the 6th-grade textbooks analysed contain macroscopic images and sub-microscopic images associated with environmental content. Of all the 6th-grade textbooks analysed, the textbook DZS/6 has the highest percentage of pictorial material Type I and Type II related to environmental content (2.0%), while the lowest percentage of pictorial material Type I and Type II in connection with environmental content is in the textbook R/6 (0.4%).

Table 7

Analysis of pictorial material type I and type II in sixth-grade textbooks

Publisher	Pictorial material type I		Pictorial material type II			TP
	RI	CI	MI	SuI	SyI	
DZS/6	6/257 (2.3%)	2/130 (1.5%)	0/13	0/8	0/0	8/408 (2.0%)
NA/6	4/331 (1.2%)	0/50	0/3	0/3	0/0	4/387 (1.0%)
R/6	2/348 (0.6%)	0/86	0/9	0/7	0/0	2/450 (0.4%)
M/6	7/297 (2.4%)	0/69	0/7	0/4	0/0	7/377 (1.8%)

RI Number of realistic images (photograph) associated with environmental content / Number of all realistic images (%).
CI Number of conventional images (graph, diagram, drawing, diagram, model of a molecule) associated with environmental content / Number of all conventional images (%).
MI Number of macroscopic images (photograph of an experiment or phenomenon) associated with environmental content / Number of all macroscopic images (%).
SuI Number of sub-microscopic images associated with environmental content / Number of all sub-microscopic images (%).
SyI Number of symbolic images associated with environmental content / Number of all symbolic images (%).
TP Number of pictorial material Type I and Type II associated with environmental content/ Total pictorial material Type I and Type II (%).

Although the textbooks for the 7th grade contain a large amount of pictorial material, they differ significantly in the amount of pictorial material of Type I and Type II. As expected, realistic images make up the majority of the pictorial material in all the textbooks analysed, followed by conventional images, macroscopic images, and sub-microscopic images of science phenomena (Table 8). Symbolic images are only present in textbooks DZS/7, NA/7 and R/6. The images are of high quality and complement the textual material in the textbooks. The textbook NA/7 contains the most images (532 images), followed by M/7 (523 images) and R/7 (357 images), while the fewest images can be found in the textbook DZS/7 (350 images). Textbook R/7 contains the most realistic images associated with environmental content (2.5%), while the lowest number of realistic images associated with environmental content is found in textbook DZS/7 (0.4%). Only the textbooks DZS/7 and R/7 contain conventional images related to environmental content. None of the textbooks examined for 7th grade contain macroscopic images, sub-microscopic images, or symbolic images related to environmental content. Of all the 7th-grade textbooks analysed, R/7 has the highest percentage of pictorial material of Types I and II related to environmental content (2.0%), while the two textbooks, DZS/7 and M/7 have the lowest percentage of pictorial material of Types I and II related to environmental content (0.6%).

Table 8

Analysis of Type I and Type II pictorial material in 7th-grade textbooks

Publisher	Pictorial material type I		Pictorial material type II			TP
	RI	CI	MI	SuI	SyI	
DZS/7	1/230 (0.4%)	1/62 (1.6%)	0/31	0/26	0/1	2/350 (0.6%)
NA/7	8/362 (2.2%)	0/119	0/27	0/22	0/2	8/532 (1.5%)
R/7	6/236 (2.5%)	1/80 (1.3%)	0/31	0/9	0/1	7/357 (2.0%)
M/7	3/377 (0.8%)	0/108	0/18	0/20	0/0	3/523 (0.6%)

RI Number of realistic images (photograph) associated with environmental content / Number of all realistic images (%).
CI Number of conventional images (graph, diagram, drawing, diagram, model of a molecule) associated with environmental content / Number of all conventional images (%).
MI Number of macroscopic images (photograph of an experiment or phenomenon) associated with environmental content / Number of all macroscopic images (%).
SuI Number of sub-microscopic images associated with environmental content / Number of all sub-microscopic images (%).
SyI Number of symbolic images associated with environmental content / Number of all symbolic images (%).
TP Number of pictorial material of Type I and Type II associated with environmental content/ Total pictorial material type I and type II (%).

Table 9 shows the results of the analysis of the textual material, such as explanations, instructions for experiments, interesting facts, summaries, explanations of new concepts, activities in the notebook, motivational content, didactic components, and tasks which are directly related to environmental content in each of the 6th-grade textbooks studied.

The most textual material related to environmental content is found in textbook M/6 (9.4% of the total textual material), followed by textbook DZS/6 (5.4%) and NA/6 (4.3%). The lowest percentage of textual material relating to environmental content is included in textbook R/6 (2.7%). Summaries of the most important concepts can be found at the end of the chapters in all textbooks.

Tasks relating to the environmental content can only be found in the textbooks DZS/6, R/6, and M/6; the textbook R/6 contains the highest proportion of tasks relating to the environmental content (21.7%), followed by M/6 (16%) and DZS/6 (2%). Tasks for the students can be found at the end of the respective chapter (DZS/6, R/6, and M/6) and in the text (DZS/6, R/6, and M/6).

The textbook R/6 also contains a checkbox for the integration of the students' knowledge, which is designed like an interdisciplinary textbook. The *Activities in the notebook*, in which students are encouraged to continue the learning process in the corresponding notebook, are not included in the textbooks studied. Additional interpretations of new concepts are presented in the

Table 9

Analysis of textual material and tasks in sixth-grade textbooks

Publisher	Textual material								Tasks		
	Tm1	Tm2	Tm3	Tm4	Tm5	Tm6	Tm7	Tmsum	T1	T2	Tsum
DZS/6	20/285 (7%)	0/49	3/54 (5.6%)	1/36 (2.8%)	0/9	0	0/9	24/442 (5.4%)	0/125 (0%)	4/76 (5.2%)	4/201 (2%)
NA/6	3/81 (3.7%)	0/5	3/67 (4.5%)	1/8 (12.5%)	0	0	0	7/161 (4.3%)	0	0	0
R/6	2/287 (0.7%)	5/36 (13.9%)	0/5	2/32 (6.2%)	0/12	0	2/25 (8%)	11/397 (2.7%)	7/32 (21.9%)	1/5 (20%)	8/37 (21.7%)
M/6	1/19 (5.3%)	5/44 (11.4%)	2/31 (6.4%)	2/17 (11.8%)	0	0	2/17 (12%)	12/128 (9.4%)	7/47 (14.9%)	1/3 (33.3%)	8/50 (16%)

Table 10

Analysis of textual material and tasks in seventh-grade textbooks

Publisher	Textual material								Tasks		
	Tm1	Tm2	Tm3	Tm4	Tm5	Tm6	Tm7	Tmsum	T1	T2	Tsum
DZS/7	16/284 (5.6%)	0/20	2/41 (4.9%)	3/37 (8.1%)	1/11 (9.1%)	0	0/39	24/443 (5.4%)	4/115 (3.5%)	2/57 (3.5%)	6/172 (3.5%)
NA/7	6/97 (6.2%)	0/25	6/133 (4.5%)	1/21 (4.8%)	0	0	0/5	13/281 (4.6%)	0	1/21 (4.8%)	1/21 (4.8%)
R/7	18/323 (5.2%)	2/60 (3.3%)	1/7 (14.3%)	4/46 (8.7%)	1/18 (5.5%)	0	2/42 (4.8%)	28/496 (5.6%)	5/46 (10.9%)	1/4 (25%)	6/50 (12%)
M/7	2/14 (14.3%)	2/34 (5.9%)	3/46 (6.5%)	1/22 (4.5%)	0	0	1/22 (4.5%)	9/138 (6.5%)	2/41 (4.9%)	0/7	2/48 (4.2%)

Tm1 Number of explanations related to environmental content/number of all explanations.
Tm2 Number of instructions for experiments related to environmental content/number of all instructions for experiments.
Tm3 Number of interesting facts related to environmental content/number of all interesting facts.
Tm4 The number of summaries related to environmental content/number of all summaries.
Tm5 The number of explanations of new concepts related to environmental content/number of all explanations of new concepts.
Tm6 Number of activities in the notebook related to environmental content/number of all activities in the notebook.
Tm7 Number of motivating content related to environmental content/number of all motivating content.
Tmsum The total number of didactic components related to environmental content.
T1 The number of tasks in the text that are linked to environmental content/number of all tasks in the text.
T2 The number of tasks at the end of the chapters that are linked to environmental content/number of all tasks at the end of the chapters.
Tsum The total number of tasks associated with environmental content / the total number of tasks.

textbooks DZS/6 and R/6. All textbooks, with the exception of the textbook NA/6, contain an introductory text to arouse the students' interest. Other textbooks contain further specific sections, such as: in NA/6 the chapter *Do it yourself*, in DZS/6 a part entitled *Some instructions on first aid in case of injuries* and *Optional knowledge*, and in R/6 the chapters *For the curious*, *Connect the knowledge* and *Key ideas and knowledge*.

In addition to the textual and pictorial elements of the textbook, all of the 6th-grade textbooks examined contain a section entitled *Instructions for Experimental Work and Explanations and Interesting Facts*.

Table 10 shows the analysis of the textual material in relation to environmental content in each 7th-grade textbook. The textbooks analysed differ in terms of textual material and tasks related to environmental content.

The highest percentage of textual material related to environmental content was found in textbook M/7 (6.5%) and the lowest in textbook NA/7 (4.6%). Textbook M/7 contains the most explanations of environmental content (14.3%), and textbook R/7 contains the least (5.2%). The textbook R/7 contains the highest percentage of interesting facts (14.3%) and summaries (8.7%) related to environmental content.

Tasks relating to the environmental content can be found in all of the 7th-grade textbooks examined. The textbook R/7 contains the highest proportion of tasks on environmental content (12%, most tasks are found between the text and at the end of each chapter), followed by NA/7 (4.8%), M/7 (4.2%) and DZS/7 (3.5%).

Environmental content is present in all textbooks analysed, but judging by the results of the analysis, this topic is insufficiently presented. All textbooks analysed contain explanations of new concepts, instructions for experiments, interesting facts, summaries, and introductory motivation at the beginning of each chapter. None of the textbooks contain the *Activities in the notebook* section. The textbooks DZS/7, R/7 and M/7 also contain tasks for students between the text and tasks at the end of each chapter. The textbook R/7 contains sections such as *Health tips*, *For the curious*, *You can also read,* and *Protecting nature*.

Discussion

This study aimed to determine what learning objectives relating to environmental content are included in the old and current science curriculum for Grades 6 and 7 and whether the science textbooks for those grades offer students opportunities to develop sustainable development competencies in relation to environmental content.

The old Grade 6 curriculum does not contain any learning objectives that relate directly to environmental content, while the old Grade 7 curriculum contains some of the learning objectives that relate to environmental content. In the science curriculum for Grades 6 and 7, there is a chapter on the impact of humans on the environment. The mentioned chapter contains eight learning objectives related to environmental content. These eight learning objectives account for only 8.6% of the learning objectives directly related to environmental content, compared to all 93 learning objectives in the Grade 6 curriculum. It can be seen that the curriculum has changed to such an extent that the current curriculum contains learning objectives that are directly linked to the development of students' environmental knowledge, whereas there were no such objectives in the old curriculum.

In the current Grade 7 curriculum, eleven learning objectives are listed in the chapter on human impact on the environment. At the level of all learning objectives in the current Grade 7 science curriculum, these eleven learning objectives account for 11% of all (100) learning objectives of that grade. Although there are not many learning objectives related to environmental content in the current curriculum, it can be concluded that the reform of the curriculum in 2011 has favoured environmental content and that appropriate implementation in the school setting promotes the development of environmental competences to some extent.

In summary, it is important to mention that in the renewed science curriculum in both grades, which will be the result of the current curriculum reform (see above), a significant increase in learning objectives for sustainable development should be integrated into different topics of the curriculum in order to fulfil the criterion that any curriculum should develop students' competences to actively participate in sustainable development activities as adult critical citizens. This is also important because, according to our findings, the current textbooks available to students lack direct implementation of science-oriented sustainable development goals such as natural resource management, climate change, water-related issues, marine issues, biodiversity and ecosystems, circular economy, environmentally sound management of chemicals and waste, and many other topics. For this reason, it is recommended that the renewed curriculum be introduced in the 2026/27 school year, and the corresponding textbooks should more clearly include the implementation of the science-oriented sustainable development goals that are currently missing.

In line with our findings, some other studies (Lane & Wilke, 1994; Ernst, 2007, 2009; Fraser et al., 2015; Ashmann & Franzen, 2017) reported that although it is possible to find content in the curriculum that could promote the development of specific environmental competences among students, and they also emphasised that there are problems among teachers to teach environmental content. Other barriers include lack of training or opportunities for ongoing professional development, lack of technical support, safety concerns, teachers' responsibility for learning outside the classroom, lack of resources, lack of interest and support from local partners, and lack of support from parents (Rebolj & Devetak, 2012).

After analysing selected science textbooks for Grades 6 and 7, it can be concluded that the textbooks differ in terms of the number of pages and chapters, the number of pages per chapter, the chapter headings (although they deal with similar topics) and the amount of pictorial material that relates directly to the environmental content. Realistic images predominate in all textbooks, followed by conventional images and macroscopic images. Moreover, all textbooks include images because visualisation plays a very important role in the comprehension of science content (Bunce & Gabel, 2002; Dimopoulos et al., 2003), and these images are appropriate with regard to the cognitive development of the students and the type of content presented. Images that are presented vividly and placed in the right context can have a major impact on the development of environmental competences in both children and adults, as they highlight the state of the environment and, ultimately, the consequences of pollution. Therefore, it makes sense that the number of visuals in textbooks showing environmental problems and impacts should increase, as this should have a positive impact on a more positive attitude towards the environment (Ahmad et al., 2015; Chen, 2017). Although all the textbooks studied contain pictorial material directly related to environmental content, according to Paivio's theory (1991), there are not enough images to promote the development of environmental values in students through visual channels.

The textbooks studied also differ in terms of the textual material that presents environmental content. Our findings show that the amount of textual material in textbooks is increasing in favour of environmental content. This suggests that there is some environmental content in 6^{th}- and 7^{th}-grade science textbooks that are consistent with the learning goals of the curriculum but that some sustainability content is still missing (e.g., local and global content on protecting, restoring and promoting the sustainable use of terrestrial ecosystems, sustainable management of forests, halting and reversing land degradation and halting biodiversity loss, reducing death and diseases from hazardous chemicals, and air, water and soil pollution, strengthening resilience and capacity to adapt to climate-related risks and natural disasters, energy consumption, waste generation, public health threats, poverty, social exclusion, natural resource management, biodiversity loss and land use, etc.) and should be part of the new textbooks developed by publishers in the future. For this reason, the curriculum reform currently underway in Slovenia should thoroughly consider the integration of science-oriented sustainable development into the science curriculum in Grades 6 and 7 of primary school.

Overall, it has been proven that science is not one of the most popular school subjects among students (Grubelnik, 2011), but at the same time, the data show that fewer and fewer students are choosing to study science (Šorgo et al., 2018). Nevertheless, the data from TIMSS and PISA show that Slovenian students achieve better results on average in science knowledge tests than students in other participating countries (Japelj Pavešić et al., 2012; Štraus et al., 2007) and this could also be reflected by the use of quality textbooks in schools.

Conclusion

The results of the analysis of science Grade 6 and 7 curricula and textbooks give us an insight into the state of environmental education in Slovenia. From the results, guidelines for better and stronger integration of environmental content in textbooks and curricula could be derived for the renewal of curriculum in the framework of the Recovery and Resilience Plan.

The results of this study can influence teachers' decisions when choosing a textbook, as they can draw attention to important didactic components of textbooks, for example, the textbook by DZS, which contains various didactic elements that define a quality textbook according to selected criteria. At the same time, the survey revealed some inconsistencies in the textbooks that teachers should be aware of in order to supplement their lessons with additional teaching material to achieve the learning objectives. These findings can also help textbook authors, editors, and publishers as they can significantly improve the didactic value of existing textbooks in future editions. It is also important that authors and publishers include appropriate pictorial and textual elements in future textbooks that will be developed after the introduction of the new curriculum in Slovenian schools at the beginning of the 2026/27 school year in order to improve the development of students' environmental competences.

Considering the analysis presented in this paper, the limitation of this study is the lack of an in-depth content analysis of the environmental textual and pictorial elements of the specific textbooks. This should be done in the future textbooks that will be published after the renewal of the science curriculum in 2026. It is important to emphasise that an examination of curricula and related textbooks is possible, focusing on subjects such as home economics, biology, chemistry, physics, and geography. Such an analysis could provide a more comprehensive overview of the environmental competencies promoted at the lower secondary level. It is also recommended to investigate how Slovenian teachers and students use textbooks in science classrooms and how much knowledge they gain by using textbooks in the future, regardless of whether they are classic or digital books, such as e-textbooks, as the development of digital competences is as important as that of sustainability, according to the recommendations of the EU commission (Ferrari & Punie, 2013).

Ethical statement

The research did not involve human and animal subjects. The reviews on which it was based aggregated studies that had already received ethical approval. Consequently, no additional ethical approval was necessary.

Disclosure statement

The authors have no conflict of interest to declare.

References

Agbedahin, A. V. (2019). Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future. *Sustainable Development*, *27*(4), 669–680.

Ahmad, J., Sritharan, G., & Nasir, N. N. (2015). The effectiveness of video and pamphlets in influencing youth on environmental education. *Jurnal Komunikasi: Malaysian Journal of Communication*, *31*(1), 281–296.

Ashmann, S., & Franzen, R. L. (2017). In what ways are teacher candidates being prepared to teach about the environment? A case study from Wisconsin. *Environmental Education Research, 23*(3), 299–323. https://doi.org/10.1080/13504622.2015.1101750

Bačič, T., Vilfan, M., Strgulc Krajšek, S., Dolenc Koce, J., & Krajšek, V. (2012). *Spoznavamo naravo 6. Učbenik za naravoslovje v 6. razredu osnovne šole [We learn about the nature 7, Science textbook for 7th grade of primary school].* Narava d.o.o.

Bačič, T., Vilhar, B., Vilfan, M., Strgulc Krajšek, S., Fišer, C., Bevk, D., & Tkavc, R. (2014). *Spoznavamo naravo 7. Učbenik za naravoslovje v 7. razredu osnovne šole [We learn about the nature 7, Science textbook for 7th grade of primary school]*. Narava d.o.o.

Bianchi, G., Pisiotis, U., & Cabrera, M. (2022). *GreenComp, the European sustainability competence framework, European Commission*. Publications Office of the European Union. https://doi.org/10.2760/13286

Bromley, P., Meyer, J. W., & Ramirez, F. O. (2011). The worldwide spread of environmental discourse in history, civics, and social studies textbooks. *Comparative Education Review*, *55*(4), 517–545.

Bunce, D. M., & Gabel, D. (2002). Differential Effect in the achievement of males and females of teaching the particulate nature of chemistry. *Journal of Research in Science Teaching, 39*(10), 911–972. https://doi.org/10.1002/tea.10056

Chen, X. (2017). A comparative study of visual representations in conventional, digitized and interactive high school science textbooks. *Journal of Visual Literacy, 36*(2), 104–122.

Cook, M. (2008). Students' comprehension of science concepts depicted in textbook illustrations. *Electronic Journal of Science Education, 12*(1), 1–14.

Dermastia, M., Denac, D., Goričan, Š., Repnik, R., Urbančič, M., & Vidic, T. (2017). *Jaz pa vem, kako rožice cveto. Naravoslovje za 6. razred osnovne šole [But I know how flowers bloom… Science for 6th grade of primary school]*. Modrijan.

Devetak, I., Rozman, L., Sopotnik, M., & Susman, K. (2013). *Dotik narave 7. Učbenik za naravoslovje v 7. razredu osnovne šole [Touch of Nature 7. Science textbook for 7th grade of primary school]*. Rokus Klett.

Devetak, I., & Vogrinc, J. (2013). The criteria for evaluating the quality of the science textbooks. In M. S. Khine (Ed.), *Critical Analysis of Science Textbooks* (pp. 3–15). Springer. https://doi.org/10.1007/978-94-007-4168-3_1

Devetak, I., Vogrinc, J., & Glažar, S. A. (2010). States of matter explanations in Slovenian textbooks for students aged 6 to 14. *International Journal of Environmental and Science Education, 5*(2), 217–235.

Dimopoulos, K., Koulaidis, V., & Sklaveniti, S. (2003). Towards an analysis of visual images in school science textbooks and press articles about science and technology. *Research in Science Education, 33*(2), 189–216. https://doi.org/10.1023/A:1025006310503

Dunn, P. K., Brunton, E. A., & Farrar, M. B. (2022). Your online textbook is ready: a shareable, interactive online textbook in response to COVID-19 lockdowns. *International Journal of Mathematical Education in Science and Technology*, *53*(3), 582–593.

Eilks, I. (2015). Science education and education for sustainable development-justifications, models, practices and perspectives. *Eurasia Journal of Mathematics, Science & Technology Education*, *11*(1), 149–158.

Erjavšek, M., Lovšin Kozina, F., & Kostanjevec, S. (2021). In-service home economics teachers' attitudes to the integration of sustainable topics in the home economics subject. *Center for Educational Policy Studies Journal*, *11*(1), 27–47. https://doi.org/10.26529/cepsj.614

Ernst, J. (2007). Factors associated with K–12 teachers' use of environment-based education. *The Journal of Environmental Education, 38*(3), 15–32. https://doi.org/10.3200/JOEE.38.3.15-32

Ernst, J. (2009). Influences on US middle school teachers' use of environment-base Education. *Environmental Education Research, 15*(1), 71–92. https://doi.org/10.1080/13504620802710599

Ferrari, A., & Punie, Y. (2013). *DIGCOMP: A framework for developing and understanding digital competence in Europe*. Publications Office of the European Union. http://digcomp.org.pl/wp-content/uploads/2016/07/DIGCOMP-1.0-2013.pdf

Fraser, J., Gupta, R., & Krasny, M. E. (2015). Practitioners' perspectives on the purpose of environmental education. *Environmental Education Research, 21*(5), 777–800. https://doi.org/10.1080/13504622.2014.933777

Freire, S., Baptista, M., & Freire, A. (2016). Sustainability and science learning: perceptions from 8th grade students involved with a role playing activity. *Universal Journal of Educational Research, 4*(8), 1757–1763.

Gkitzia, V., Salta K., & Tzougraki C. (2011). Development and application of suitable criteria for the evaluation of chemical representations in school textbooks. *Chemistry Education Research and Practice, 12*, 5–14.

Glavič, P. (2006). *Pripombe prof. dr. Petra Glaviča na Nacionalni progam visokega šolstva 2006–2010 [Comments by Prof. Dr. Petr Glavič on the National Higher Education Program 2006-2010]*. Faculty of Chemistry and Chemical Technology, University of Ljubljana. http://abra.fkkt.uni-lj.si/fn01leban/resolucija/7.doc

Grubelnik, V. (Ed.) (2011). *Razvoj naravoslovnih kompetenc [Development of science competences]*. Faculty of natural sciences and mathematics, University of Maribor. http://kompetence.uni-mb.si/

Holcar, A. (2009). Ocenjevanje za učenje [Assessment for learning]. In M. Turk-Škraba (Ed.), *Didaktika ocenjevanja znanja. Vodenje procesa ocenjevanja za spodbujanje razvoja učenja* (pp. 116–121). Zavod RS za šolstvo.

Japelj Pavešić, B., Svetlik, K., & Kozina, A. (2012). *Znanje matematike in naravoslovja med osnovnošolci v Sloveniji in po svetu, izlsedki raziskave TIMSS 2011 [Knowledge of mathematics and science among primary school students in Slovenia and worldwide, results of the 2011 TIMSS survey]*. Pedagoški inštitut. https://www.pei.si/wp-content/uploads/2018/12/porocilo_timss11_celo.pdf

Jimenez, J. D., Lerch, J., & Bromley, P. (2017). Education for global citizenship and sustainable development in social science textbooks. *European Journal of Education, 52*(4), 460–476.

Johnstone, A. H. (1982). Macro- and Micro-chemistry. *School Science Review, 64*, 377–379.

Johnston, N., & Salaz, A. M. (2019). Exploring the reasons why university students prefer print over digital texts: An Australian perspective. *Journal of the Australian Library and Information Association*, *68*(2), 126–145.

Kalin, J. (2004). Vloga medijev pri sodobnem pouku in presojanje njihove učinkovitosti [The role of media in modern lessons and the judgment of their efficiency]. In M. Blažič (Ed.), *Media in Education* (pp. 210–215). Higher Education Centre.

King, C. J. H. (2010). An analysis of misconception in science textbooks: Earth science in England and Wales. *International Journal of Science Education, 32*(5), 565–601. https://doi.org/10.1080/09500690902721681

Kopnina, H. (2020). Education for the future? Critical evaluation of education for sustainable development goals. *The Journal of Environmental Education*, *51*(4), 280–291.

Laçin Şimşek, C. (2011). Investigation of environmental topics in the science and technology curriculum and textbooks in terms of environmental ethics and aesthetics. *Educational Sciences: Theory and Practice, 11*(4), 2252–2257.

Lane, J., & Wilke, R. (1994). Environmental education in Wisconsin: A teacher survey. *The Journal of Environmental Education*, *24*(4), 9–14. https://doi.org/10.1080/00958964.1994.9941959

Lau, K. H., Lam, T., Kam, B. H., Nkhoma, M., Richardson, J., & Thomas, S. (2018). The role of textbook learning resources in e-learning: A taxonomic study. *Computers & Education*, *118*, 10–24. https://doi.org/10.1016/j.compedu.2017.11.005

Lemke, J. L. (1998). Multiplying meaning: Visual and verbal semiotics in scientific text. In J. R. Martin & R. Veel (Eds.), *Reading Science: Critical and Functional Perspectives on Discourses of Science* (pp. 87–113). Routledge.

Martin, O. M., Mullis, V. I., Foy, P., & Stanco, M. G. (2011). *TIMSS 2011 international results in science*. International Association for the Evaluation of Educational Achievement, The Netherlands.

Martínez-Gracia, M. V., Gil-Quilez, M. J., & Osada, J. (2006). Analysis of molecular genetics content in Spanish secondary textbooks. *Journal of Biological Education, 40*(2), 35–60. https://doi.org/10.1080/00219266.2006.9656014

Mayer, R. E. (1993). Illustrations that instruct. In R. Glaser (Ed.), *Advances in instructional psychology* (pp. 253–284). Erlbaum.

Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist, 32*(1), 1–19. https://doi.org/10.1207/s15326985ep3201_1

Mulvik, I., Pribuišis, K., Siarova, H., Vežikauskaite, J., Sabaliauskas, E., Tasiopoulou, E., Gras-Velazquez, A., Bajorinaite, M., Billon, N., Fronza, V., Disterheft, A., & Finlayson, A. (2021). *Education for environmental sustainability: policies and approaches in European Union Member States. Final Report*. European Commission. https://op.europa.eu/en/publication-detail/-/publication/a193e445-71c6-11ec-9136-01aa75ed71a1

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology, 45*(3), 255–287.

Peacock, A., & Gates, S. (2000). Newly qualified primary teachers' perceptions of the role of text material in teaching science. *Research in Science & Technological Education, 18*(2), 155–171. https://doi.org/10.1080/713694982

Quinn, F., Elliott, S., Taylor, N., & Littledyke, M. (2015). Education for sustainability in primary science education. In N. Taylor, F. Quinn, & C. Eames (Eds.), *Educating for Sustainability in Primary Schools* (pp. 91–119). Teaching for the Future. Sense Publishers.

Rauch, F., & Steiner, R. (2013). Competences for education for sustainable development in teacher education. *Center for Educational Policy Studies Journal*, *3*(1), 9–24. https://doi.org/10.26529/cepsj.248

Rebolj, N., & Devetak, I. (2012). Teachers' opinion about the development of environmental competences in primary school. In M. Orel (Ed.), *EDUvision 2012 Modern Approaches to Teaching*

Coming Generation (pp. 497–506). EDUvision.

Reed, S. K. (2010). *Cognition: Theories and application* (8th ed.). Wadsworth Cengage Learning.

Regulation of Textbook Approval (Pravilnik o potrjevanju učbenikov). (2015). Official Gazette of the Republic of Slovenia, 2nd paragraph (no. 34/15 and 27/17). http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12484#

Reid, D. J., Briggs, N., & Beveridge, M. (1983). The effect of pictures upon the readability of a school science topic. *British Journal of Educational Psychology*, *53*(3), 327–335. https://doi.org/10.1111/j.2044-8279.1983.tb02565.x

Rieckmann, M., Mindt, L., & Gardiner, S. (2017). *Education for Sustainable Development Goals: Learning Objectives*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000247444

Roberts, K., Benson, A., & Mills, J. (2021). E-textbook technology: Are instructors using it and what is the impact on student learning? *Journal of Research in Innovative Teaching & Learning, 14*(3), 329–344.

Roczen, N. (2011). *Environmental competence: the interplay between connection with nature and environmental knowledge in promoting ecological behavior*. [Doctoral dissertation (Research TU/e / Graduation TU/e), Industrial Engineering and Innovation Sciences]. Technische Universiteit Eindhoven. https://doi.org/10.6100/IR719557

Shalgimbekova, K., Eremeeva, O., & Pronkin, N. (2023). How the teacher's choice of e-textbook affects the primary school students' performance? *Education And Information Technologies*, 1–14. https://doi.org/10.1007/s10639-023-11937-9

Stará, J., Chvál, M., & Starý, K. (2017). The role of textbooks in primary education. *E-Pedagogium*, *17*(4), 60–69.

Sternberg, R. J. (2003). *Cognitive theory* (3rd ed.). Thomson Wadsworth.

Stylianidou, F., Ormerod, F., & Ogborn, J. (2002). Analysis of Science Textbook Pictures about Energy and Pupils' readings of them. *International Journal of Science Education, 24*(3), 257–283. https://doi.org/10.1080/09500690110078905

Šorgo, A., Čeh, B., & Slavinec, M. (2013). *Aktivno v naravoslovje 2. Učbenik za naravoslvje v 7. razredu osnovne šole [Active in the science 2. Science textbook for 7th grade of primary school]*. DZS.

Šorgo, A., Dojer, B., Golob, N., Repnik, R., Repolusk, S., Pesek, I., ... & Špur, N. (2018). Opinions about STEM content and classroom experiences as predictors of upper secondary school students' career aspirations to become researchers or teachers. *Journal of Research in Science Teaching*, *55*(10), 1448–1468.

Šorgo, A., Glažar, S. A., & Slavinec, M. (2012). *Aktivno v naravoslovje 1. Učbenik za naravoslvje v 6. razredu osnovne šole [Active in the science 1. Science textbook for 6th grade of primary school]*. DZS.

Štraus, M., Repež, M., & Štigl, S. (2007). *Program mednarodne primerjave dosežkov učencev – OECD PISA – Naravoslovni, bralni in matematični dosežki slovenskih učencev*. [Program for International Student Assessment – OECD PISA – Slovenian students' performance in science, reading and mathematics]. National PISA Center. Pedagogical Institute. https://www.pei.si/wp-content/uploads/2018/12/PISA2006NacionalnoPorocilo.pdf

Tome, S., Ravnjak, B., Glažar, S.A. & Repnik, R. (2016). *Ste jo videli že, srno?. Naravoslovje za 7. razred osnovne šole [Have you seen her yet, the doe?. Science textbook for 7th grade of primary school]*. Modrijan.

Torkar, G., Devetak, I., & Kovič, M. (2012). *Dotik narave 6. Učbenik za naravoslovje v 6. razredu osnovne šole [Touch of Nature 6. Science textbook for 6th grade of primary school]*. Rokus Klett.

Wade, R. & Eland, W. (1995). Connections, rewards, and challenges. *National Society for Experiential Education Quarterly, 21*(1), 4–5.

Yurtsever, N., & Angın, D. E. (2022). Examining the mediating role of altruism in the relationship between empathic tendencies, the nature relatedness, and environmental consciousness. *Center for Educational Policy Studies Journal, 12*(1), 217–239.

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Perceptions of the Teaching Profession and Motivation to Teach Among Slovenian University Students

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This study examined the perception of the teaching profession among students of social sciences and languages who were finishing their undergraduate studies and intended to continue their studies with a master's degree. A subgroup of students planning to study for a master's degree in teaching reported on their motivation to teach and their satisfaction with their career choice, while a subgroup of students who planned to pursue a master's degree programme without a teaching degree responded to an open-ended question about why they did not want to become teachers. Participants answered the FIT-Choice Scale, which measures twelve motivational factors and six perceptions about the teaching profession. Students recognised teachers' expertise; however, social status and salary were rated lower, indicating an imbalance between demands and rewards in the teaching profession. Altruistic and intrinsic motives were the main reasons for choosing the teaching profession. Students who will study teaching also rated their ability to become a teacher highly. Extrinsic factors (job transferability, teaching as a fallback career and time for family) were less important. Qualitative thematic analysis of the responses of students who will not study to become a teacher revealed that low intrinsic value (e.g., disinterest in teaching) and low personal utility value (e.g., better professional development elsewhere) were the most common themes. The high job demands due to demanding interactions with children and parents were also mentioned, while the teacher education programme was perceived as excessively extensive. The implications of the study highlight important considerations for policymakers and teacher education programmes.

Keywords: motivation to teach, perception of the teaching profession, university students

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Zaznave učiteljskega poklica in motivacija za poučevanje med slovenskimi študenti

Melita Puklek Levpušček in Katja Depolli Steiner

V raziskavi sva preučevali zaznave učiteljskega poklica med študenti družboslovja in jezikoslovja na dveh slovenskih filozofskih fakultetah, ki so zaključevali dodiplomski študij in se odločali za smer študija na magistrski stopnji. Skupina študentov, ki je izrazila namero po nadaljevanju študija na pedagoški smeri, je prav tako poročala o motivaciji za poučevanje oz. učiteljski poklic in svojem zadovoljstvu s karierno izbiro, skupina študentov, ki je izrazila namero po nadaljevanju študija na nepedagoški smeri, pa je odgovarjala na odprto vprašanje o tem, zakaj se niso odločili za pedagoško smer študija. Udeleženci so izpolnjevali vprašalnik FIT-Choice, ki meri dvanajst motivacijskih dimenzij in šest vidikov zaznav učiteljskega poklica. Študentje so visoko ocenili strokovno zahtevnost učiteljevega dela, nižje pa so ocenili učiteljev družbeni status in plačilo, ki ga prejema za svoje delo. V njihovih odgovorih se odraža neravnovesje med zahtevnostjo učiteljevega dela in nagradami (družbeni status, plačilo), ki jih učitelj prejema za svoje delo. Med razlogi, ki jih bodoči študentje pedagoških smeri navajajo kot najpomembnejše za izbiro učiteljskega poklica, so altruistični in intrinzični motivi. Ti študentje so tudi visoko ocenili svoje zmožnosti za opravljanje učiteljskega poklica. Zunanji dejavniki, kot so: možnost zaposlitve drugod po svetu, poučevanje kot rezervna kariera in več časa za družino, so se izkazali kot manj pomembni razlogi za odločitev za učiteljski poklic. Kvalitativna tematska analiza odgovorov študentov, ki so se odločili za nepedagoško smer študija, je pokazala, da sta nizka notranja vrednost (npr. nezanimanje za poučevanje) in nizka vrednost osebne koristi (npr. boljše karierne priložnosti drugje) najpogostejši temi, ki jih omenjajo študentje. Prav tako so bile pogosto omenjene visoke zahteve poklica zaradi zahtevnih interakcij z otroki in s starši, več študentov pa omenja tudi preobsežen program pedagoških predmetov in možnost njihovega opravljanja po končanem magistrskem študiju. V diskusiji poudarjava pomembne vidike motiviranja študentov za karierno pot učitelja.

Ključne besede: motivacija za poučevanje, zaznave učiteljskega poklica, študentje

Introduction

The Slovenian education system has recently faced a significant shortage of primary and secondary school teachers. According to the Employment Forecast among Employers (Employment Service of Slovenia, 2022), 52.2% of employers in the primary school sector and 57.5% in the secondary school sector anticipated difficulties recruiting staff. The main reason given is the lack of personnel in the labour market, followed by the lack of skills, work experience, and professional qualifications. The age structure of Slovenia's teaching workforce is also a concern. The average age of Slovenian teachers is 46, which is two years higher than the average age in OECD member countries (OECD, 2019). One-third of primary school teachers and 38% of secondary school teachers are over 50 years old, while 9.2% and 4.6% of primary and secondary school teachers, respectively, are under 30 years old (OECD, 2023). The issue of teacher retention in the education system and the problem of an ageing teacher population coupled with a lower influx of young teachers is not limited to Slovenia but is also common in other European and global contexts (Nesje et al., 2018; Shang et al., 2022; Tiplic et al., 2015).

Examining and understanding the reasons that young people choose to become teachers or not is important from several perspectives. It sheds light on how young people justify their decisions about their future careers, what personal and social factors influence their career thinking, what thoughts they have about the teaching profession, how they evaluate the profession, why they might not choose it, and what key factors ultimately determine their decision to become a teacher. A prospective teacher's professional identity takes shape before their academic career begins. The initial professional identity is influenced not only by personal factors but also by the broader social context that the young person observes and reflects on, for example, impressions of how the teaching profession is valued in society or the attitudes of significant others (e.g., parents, peers, teachers) towards the teaching profession (Torres-Cladera et al., 2021). Before deciding to become a teacher, young people have years of experience as students, including their interest in academic subjects, their academic performance, their interactions with teachers, and their experiences with classroom and school dynamics during their education. These social influences and experiences may encourage or discourage individuals from replicating these experiences in their careers (Bergmark et al., 2018).

Theoretical background

Motivation to teach refers to internal and external drives that guide individuals in their choice of teaching profession, their perseverance in training for the future teaching profession and later in their teaching career, and the extent to which they dedicate themselves to fulfilling their professional duties with high quality (Sinclair, 2008).

In a review article, Fray and Gore (2018) present a summary of studies on prospective teachers' professional motivation published in 23 countries between 2007 and 2014 and identify three main motivations for the teaching profession. These include extrinsic, intrinsic, and altruistic motives, with the latter two predominating as the main reasons for choosing the teaching profession. Extrinsic motives refer to aspects not directly related to the teaching profession, such as salary, social status, and working conditions. Intrinsic motives include reasons directly related to the importance of the teaching profession, enthusiasm for it, subject knowledge, and professional competence. Altruistic motives include the perception of the teaching profession as socially significant and the desire to contribute to the development of children and the betterment of society. Tang et al. (2015) also found that the most common reasons for choosing the teaching profession among prospective teachers are intrinsic and altruistic motives, leading to greater satisfaction. However, initial intrinsic motivation is not necessarily a guarantee that individuals will persevere in the teaching profession, and over time, initial enthusiasm for the teaching profession may wane (Sinclair, 2008), as the reality of working directly in the classroom may not match an individual's initial expectations of the job. Teachers face work overload and often do not receive adequate support in their work environment, leading to dissatisfaction and early exit from the profession (Kim & Cho, 2014). In addition, students who choose to study teaching primarily for extrinsic reasons are more likely to drop out or experience a decline in their academic performance over time (Malmberg, 2006). In general, motives from all three categories intertwine for individuals, but from the perspective of career persistence and quality of performance, it is essential that altruistic and intrinsic motives predominate. In contrast, extrinsic motives are the only supporting reasons for choosing the teaching profession (Struyven et al., 2013).

In Slovenia, there are only a few studies on the motivation of prospective teachers, two of which are from recent years. Among teacher education students at the Faculty of Arts of the University of Ljubljana studying to become teachers at primary or secondary schools, altruistic and intrinsic motivations for the teaching profession were found to be most important (Depolli Steiner, 2022), while among students at the Faculty of Education of the University of Ljubljana studying to become teachers at primary schools, the intrinsic factor of caring was the most important reason (Tašner et al., 2017). In both studies, extrinsic reasons were only rated as moderately important. These findings are in line with the two older studies in which intrinsic and altruistic factors were cited as the most important reasons for choosing the teaching profession among Slovenian students (Krečič & Grmek, 2005; Kyriacou & Kobori, 1998).

The Australian authors Richardson and Watt (Richardson & Watt, 2006; Watt & Richardson, 2007) have developed a model that systematically presents the factors critical to an individual's decision to pursue a teaching career (Factors Influencing Teaching or FIT-Choice model). These factors include an individual's self-beliefs and task perceptions, values, interests, and prior educational experiences. For example, if a person is enthusiastic about the teaching profession, enjoys working with young people, has had positive experiences as a student, and does not perceive the profession as overly demanding, they are more likely to choose teaching. In describing the personal factors that influence the decision to become a teacher, the authors draw on the expectancy-value theory of motivation developed by Allan Wigfield and Jacquelynne Eccles (1992). They explain the reasons behind individuals' decisions and behaviours, especially in academic and professional contexts. The motivation to engage in a particular activity is based on two key factors: a) the individual's belief that he or she is capable of successfully performing a task or activity, and b) the value he or she places on the task or activity. The more the individual believes that he or she can be successful in a particular activity and the higher he or she values that activity, the more motivated he or she is to engage in or perform that activity (Wigfield & Eccles, 2000). Beliefs in one's abilities can be further divided into a) self-efficacy beliefs (a person's belief in his or her ability to perform a task or activity) and b) task difficulty expectations (a person's perception of how difficult a task or activity is). The assessment of the value individuals place on a task or activity is categorised by Wigfield and Eccles (2000) as a) attainment value (related to the importance individuals place on successfully performing the task), b) intrinsic value (related to personal interest and enjoyment in the task or activity) and c) utility value (related to the perceived usefulness or importance of the task in achieving personal goals). Richardson and Watt (2006) and Watt and Richardson (2007) have adopted the concept of beliefs and values as factors influencing the decision to enter a teaching profession in the FIT-Choice model (Table 1).

Table 1

FIT-Choice theoretical model of motivations for choosing a teaching career as empirically validated by the FIT-Choice Scale questionnaire in Watt and Richardson (2007)

Domains of the FIT-Choice model							
		Not higher order dimension	Higher order dimension	First order dimension			
Antecedent	Socialisation influences	B Prior teaching and learning experiences					
		B Social influences					
		D Social dissuasion					
Proximal influences	Task perceptions		C Task demand	Expertise	Difficulty		
			C Task return	Social status and teacher morale	Salary		
	Self-perceptions	B Ability					
	Values		B Personal utility value	Job security	Time for family	Job transferability	
			B Social utility value	Shape the future of children/ adolescents	Work with children/ adolescents	Make social contribution	Enhance social equity
		B Intrinsic career value					
Outcome	Satisfaction with choice	D Satisfaction with choice					

Note. B = Reasons influencing teaching choice, C = Perceptions about teaching, D = Career commitment and satisfaction.

The core components of the model (proximal influences) include three main value dimensions (intrinsic value, personal utility value, and social utility value) and self- and task perceptions about choosing teaching as a career (Nesje et al., 2018). Consistent with the expectancy-value theory, Watt and Richardson (2007) and Watt et al. (2012) defined the value components as intrinsic motivation in teaching and enjoyment of (*intrinsic career value*), extrinsic motivations associated with a teaching profession, such as job security, time for family, and job transferability (*personal utility value*), and altruistic motivations, such as shaping future of children/adolescents, working with children/adolescents, making a social contribution, and enhancing social equity (*social utility value*). The model also includes maladaptive motivation, such as teaching as a *fallback career*. Self-perceptions in the model are defined as an individual's confidence in his or her *ability* to perform the tasks of a teacher, while task-perceptions are related to *demands* and *returns* in the teaching profession. Demands and returns both refer to 'costs' or the potential sacrifices individuals must make to pursue a teaching career. Such costs could be a perceived mismatch between the demands of the teaching profession (e.g., high levels of expertise and high workload) and the perceived 'rewards' (e.g., high social status of teachers and good salary). These 'rewards' tend to be rated low by prospective and practising teachers, leading to higher 'cost' scores and lower motivation to become a teacher (Nesje et al., 2018). The FIT-Choice model also includes socialisation influences that may influence teaching career choices, such as prior learning and teaching experiences and the social support of significant others. The model also includes the outcome variable, satisfaction with the choice to become a teacher.

Watt and Richardson (2007) developed the FIT-Choice Scale questionnaire based on the presented model, which has been used and validated in different cultural contexts in Asia, Europe, Australia, and North America (e.g., Jugović et al., 2012; Nesje et al., 2018; Simić et al., 2022; Shang et al., 2022; Watt et al., 2013). The dimensions that have consistently emerged as the strongest reasons for students' desire to become teachers in different cultural contexts are the following (Nesje et al., 2018; Simić et al., 2022; Watt & Richardson, 2007): the intrinsic value of the teaching profession, shaping the future of youth, self-perceived teaching ability, contribution to societal progress, and job security. Students who aspire to the teaching profession attribute their career decision to a lesser extent to social influence (e.g., parents, peers) and to choosing teaching as a fallback option. Less important reasons mentioned by students include job transferability, more time for family, and career benefits (e.g., longer vacations and shorter work hours). Most studies on reasons for choosing a teaching profession included samples of students already enrolled in a teacher education programme. One exception is two studies by Giersch (2016, 2021), who suggests more research on students who are faced with deciding which study programme to choose; what are their thoughts and perceptions before they finally decide to study teaching? At the same time, it is important also to hear the voices of students who decided not to study teaching even though they had the opportunity to do so. This study addresses Giersch's suggestion by including a sample of students nearing the end of their bachelor's degree and deciding on a master's programme that offers them a teaching or non-teaching degree.

Research aims

The first aim of this study was to investigate the perceptions (beliefs) about the teaching profession among Slovenian students of social sciences and languages during the transition to the master's programme. Our aim was to identify possible differences in these beliefs between two groups of students: those who intend to enrol in a master's degree programme in teaching in the coming academic year(s) and those who intend to enrol in a non-teaching degree programme. The second research objective was to explore the motivations for pursuing a teaching career and to assess satisfaction with career choice among students intending to enrol in a master's degree programme in teaching. The final research objective focused on understanding the reasons that prevented students who had opted for a non-teaching master's programme from choosing a teaching profession.

Method

Participants

The study encompassed students from two Slovenian faculties specialising in social sciences and languages (Faculty of Arts, University of Ljubljana, and Faculty of Arts, University of Maribor). These faculties provide education for future teachers of general-education subjects at both lower and upper-secondary school levels, offering teacher training programmes at the master's level.[3] Students obtaining a bachelor's degree from these faculties typically study one or two subjects of their choice. They can subsequently pursue a two-year master's programme tailored to prepare them specifically for the teaching profession. Alternatively, they have the option to choose non-education majors in their master's programme.

3 Teacher education in Slovenia lasts five years or 300 ECTS (integrated master's degree programmes, 3+2 or 4+1) and includes the same requirements for the pedagogical qualification of teachers of general-education and theoretical professional subjects at the primary and secondary levels. There are two paths to teaching qualification: within a concurrent model (pedagogical courses parallel to courses in the subject areas) or within a consecutive model (completed master study programme followed by a non-degree teacher training programme of 60 ECTS) (Taštanoska, 2022; Valenčič Zuljan et al., 2011).

Participants in the sample were finishing their third or subsequent year of bachelor's studies at the time of data collection. A total of 238 students participated (82% female, 16% male, 2% non-binary gender), most of them from the University of Ljubljana (77%). The age of the students ranged from 20 to 38 years (M = 22.6, SD = 2.04). Most students were enrolled in a combined degree programme (two subjects; 71%). The sample consisted of students of language studies (33%), students of non-language studies (34%), and students with a combination of language and non-language studies (33%). Part of the participants, 16%, indicated that they would not pursue a master's degree (at all or in Slovenia), while the majority of the participants intended to enrol in a master's programme, most of them (79%) in one of the two faculties of arts and only a small part (5%) in another faculty. Of the 189 participants who chose the faculty of arts, about half will enrol in a teacher education programme, and the other half in a non-teacher education programme. These two groups are similar in terms of age (t (187) = 1.225, p = .222), gender ($\chi^2(2)$ = 3.51, p = .173), and choice of university ($\chi^2(1)$ = 2.42, p = .120)

Instruments

The online survey began with demographic questions: university, age, gender, current major(s), and year of study. Other questions related to students' intentions regarding their master's degree. First, they were asked about their intentions to continue their master's degree in Slovenia. If the answer was 'yes', we asked them about the university and faculty where they intended to continue their studies. If they chose one of the two targeted faculties of arts, we asked them about the programme of study they intended to choose. Based on their answers, we divided the participants into a 'teaching degree' (will enrol in a teacher education programme) and a 'non-teaching degree' (will not enrol in a teacher education programme) group. The 'teaching degree' group then answered the full FIT-Choice Scale (the instrument described below), while the 'non-teaching degree' group answered the open question: 'Please provide reasons why you did not choose to study teaching in your master's programme' and then answered selected parts of the FIT-Choice Scale (Part C and Part D - social dissuasion; see Table 1).

The FIT-Choice Scale (Watt & Richardson, 2007) is a self-report instrument that measures different types of motivational reasons for individuals' decisions to become teachers. The scale was translated from English to Slovenian using a back-translation procedure. In the first part of the questionnaire, the 12 dimensions measuring different motivations for becoming a teacher (labelled 'B' in Table 1) include items with the same introductory statement ('I chose to become a teacher because...') and a response scale ranging from 1 (not at all important) to 7 (extremely important). The subscales in this part are *perceived teaching ability*, *intrinsic value*, *fallback career*, *job security*, *time for family*, *job transferability*, *shape future of children/adolescents*, *enhance social equity*, *make social contribution*, *work with children/adolescents*, *prior teaching and learning experiences*, and *social influences* (Watt & Richardson, 2007). The second part (labelled 'C' in Table 1) describes perceptions about the teaching profession. The subscales are *expert career*, *high demand*, *social status,* and *salary*. The third part of the questionnaire (labelled 'D' in Table 1) measures two perceptual dimensions of career commitment and satisfaction: *social dissuasion* and *satisfaction with choice*. In both the second and the third part, the participants rated the extent to which they agreed with the questions on teaching: 1 (not at all) to 7 (extremely).

Research design

Data were collected in June 2023 via an online questionnaire in the 1KA online survey (https://www.1ka.si/d/en) application. The survey was available for six weeks. An invitation to the survey with a link to the questionnaire was emailed to all potential participants (i.e., students in their third or subsequent year of undergraduate study) at the two target faculties. Participation was voluntary and completely anonymous. A total of 355 respondents completed all or part of the questionnaire. After data cleaning, responses from 238 respondents were included in the sample. Data cleaning involved eliminating data from 78 respondents who started the survey but did not complete it (they answered only some of the demographic questions) and 49 respondents who did not meet our target criteria (e.g., they already had a master's degree). Statistical analyses that included responses on the FIT-Choice Scale and reasons for not choosing a teacher education programme were conducted on the data of 189 participants who intended to continue their master's studies at one of the faculties of arts.

Results

The FIT-Choice Scale

The Slovenian version of the FIT-Choice Scale has not yet been validated. Most studies validating non-English versions of the FIT-Choice Scale used a CFA (e.g., Nesje et al., 2018; Simić et al., 2022). However, since fewer than 100 participants in our study answered the full scale, we could not conduct a CFA;

instead, we conducted an item analysis (see Tables 2, 3, and 4). Checking the corrected item-total correlations and Cronbach's alphas if the item was deleted showed sufficient discrimination and reliability of the items on the individual subscales, except for three items (B22, B35 and C5), which were thus deleted in the subsequent analyses to increase the reliability of the subscales. The Cronbach alpha reliability coefficients showed very good internal consistencies for most subscales. As shown in Table 2, only two subscales (*job transferability* and *social dissuasion*) had alpha values below 0.80 but were still in the acceptable range (.68 and .71, respectively).

Table 2

Item Analysis of the FIT-Choice Scale, Part B (Reasons influencing teaching choice)

Subscales and items	n	α	M	SD	r_c	$\alpha_{\text{if item deleted}}$
Ability	94	.80	5.25	1.23		
B5 I have the qualities of a good teacher			5.28	1.39	.62	.74
B19 I have good teaching skills			5.06	1.49	.78	.57
B43 Teaching is a career suited to my abilities			5.40	1.50	.54	.83
Intrinsic career value	94	.84	5.19	1.50		
B1 I am interested in teaching			5.55	1.54	.78	.73
B7 I've always wanted to be a teacher			4.35	2.04	.62	.91
B12 I like teaching			5.66	1.50	.79	.73
Fallback career	94	.80	2.48	1.76		
B11 I was unsure of what career I wanted			2.80	2.02	.55	.24
B35* I was not accepted into my first-choice career			1.43	1.28	.12	.80
B48 I chose teaching as a last-resort career			2.16	1.85	.62	.13
Job security	94	.82	4.89	1.45		
B14 Teaching will offer a steady career path			5.29	1.58	.58	.84
B27 Teaching will provide a reliable income			4.57	1.77	.70	.73
B38 Teaching will be a secure job			4.82	1.70	.75	.67
Time for family	94	.89	3.54	1.59		
B2 Part-time teaching could allow more family time			3.74	1.89	.69	.88
B4 As a teacher, I will have lengthy holidays			3.09	1.89	.76	.86
B16 Teaching hours will fit with the responsibilities of having a family			4.20	1.89	.71	.88
B18 As a teacher, I will have a short working day			3.11	1.83	.79	.86
B29 School holidays will fit in with family commitments			3.57	1.99	.74	.87
Job transferability	94	.68	3.06	1.56		
B8 Teaching will be a useful job for me to have when travelling			2.76	1.76	.46	.43

Subscales and items	*n*	*α*	*M*	*SD*	r_c	$\alpha_{\text{if item deleted}}$
B22* A teaching qualification is recognised everywhere			4.03	1.78	.28	.68
B45 A teaching job will allow me to choose where I wish to live			3.37	1.81	.51	.35
Shape future of children/adolescents	94	.90	5.55	1.38		
B9 Teaching will allow me to shape child/adolescent values			5.74	1.50	.79	.88
B23 Teaching will allow me to influence the next generation			5.53	1.43	.81	.86
B53 Teaching will allow me to have an impact on children/adolescents			5.38	1.59	.83	.84
Enhance social equity	94	.88	4.93	1.50		
B36 Teaching will allow me to raise the ambitions of underprivileged youth			4.84	1.67	.74	.85
B49 Teaching will allow me to benefit the socially disadvantaged			4.90	1.61	.80	.81
B54 Teaching will allow me to work against social disadvantage			5.04	1.73	.77	.83
Make social contribution	94	.85	5.33	1.43		
B6 Teaching allows me to provide a service to society			5.84	1.38	.76	.77
B20 Teachers make a worthwhile social contribution			5.57	1.46	.76	.76
B31 Teaching enables me to 'give back' to society			4.59	2.00	.70	.85
Work with children/adolescents	94	.94	5.33	1.70		
B13 I want a job that involves working with children/adolescents			5.37	1.84	.88	.91
B26 I want to work in a child/adolescent-centred environment			5.12	1.85	.85	.94
B37 I like working with children/adolescents			5.51	1.69	.91	.90
Prior teaching and learning experiences	94	.93	4.90	1.78		
B17 I have had inspirational teachers			5.00	1.95	.89	.87
B30 I have had good teachers as role models			4.86	1.94	.89	.87
B39 I have had positive learning experiences			4.85	1.81	.79	.95
Social influences	94	.80	3.49	1.64		
B3 My friends think I should become a teacher			3.21	1.93	.60	.77
B24 My family think I should become a teacher			3.38	1.92	.63	.73
B40 People I've worked with think I should become a teacher			3.87	1.96	.70	.67

Note: * = item deleted in subsequent analyses to enhance subscale reliability; α = Cronbach's alpha for the subscale (without the excluded item); r_c = corrected item-total correlation; items were rated on a scale of 1 to 7. The items are presented as published in Richardson and Watt (2006).

Table 3

Item Analysis of the FIT-Choice Scale, Part C (Perceptions about teaching)

Subscales and items	*n*	*α*	*M*	*SD*	r_c	$\alpha_{if\ item\ deleted}$
Expert career	170	.87	5.38	1.22		
C10 Do you think teaching requires high levels of expert knowledge?			5.80	1.33	.76	.81
C14 Do you think teachers need high levels of technical knowledge?			5.08	1.37	.74	.82
C15 Do you think teachers need highly specialised knowledge?			5.26	1.42	.75	.81
High demand	170	.81	5.97	0.94		
C2 Do you think teachers have a heavy workload?			5.61	1.28	.68	.75
C7 Do you think teaching is emotionally demanding?			6.17	1.02	.67	.75
C11 Do you think teaching is hard work?			6.15	1.00	.68	.74
Social status	170	.92	3.19	1.27		
C4 Do you believe teachers are perceived as professionals?			3.21	1.50	.70	.88
C5* Do you think teachers have high morale?			4.17	1.14	.31	.92
C8 Do you believe teaching is perceived as a high-status occupation?			3.32	1.54	.82	.86
C9 Do you think teachers feel valued by society?			3.16	1.43	.79	.86
C12 Do you believe teaching is a well-respected career?			3.12	1.40	.86	.85
C13 Do you think teachers feel their occupation has high social status?			3.12	1.38	.80	.86
Salary	170	.91	3.10	1.32		
C1 Do you think teaching is well paid?			3.08	1.33	.83	–
C3 Do you think teachers earn a good salary?			3.12	1.43	.83	–

Note: * = item deleted in subsequent analyses to enhance subscale reliability; α = Cronbach's alpha for the subscale (without the excluded item); r_c = corrected item-total correlation; items were rated on a scale of 1 to 7. The items are presented as published in Richardson and Watt (2006).

Table 4

Item Analysis of the FIT-Choice Scale, Part D (Career commitment and satisfaction)

Subscales and items	*n*	*α*	*M*	*SD*	r_c	$\alpha_{if\ item\ deleted}$
Social dissuasion	169	.71	3.21	1.50		
D2 Were you encouraged to pursue careers other than teaching?			3.27	1.93	.52	.63
D4 Did others tell you teaching was not a good career choice?			3.27	1.94	.53	.62
D6 Did others influence you to consider careers other than teaching?			3.10	1.79	.54	.62
Satisfaction with choice	92	.88	5.13	1.33		
D1 How carefully have you thought about becoming a teacher?			5.17	1.47	.64	.94
D3 How satisfied are you with your choice of becoming a teacher?			5.10	1.53	.84	.77
D5 How happy are you with your decision to become a teacher?			5.13	1.42	.84	.77

Note: α = Cronbach's alpha for the subscale (without the excluded item); r_c = corrected item-total correlation; items were rated on a scale of 1 to 7. The items are presented as published in Richardson and Watt (2006).

Tables 2, 3, and 4 also show the mean values and standard deviations of the subscales. Participants in the 'teaching degree' group who completed part B of the FIT-Choice Scale indicated that the most important reason for choosing the teaching profession was *shape future of the children/adolescents*. The item that scored highest on this scale was B9 ('Teaching will allow me to shape child/adolescent values'). The reasons that closely follow are *make social contribution* (the highest rated item was B6, 'Teaching allows me to provide a service to society'), *work with children/adolescents* (the highest rated item was B37, 'I like working with children/adolescents'), *ability* (the highest rated item was B43 'Teaching is a career suited to my abilities'), and *intrinsic career value* (the highest rated item was B12 'I like teaching'). Fairly important reasons were also *enhance social equity*, *prior teaching and learning experience*, and *job security*. Students rated job security as an important reason for choosing teaching as a career; however, they rated the job security reason 'teaching as a steady career path' higher than economic security (i.e., a reliable income). Moderately important reasons were *time for family*, *social influences*, and *job transferability*. Social influences, such as family and friends, were rated below average. The least important reason, which was rated relatively low, was *fallback career*.

Part C, which deals with perceptions of the teaching profession and which was completed by both the group with and the group without a teaching degree, showed that teaching was rated highly on the *high demand* and *expert career* subscales, while it was in the middle of the scale on the *social status* and *salary* subscales. Hard work (C11), emotionally demanding work (C7) and a heavy workload (C2) were rated highest, showing that students recognise the high complexity of teachers' work. On the other hand, there was a discrepancy in the students' perception of the teaching profession. Students strongly agreed that the teaching profession requires a high level of expertise (C10, C15), but they rated the status of the teacher in society as below average (C9, C12, C13).

Part D, which relates to professional commitment and satisfaction, was completed by the 'teaching degree' group on both subscales, while the 'non-teaching degree' group only completed one scale. The 'teaching degree' group rated *satisfaction with choice of becoming a teacher* quite highly, while *social dissuasion* (i.e., social pressures to pursue other careers than teaching) was rated below the middle of the scale (both groups combined).

The differences between the 'teaching degree' and 'non-teaching degree' groups were very small. As the variances of the data were not homogeneous according to the Levene test, the data were compared using the Mann-Whitney test. Only two differences were statistically significant: *expert career* (U = 2927.00, Z = -2.057, p = .040, r = .18) and *social dissuasion* (U = 2701.00, Z = -2.663, p = .008, r = .24) were both rated higher by the 'teaching degree' group. Students who chose to enrol in a teaching degree programme rated the expertise of a teaching career higher and reported higher social pressure to choose a career other than teaching than students who chose to enrol in a non-teaching degree programme.

Thematic analysis of open-ended responses

The open answers to the question 'Please provide reasons why you did not choose to study teaching in your master's programme' of the participants from the 'non-teaching degree' group were analysed using a coding thematic analysis that identifies 'themes' in qualitative data sets (Boyatzis, 1998). In defining themes, we used a 'domain summary' approach, meaning we analysed a semantic or surface level of meaning by summarising what participants said in relation to a topic (Braun et al., 2019). Initial themes or categories were developed at the beginning of the analysis process. The authors first read all responses and found that the most common reasons for not choosing to study teaching were consistent with the motives and perceptions conceptualised in the FIT-Choice model, albeit in reverse. Therefore, the preliminary codebook included themes describing proximal influences (values, self-perceptions, and task perceptions) and socialisation influences. Specifically, the predefined themes were as follows: low intrinsic career value, low social utility value, low personal utility value, low ability, high/low task demand, low task return, negative prior teaching and learning experience, and social influences. After creating the first version of the codebook, we decomposed the participants' responses into individual units of analysis. The unit of analysis was each individual reason found in the participants' responses. Each author independently created a list of units of analysis that were later compared to determine agreement. The total number of units of analysis was 163 for 78 participants who responded to the question. Each author then coded the units of analysis (reasons) into the predetermined themes (categories). A participant could provide one or more reasons why he or she chose not to pursue teacher education, and these reasons were assigned to one or more corresponding categories.

In addition, we found that certain units of analysis did not fit any of the previously established themes. Therefore, we added new categories to the codebook that were not captured in the FIT-Choice model but were discovered in the students' responses: teacher training programme, school system, and constraints. We found 88% agreement among the two authors in coding the units of analysis into the appropriate themes. After coding all reasons into their respective categories, we conducted frequency analyses. We counted all themes mentioned by each participant. The theme was counted only once if multiple units of analysis within a participant were assigned to the same theme.

Table 5 shows the final coding system with all the themes, their descriptions, and frequencies. As can be seen, the students who do not intend to study teaching mostly gave reasons in the categories of low intrinsic career value and low personal utility value. They feel that they have no intrinsic interest in teaching (e.g., 'Teaching does not interest me'; 'I do not see myself in the role of a teacher'; 'I know I would not enjoy it') or are more likely to pursue other professional career plans. Many feel that they will not be able to develop professionally if they choose a teaching career (e.g., 'If I choose a teaching programme, I would limit myself to teaching, but I want to work in different domains'; 'I cannot achieve a lot as a teacher in a professional sense'; 'The promotion possibilities are weak'). Sixteen participants also perceived high task demand, mainly because of demanding children and their parents ('I do not like parental attitudes towards teachers'; 'Parents get absolutely too involved in the teacher's work'; 'Nowadays children are very demanding'; 'It is a psychologically very demanding profession'). Fourteen participants feel that the teacher training programme is too extensive (i.e., there is less opportunity to acquire quality subject knowledge), and some students also mentioned the possibility of completing the teacher training programme after the master's degree. Social influences, personal experiences with teaching and learning, and low confidence in one's teaching skills were mentioned by only a few participants.

Table 5

Coding thematic analysis of participants' responses to the question 'Please provide reasons why you did not choose to study teaching in your master's programme'

Predetermined themes (FIT-Choice model)	Theme description	Frequency
Value		
Low intrinsic career value	No interest in teaching, no enjoyment in teaching	26
Low social utility value	Dislike children, dislike working with children or people in general	12
Low personal utility value	Other career plans, low job transferability, not stimulating working environment	23
Self-perceptions		
Low ability	Dislike performing, high speech anxiety, lack of rhetoric skills, lack of abilities to work with children	6
Task-perceptions		
High/low task demand	Demanding children, demanding parents, emotionally demanding job, high workload, low expert knowledge,	16
Low task return	Low salary, low social status	9
Socialisation influences		
Prior teaching and learning experiences	Negative learning experiences in school, negative teaching experiences in school	3
Social influences	Observation of parents' or friends' work as teachers	2
Other (empirically driven) themes		
Teacher training programme	Too extensive, possibility to accomplish teacher training after master's degree	14
School system	Not good conditions, bad conditions in schools, poor curriculum, poor choice on labour market	8
Constraints	No possibility of choosing teacher training, already have a teaching degree but have not decided yet	11

Note. The frequency of each theme represents the number of participants who mentioned the theme in their answers.

Discussion

We investigated and compared perceptions of the teaching profession among students of social sciences and languages who were in the final stages of their undergraduate studies (i.e., bachelor's degree) and who opted for a 'teaching degree' or a 'non-teaching degree' in their master's programme. We were also interested in the predominant motivations for becoming a teacher and satisfaction with the career choice among students who confirmed their intention to pursue a master's study in a teaching degree programme. Another research aim was to find out why students who intended to continue their master's studies in a non-teaching degree programme did not choose to become teachers.

Participants answered a FIT-Choice Scale (Watt & Richardson, 2007) that included 12 motivational factors for becoming a teacher and six perceptions about the teaching profession. Both groups of students answered questions on five areas of perceptions of the teaching profession (level of teachers' expert knowledge and job demands, social status of teachers, perceptions of teacher salary, and social discouragement to become a teacher), while a "teaching degree" group additionally assessed motivational reasons for their decision to become a teacher and their satisfaction with the career choice. The most important reasons for choosing the teaching profession were altruistic and intrinsic, such as making a social contribution, working with children, shaping children's futures, and the intrinsic value of the teaching profession. These findings complement previous studies with student teachers (e.g., Depolli Steiner, 2022; Nesje et al., 2018; Simić et al., 2022; Tang et al., 2015; Watt & Richardson, 2007). Quality teaching has many facets, including subject knowledge, didactic skills, and classroom management skills. However, it cannot be achieved without enthusiasm and high commitment to the teaching profession and the education of students (Heinz, 2015). Therefore, it is positive that the most common motives motivating young people to study teaching in different countries are inherently intrinsic and socially oriented. They lay the foundation for later high-quality professional competences through the teacher education programme and school practice. Similar to the study with Slovenian student teachers before the Bologna curricular reform (Krečič & Grmek, 2005), the group of students in our study who intend to become prospective teachers also highly rated their abilities to become teachers. Teaching ability-related beliefs proved to be a very important motive in one's decision to become a teacher (Nesje et al., 2018; Simić et al., 2022; Watt & Richardson, 2007). If young people identify their attributes as similar to those of effective teachers, they develop a strong connection with the teaching profession, leading them to perceive teaching as a natural and likely path (Younger et al., 2004). In contrast, students in our study referred to extrinsic reasons such as job transferability, social influences and time for family, and teaching as a fallback career as less important motives for becoming a teacher. The low importance of reasons unrelated to the profession itself proves once again that the main reasons that drive students to pursue a teaching career are commitment and service role. However, the importance of extrinsic reasons for the decision to become a teacher varies depending on the socio-cultural context. According to Heinz's (2015) review of studies that examined the career motivation of student teachers across different countries, extrinsic reasons such as the social status of teachers, the level of pay, job security and the possibility of better managing time for work and family may be less attractive in European countries, North America, and Australia. However, they can be very influential reasons for choosing a teaching career in Asian, African, or South American countries.

The participants in our study rated teachers' expert knowledge as above average and perceived teaching as a very demanding job. In contrast, the social status of teachers and their salaries were rated much lower, suggesting that the demands and rewards of the teaching profession are not balanced from the students' perspective. However, the students who decided to continue their studies as prospective teachers showed above-average satisfaction with their career choice, indicating their enthusiasm about the profession unweighted the perceived challenges.

In the study, we followed Giersch's (2016, 2021) suggestion to investigate not only the motives of students for choosing the teaching profession but also a counterfactual group of students who did not choose to study teaching. A qualitative thematic analysis was used to examine the responses of students who had decided not to study teaching in their upcoming master's programme to the open-ended question: 'Please provide reasons why you did not choose to study teaching in your master's programme'. Most cited reasons belong to categories of low intrinsic career value and low personal utility value. The 'non-teaching degree' group expressed disinterest in teaching and preferred other career paths because they expected better professional development elsewhere. One fifth of participants perceived high task demand due to challenging interactions with students and parents. They also expressed concerns about the extensive nature of the teacher training programme and the possibility of pursuing it after completing their master's degree. Other themes were mentioned less frequently, such as negative prior experiences with teaching and learning, social influences, and low confidence in teaching skills.

Although the above results suggest a rather low motivation for the teaching profession in non-education major students, the 'teaching degree' and the 'non-teaching degree' groups differed only in two dimensions (i.e., perceptions of the teaching profession) of the FIT-Choice Scale. The reported level of social dissuasion was below average in both groups. However, the first group reported more social disincentives to continue their studies as prospective teachers than the second group. It could be that students who chose to study teaching experienced more negative comments from others when talking about their decision to become teachers. The 'non-teaching degree' group probably discussed this topic less with others because they had no intention of becoming teachers. In addition, the expertise of teachers was rated higher by the students who intend to become teachers, indicating that they are well aware of the professional knowledge and skills required for the teaching profession. The perception of teaching as a highly skilled profession could be an additional motivating factor for entering the teaching profession.

This study is limited in scope, as it only included Slovenian bachelor's students of social sciences and languages who may choose to study teaching at the master's level. Future studies should also include other faculties that educate prospective teachers for secondary education (e.g., students of natural sciences or mathematics). The study sample was unbalanced regarding university (77% of participants studied at the University of Ljubljana) and gender (82% females). However, the gender distribution of the sample corresponds to the gender ratio of students studying at Slovenian faculties of arts.

Conclusions

The results of our study indicate that bachelor's students who intend to continue their master's studies in a teaching degree programme have predominantly intrinsic and altruistic motives to pursue a teaching career. This finding is consistent with previous research and suggests that the inclination to become a teacher is often based on a genuine commitment to the teaching profession and a desire to contribute to the betterment of society by teaching young generations. As teacher shortages are a global problem affecting many countries worldwide, school policies should make more efforts to 'attract, recruit and retain sufficient numbers of motivated and committed student teachers' (Heinz, 2015, p. 260). The core professional identity derived from one's school experiences and motivation to teach should be further shaped and reflected through high-quality experiences in teacher education and school practice in the subsequent academic career. The quality of interactions with school and university tutors is a crucial factor in prospective students' formative process

(Torres-Cladera et al., 2021). In practice, it is important to select school mentors who can serve as supportive partners in developing student teachers' core beliefs about good teaching and who do not confine teacher candidates to their 'tried and tested' teaching methods (Butler, 2021). Emphasising the intrinsic and altruistic aspects of the teaching profession and promoting a match between personal qualities and effective teaching qualities can attract students who are genuinely motivated to become teachers. Teacher education programmes should focus on supportive communication and teaching methods that foster intrinsic motivation in student teachers. By emphasising the social impact and role of teachers in shaping students' futures, these programmes can strengthen the commitment of future teachers. Emphasising the expertise required for effective teaching can raise students' awareness of the complexity of the profession and attract candidates who value the intellectual and pedagogical aspects of teaching. Policymakers should address the perceived imbalance between the demands of the profession and the perceived benefits and improve the social standing of teachers, which could help attract more candidates to the teaching profession.

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References

Bergmark, U., Lundström, S., Manderstedt, L., & Palo, A. (2018). Why become a teacher? Student teachers' perceptions of the teaching profession and motives for career choice. *European Journal of Teacher Education*, *41*(3), 266–281. https://doi.org/10.1080/02619768.2018.1448784

Boyatzis, R. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage.

Braun, V., Clarke, V., Hayfield, N., & Terry, G. (2019). Thematic analysis. In P. Liamputtong (Ed.), *Handbook of research methods in health social sciences* (pp. 843–860). Springer. https://doi.org/10.1007/978-981-10-5251-4_103

Butler, A. S. (2021). The impact of external contextual factors on teaching candidates. *Center for Educational Policy Studies Journal*, *11*(3), 55–74. https://doi.org/10.26529/cepsj.1072

Depolli Steiner, K. (2022). Teacher motivation and commitment to the teaching profession among Slovenian teacher education students. *Psihološka obzorja, 31*, 516–525. https://doi.org/10.20419/2022.31.559

Employment Service of Slovenia. (2022). *Učitelji in drugi strokovni delavci osnovnih in srednjih šol. Prikaz podatkov iz raziskav Napovednik zaposlovanja, Poklicni barometer in evidenc ZRSZ* [Teachers and other professional workers in primary and secondary schools. Review of data from the Employment Forecast among Employers, the Occupational Barometer and the records of the Employment Service of Slovenia]. Employment Service of Slovenia.

Fray, L. & Gore, J. (2018). Why people choose teaching: A scoping review of empirical studies, 2007–2016. *Teaching and Teacher Education: An International Journal of Research and Studies, 75*(1), 153–163. http://dx.doi.org/10.1016/j.tate.2018.06.009

Giersch, J. (2016). A test of personal and social utility values and the appeal of a career in teaching. *Educational Research for Policy and Practice, 15*(3), 163–173. https://doi.org/10.1007/s10671-016-9194-7

Giersch, J. (2021). Motivations to enter teaching: an investigation with non-education university students. *Journal of Education for Teaching*, *47*(3), 426–438. https://doi.org/10.1080/02607476.2021.1880870

Heinz, M. (2015). Why choose teaching? An international review of empirical studies exploring student teachers' career motivations and levels of commitment to teaching. *Educational Research and Evaluation*, *21*(3), 258–297. https://doi.org/10.1080/13803611.2015.1018278

Jugović, I., Marušić, I., Ivanec, T. P., & Vidović, V. V. (2012). Motivation and personality of preservice teachers in Croatia. *Asia-Pacific Journal of Teacher Education, 40*(3), 271–287. https://doi.org/10.1080/1359866X.2012.700044

Kim, H., & Cho, Y. (2014). Preservice teachers' motivation, sense of teaching efficacy, and expectation of reality shock. *Asia-Pacific Journal of Teacher Education, 42*(1), 67–81. https://doi.org/10.1080/1359866X.2013.855999

Krečič, M. J., & Grmek, M. I. (2005). The reasons students choose teaching professions. *Educational Studies, 31*(3), 265–274. https://doi.org/10.1080/03055690500236449

Kyriacou, C., & Kobori, M. (1998). Motivation to learn and teach English in Slovenia. *Educational Studies*, *24*(3), 345–351. https://doi.org/10.1080/0305569980240307

Malmberg, L.-E. (2006). Goal-orientation and teacher motivation among teacher applicants and student teachers. *Teaching and Teacher Education, 22*(1), 58–76. https://doi.org/10.1016/j.tate.2005.07.005

Nesje, K., Brandmo, C., & Berger, J. L. (2018). Motivation to become a teacher: A Norwegian validation of the Factors Influencing Teaching Choice Scale. *Scandinavian Journal of Educational Research*, *62*(6), 813–831. https://doi.org/10.1080/00313831.2017.1306804

OECD. (2019). *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*. TALIS, OECD Publishing. https://doi.org/10.1787/1d0bc92a-en

OECD. (2022). *Education at a glance 2022: OECD indicators*. OECD Publishing. https://doi.org/10.1787/3197152b-en

OECD. (2023). *Teachers by age (indicator).* OECD iLibrary. https://doi.org/10.1787/93af1f9d-en

Richardson, P. W., & Watt, H. M. G. (2006). Who chooses teaching and why? Profiling characteristics and motivations across three Australian universities. *Asia-Pacific Journal of Teacher Education*, *34*(1), 27–56. https://doi.org/10.1080/13598660500480290

Shang, W., Yu, T., Wang, J., Sun, D., & Su, J. (2022). Why choose to become a teacher in China? A large-sample study using the Factors Influencing Teaching Choice Scale. *Asia-Pacific Journal of Teacher Education*, *50*(4), 406–423. https://doi.org/10.1080/1359866X.2022.2066504

Simić, N., Marušić Jablanović, M., & Grbić, S. (2022). Why teaching? A validation of the fit-choice scale in the Serbian context. *Journal of Education for Teaching*, *48*(1), 35–56. https://doi.org/10.1080/02607476.2021.1958655

Sinclair, C. (2008). Initial and changing student teacher motivation and commitment to teaching. *Asia-Pacific Journal of Teacher Education*, *36*(2), 79–104. https://doi.org/10.1080/13598660801971658

Struyven, K., Jacobs, K. & Dochy, F. (2013). Why do they want to teach? The multiple reasons of different groups of students for undertaking teacher education. *European Journal of Psychology of Education, 28*(3), 1007–1022. https://doi.org/10.1007/s10212-012-0151-4

Tang, S., Y. F., Wong, A., K. Y, & Cheng, M. M. H. (2015). The preparation of highly motivated and professionally competent teachers in initial teacher education. *Journal of Education for Teaching*, *41*(2), 128–144. https://doi.org/10.1080/02607476.2015.1010875

Tašner, V., Žveglič, M., & Mencin Čeplak. M. (2017). Gender in the teaching profession: university students' views of teaching as a career. *Center for Educational Policy Studies Journal*, *7*(2), 47–69. https://doi.org/10.26529/cepsj.169

Taštanoska, T., Kuščer, K, & Ambrožič Deleja, S. (2022). *The education system in the Republic of Slovenia 2021/2022.* Ministry of Education, Science and Sport of the Republic of Slovenia. https://www.eurydice.si/publikacije/The-Education-System-in-the-Republic-of-Slovenia-2021-22.pdf

Tiplic, D., Brandmo, C., & Elstad, E. (2015). Antecedents of Norwegian beginning teachers' turnover intentions. *Cambridge Journal of Education*, *45*(4), 451–474. https://doi.org/10.1080/0305764X.2014.987642

Torres-Cladera, G., Simó-Gil, N., Domingo-Peñafiel, L. (2021). Building professional identity during preservice teacher education. *Center for Educational Policy Studies Journal*, *11*(3), 35–54. https://doi.org/10.26529/cepsj.1070

Valenčič Zuljan, M., Cotič, M., Fošnarič, S., Peklaj, C., & Vogrinc, J. (2011). Teacher education in Slovenia. In M. Valenčič Zuljan & J. Vogrinc (Eds.), *European dimensions of teacher education –*

similarities and differences (pp. 295–322). Faculty of Education, University of Ljubljana and The National School of Leadership in Education. https://solazaravnatelje.si/ISBN/978-961-253-058-7.pdf

Younger, M., Brindley, S., Pedder, D., & Hagger, H. (2004). Starting points: Student teachers' reasons for becoming teachers and their preconceptions of what this will mean. *European Journal of Teacher Education*, *27*(3), 245–264. https://doi.org/10.1080/0261976042000290787

Watt, H. M. G., & Richardson, P. W. (2007). Motivational factors influencing teaching as a career choice: Development and validation of the FIT-Choice Scale. *Journal of Experimental Education, 75*(3), 167–202. https://doi.org/10.3200/JEXE.75.3.167-202

Watt, H. M. G., & Richardson, P. W. (2012). An introduction to teaching motivations in different countries: Comparisons using the FIT-Choice Scale. *Asia-Pacific Journal of Teacher Education*, *40*(3), 185–197. https://doi.org/10.1080/1359866X.2012.700049

Watt, H. M. G., Richardson, P. W., Klusmann, U., Kunter, M., Beyer, B., Trautwein, U., & Baumert, J. (2012). Motivations for choosing teaching as a career: An international comparison using the FIT-Choice scale. *Teaching and Teacher Education, 28*(6), 791–805. https://doi.org/10.1016/j.tate.2012.03.003

Watt, H. M., Richardson, P. W., & Devos, C. (2013). How does gender matter in the choice of a STEM teaching career and later teaching behaviours? *International Journal of Gender*, *Science and Technology*, *5*(3), 187–206.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12*(3), 265–310. https://doi.org/10.1016/0273-2297(92)90011-P

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

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The Frequency of Music Improvisation Activities in the Fourth and Fifth Grade of Primary School

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The aim of the present study was to investigate and compare the frequency of the implementation of music improvisation activities in music lessons by classroom teachers and subject teachers teaching music in the fourth and fifth grade in Slovenian primary schools. We also explored the teachers' sense of competence to implement music improvisation activities, reasons for the infrequent inclusion of such activities and solutions for more frequent inclusion. A descriptive nonexperimental method of research was used, collecting data with a questionnaire. The study found that teachers occasionally carry out music improvisation activities, most often rhythmic improvisation. The results showed no differences between the frequency of improvisation activities between classroom teachers and subject teachers. However, subject teachers do feel more competent to perform music improvisation activities than classroom teachers and there was a weak correlation between the sense of competence and the frequency of improvisation activities in music lessons. Teachers cite a lack of time, knowledge and self-confidence as the key reasons for the infrequent implementation of music improvisation activities. They see solutions for the more frequent inclusion of music improvisation activities in additional music improvisation training and changes in the music curricula, advocating for more flexible and broadly defined learning objectives. Due to the small sample size, the results are not generalisable, but they do provide an insight into the current state of the integration of music improvisation activities in music lessons in the fourth and fifth grade of primary school.

Keywords: classroom teachers, general music, music improvisation, primary school, subject teachers

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Pogostost dejavnosti glasbene improvizacije v četrtem in petem razredu osnovne šole

Alja Krevel in Jerneja Žnidaršič

Namen te raziskave je bil preučiti in primerjati pogostost izvajanja dejavnosti glasbene improvizacije pri pouku glasbene umetnosti med učitelji razrednega pouka in učitelji predmetnega pouka, ki poučujejo predmet glasbene umetnosti v četrtem in petem razredu slovenskih osnovnih šol. Raziskali smo tudi občutek kompetentnosti učiteljev za izvajanje dejavnosti glasbene improvizacije, razloge za redko vključevanje teh dejavnosti in rešitve za pogostejše vključevanje. Uporabljena je bila deskriptivna neeksperimentalna metoda raziskovanja, pri čemer smo podatke zbrali z vprašalnikom. Raziskava je pokazala, da učitelji občasno izvajajo dejavnosti glasbene improvizacije, najpogosteje ritmično improvizacijo. Rezultati niso pokazali razlik v pogostosti improvizacijskih dejavnosti med učitelji razrednega in predmetnega pouka. Kljub temu se učitelji predmetnega pouka čutijo kompetentnejše za izvajanje dejavnosti glasbene improvizacije kot učitelji razrednega pouka, med občutkom kompetentnosti in pogostostjo izvajanja improvizacijskih dejavnosti pri pouku glasbene umetnosti pa se je pokazala šibka korelacija. Učitelji kot ključne razloge za redko izvajanje dejavnosti glasbene improvizacije navajajo pomanjkanje časa, znanja in samozavesti. Rešitve za pogostejše vključevanje dejavnosti glasbene improvizacije vidijo v dodatnem usposabljanju v glasbeni improvizaciji in spremembah učnega načrta za glasbeno umetnost v osnovni šoli, pri čemer se zavzemajo za prožnejše in širše opredeljene učne cilje. Zaradi majhnosti vzorca rezultati niso posplošljivi, vendar nudijo vpogled v aktualno stanje vključevanja dejavnosti glasbene improvizacije pri pouku glasbene umetnosti v četrtem in petem razredu osnovne šole.

Ključne besede: glasbena improvizacija, osnovna šola, pouk glasbe, učitelji razrednega pouka, učitelji predmetnega pouka

Introduction

High-quality music education contributes significantly to the holistic development of the individual (Brdnik Juhart & Sicherl Kafol, 2021; Pesek, 1997; Sicherl Kafol, 2001) and is fulfilled through musical performance, musical listening and musical creative activities, which are constantly intertwined (Borota, 2013; Ministrstvo za šolstvo in šport in Zavod Republike Slovenije za šolstvo, 2011; Sicherl Kafol, 2001). In addition to musical recreation, creativity in music is roughly comprised of the two activity subfields of composition and improvisation (Nettl, 1974), which differ in the degree of planning and in the creative process itself. Hargreaves (1999) describes improvisation as the generation of new musical ideas without rearrangement, whereas composition may involve the reworking of musical material. In its strictest sense, music improvisation is defined as the spontaneous process of making music in real time (Alperson, 1984; The Cambridge Academic Content Dictionary) and is one of the most complex forms of creative activity (Beegle, 2010). Improvisation goes beyond the shaping of the individual's musical world and prepares them to live in a modern, complex world where 'improvisational' action and constant adaptation to change at every turn is almost an imperative (Montouri, 2003).

In the field of music pedagogy, improvisation is a sensitive topic. Despite the growing efforts to establish its presence in children's music education (Chandler, 2018; Larsson & Georgii-Hemming, 2019) and a better understanding of its beneficial effects on the individual's cognitive (Azzara, 2002; Navarro Ramón & Chacón-López, 2021) and social development and interactions (Berkowitz, 2010; Burnard & Boyack, 2013; Diaz Abrahan et al., 2022; Sawyer, 2006), the question of whether improvisation can be learned at all remains a matter of debate at all educational levels (Van der Schyff, 2019). While some embrace the view that, especially in children, improvisation can only be encouraged and nurtured (Hickey, 2009; Lanier, 2022; Wright & Kanellopoulos, 2010), others propose detailed procedures for teaching improvisational skills (Azzara, 1999; Torres, 2018; Whitcomb, 2013). These refer to different types of improvisation, most notably vocal and instrumental (Koutsoupidou, 2005; Whitcomb, 2005), melodic and rhythmic (Gruenhagen & Whitcomb, 2014), and individual and group improvisation (Beegle, 2010; Koutsoupidou, 2005; Sawyer, 1999). Research shows that teachers most often perform rhythmic and melodic improvisation, mainly in a call-and-response format, immediately followed by the use of untuned and tuned instruments (Whitcomb, 2007), with vocal improvisation being less common than instrumental improvisation (Koutsoupidou, 2005). Some advocate so-called free improvisation, in which there are no well-defined frameworks for music making and the concept of freedom holds a central position (Hickey, 2009; Higgins & Mantie, 2013; Monk, 2013; Ng, 2018) along with musical communication between individuals (Hickey, 2009; Monk, 2013). At the opposite pole on the spectrum of limitations in improvisation activities is structured improvisation. Here, the focus is on teacher guidance and music-theoretical rules (Rebne & Saetre, 2020) that promote the development of musical skills and the acquisition of musical knowledge (Brophy, 2005; Coulson & Burke, 2013; Guilbault, 2009; Whitcomb, 2013). Some authors (Beegle, 2010; Edmund & Keller, 2019) argue that it is important to keep a balance between the two when implementing music improvisation activities.

Notwithstanding the different perspectives on encouraging and/or teaching improvisation, in recent years there has been a greater understanding and appreciation of improvisation activities that focus on the process and the experience that students gain from it. Hickey (2009) argues that music improvisation is not merely a product that can be learned in a strict methodological and pedagogical sense; its quality is to foster a process that emerges in freedom and allows for self-actualisation, which is also evident in the creative process of other areas (Juriševič, 2011). Campbell (2009) argues that the music improvisation activity, more than any other musical experience, provides the learner with a holistic musical education in which music theory, aural perception and performance are richly intertwined. Improvisation is worth implementing in primary school music lessons because it provides experiences of risk and fosters spontaneity, exploration and collaboration (Higgins & Mantie, 2013).

Research shows mixed results regarding the inclusion frequency of improvisation activities in music lessons (Chandler, 2018). While music improvisation is one of the least popular musical activities (Byo, 1999) and is given very little time (Gruenhagen & Whitcomb, 2014), a study by Whitcomb (2007) found that 81% of the participating New York City teachers include improvisation in the teaching process, while improvisation is also a regular feature in the first three years of primary school according to the results of a study conducted by Orman (2002) in the eastern region of the United States. In a study on the integration of improvisation activities in music lessons in English primary schools, Koutsoupidou (2005) found that 76% of the 67 teachers who participated in the study practised improvisation on their own initiative. The main reasons teachers give for not using improvisation are a lack of experience with improvisation and a lack of knowledge of the theoretical aspects of improvisation, but the insufficient level of music improvisation activities is also due to reduced classroom discipline, as perceived by teachers, and a lack of time. The author also found that more experienced and older teachers are more likely to include improvisation activities than inexperienced and younger teachers. Only 19% of the teachers surveyed had experienced improvisation in their own primary education, which is an illuminating statistic. It is also interesting to note that no correlation was found between teachers' competences and the type of improvisation activities they used (instrumental, vocal, movement). Furthermore, Whitcomb (2007) indicates a strong correlation between the implementation of improvisation activities and teachers' previous experience gained in workshops, conferences and studies. In a later paper (Whitcomb, 2013), the author highlights the insufficient knowledge and skills of teachers in implementing music improvisation and suggests combining improvisation activities with other musical activities to maximise the economical use of time.

Despite the general positive attitudes of classroom teachers towards music teaching, Šober (2021) found that the musical background and additional musical experience of teachers significantly influenced their choice of music activities in their music lessons. Even though student teachers acquire all of the necessary knowledge and skills for high-quality music teaching during their studies, it is evident in practice that teachers who do not have a strong musical background from the outset must seek continuous professional development (Šober, 2021). Teachers frequently avoid composing or improvising in their own music instruction when they feel uncomfortable in executing these activities (Odena, 2001). Teachers' beliefs about their own creativity have a significant impact on the degree to which creativity is encouraged in the classroom and the value they place on creativity (Rubenstein et al., 2013; Sak, 2004). Moreover, research shows that classroom teachers often feel self-conscious when teaching music (Holden & Button, 2006; King, 2018; Poulter & Cook, 2019; Seddon & Biasutti, 2008; Stunell 2010; Vitale, 2020).

Research (Bell, 2003; Brophy, 2002; Madura Ward-Steinman, 2007; Mullet et al., 2016) further suggests that most music teachers experience feelings of self-consciousness and a lack of confidence in their ability to perform improvisation activities. In addition to a lack of improvisational experience in music teaching (Bernhard & Stringham, 2016; Gruenhagen & Whitcomb, 2014), issues such as a lack of time (Russell-Bowie, 2009; Wiggins & Wiggins, 2008) and the sense of chaos that comes with performing improvisation activities (Campbell, 2009) are also significant. In their research, Hickey and Schmidt (2019) studied the effect of professional development on the level of integration of improvisation and compositional activities in music teaching. They point to a lack of confidence and a lack of practical experience with improvisation as two key reasons teachers give for not sufficiently incorporating creative activities, and see the solution in better professional development of teachers, which is reflected in teachers' better understanding of creative music activities and a higher level of implementation of such activities. In a more recent study, Nikolaou (2023) conducted 13 music improvisation workshops with primary education university students. After the workshops, about half of the students (46%) expressed that they felt confident as future classroom teachers to implement music improvisation activities in their music lessons (Nikolaou, 2023).

In her research on musical creativity in Slovenian primary schools, Črčinovič Rozman (2009) found that music lessons at the classroom level focus on creative activities alongside music (e.g., fine art creativity and movement to music) rather than music-making activities, i.e., composition or improvisation. Moreover, teachers are not fully familiar with strategies for implementing music composition and improvisation. Nevertheless, both teachers and students expressed satisfaction with the level of music-making activities in the classroom. To encourage music improvisation in the classroom, the author suggests that the topic be better addressed in university curricula and that short seminars for teachers be held on the subject. Markelj (2014) studied the integration of music-making activities in music lessons at the classroom level. The results showed that teachers with higher levels of music education are more likely to include certain types of music-making activities. The author also found that teachers from the first to the third grade of primary school include rhythmic improvisation and creative music-didactic games more often than teachers from the fourth and fifth grade. However, the study's small sample size and uneven distribution of teachers based on their musical education suggest that these findings should be interpreted with caution (Markelj, 2014).

The balance between the musical activity domains of performing, listening and creating is central to the holistic musical development of a young person. It is therefore important to integrate music-making activities into the music curriculum. Improvisation is worth encouraging in primary school music lessons, as it nurtures and encourages risk-taking, spontaneity, exploration, collaboration and play (Higgins & Mantie, 2013). As there is a lack of research in Slovenia on the frequency of music improvisation activities in music education – with the exception of one master's thesis (Markelj, 2014) and the contribution of Črčinovič Rozman (2009), which covers the whole field of music creativity at the primary school classroom level – the present research aimed to gain an insight into the frequency of music improvisation activities in the fourth and fifth grade of primary school. The Slovenian Primary School Act (*Zakon o osnovni šoli*, 1996, Art. 38) states that, in the first period of primary school (grades 1–3), the compulsory curriculum, including the subject of music, is taught by the classroom teacher. In the third period of primary school (grades 7–9), all subjects are taught by subject teachers.[3] In exceptional cases, a classroom teacher may also teach in grade 6. Music lessons in the second period (grades 4–6) may be taught by both a classroom teacher and a subject teacher. Accordingly, we also wanted to examine differences in the frequency of music improvisation activities between classroom and subject teachers. Some research suggests that classroom teachers tend to feel uncomfortable teaching music (Holden & Button, 2006; Poulter & Cook, 2019), and we were interested to see whether this is also reflected in the frequency and structure of music improvisation activities in music lessons.

The main objectives of the research are to determine (1) the frequency of different types of music improvisation activities in music lessons in the fourth and fifth grade, (2) teachers' sense of competence to implement music improvisation activities, and (3) reasons for the infrequent implementation of music improvisation activities and possible solutions for their more frequent implementation.

Research Questions

The following research questions were posed in the study:

RQ 1.1: How often do teachers implement music improvisation activities in music lessons in the fourth and fifth grade of primary school?

RQ 1.2: Are there differences in the frequency of music improvisation activities in music lessons in the fourth and fifth grade between classroom and subject teachers?

RQ 1.3: Which types of music improvisation activities do teachers most frequently implement in music lessons in the fourth and fifth grade?

RQ 2.1: What proportion of teachers feel fully competent to execute music improvisation activities?

RQ 2.2: Are there differences in the sense of competence to execute music improvisation activities between classroom and subject teachers?

RQ 2.3: Is there a correlation between the frequency of music improvisation activities in music lessons and teachers' sense of competence to execute music improvisation activities?

RQ 3.1: What reasons do teachers give for the infrequent implementation of music improvisation activities in music lessons in the fourth and fifth grade?

3 Techers carry out educational work in the school (*Zakon o osnovni šoli*, 1996). Classroom teachers have completed a bachelor's degree programme in Primary Education, while subject teachers have completed a bachelor's degree programme in a specific subject. In our case, subject music teachers have completed a bachelor's degree programme in Music Education (*Pravilnik o izobrazbi učiteljev in drugih strokovnih delavcev v izobraževalnem programu osnovne šole*, 2011).

RQ 3.2: What solutions do teachers suggest for the more frequent inclusion of music improvisation activities in music lessons in the fourth and fifth grade?

Method

This study utilises a descriptive non-experimental method of educational research.

Sample

The study was based on a random sample of classroom teachers ($n = 46$) and subject teachers ($n = 20$) who teach music lessons in the fourth and/or fifth grade of primary school. There were nine subject teachers who teach in both the fourth and fifth grade. Primary school teachers from different regions of Slovenia were randomly invited to participate in the survey.

Instruments

For the purpose of the survey, an online questionnaire (1KA) was designed with a combination of closed and open-ended questions and a six-point Likert-type rating scale. The questionnaire includes general demographic questions (gender, age group, teaching specialisation, years of work experience, statistical region in which the teachers teach), two Likert-type rating scales where the teachers indicated their perception of the frequency with which music improvisation activities (and specific types of activities) are included in their music lessons, two closed-ended multiple-choice questions on the teachers' own assessment of their sense of competence to execute music improvisation activities and reasons for rarely carrying out music improvisation activities, and an open-ended question on suggested solutions for the more frequent inclusion of music improvisation activities.

Research Design

The data for the study were collected through an online survey questionnaire from January to April 2022. A total of 126 teachers commenced filling in the questionnaire, but only 82 of them fully or partially completed it. All of the partially completed questionnaires were excluded from further analysis. Thus, 66 fully completed questionnaires were obtained for the final analysis.

The data obtained from the closed-ended questions and Likert scales were quantitatively analysed using IBM SPSS version 27.0 for statistical data processing using descriptive, correlational and inferential statistics. Frequency distributions of variables (*f*, *f* %) and basic descriptive statistics (mean, standard deviation) were used. Due to the small sample size and the uneven distribution of the data, the non-parametric Mann-Whitney U test was used to compare independent samples and the Friedman test was used to compare dependent samples (with post-hoc Wilcoxon signed ranks test). The Spearman correlation coefficient was also calculated. Responses to the open-ended question were qualitatively analysed by coding.

Results and discussion

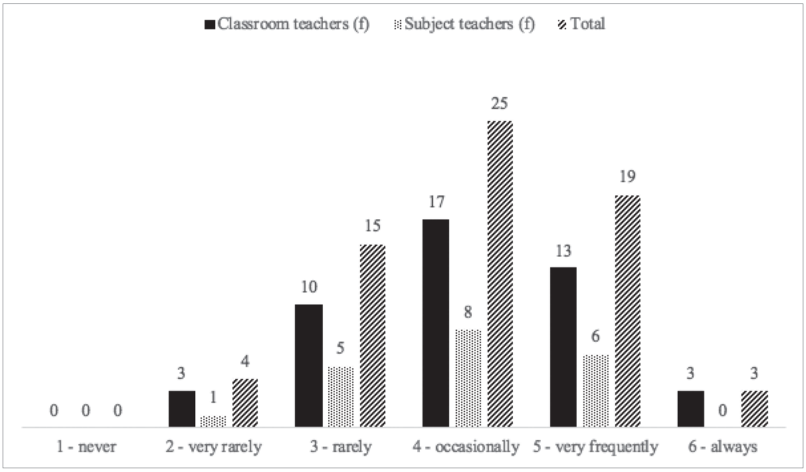
The results of the survey will be presented according to the sequence of the research questions.

RQ 1.1: How often do teachers implement music improvisation activities in music lessons in the fourth and fifth grade of primary school?

The classroom and subject teachers indicated the frequency of music improvisation activities (1 – never, 2 – very rarely or once per marking period, 3 – rarely or 2–3 times per marking period, 4 – occasionally or once per month, 5 – very frequently or 2–3 times per month, 6 – always or every lesson). The marking period in Slovenian primary school lasts five months and there are two marking periods in one school year. On average, both the classroom and the subject teachers implement music improvisation activities in music lessons occasionally (once per month) (f % = 37.9%; Me = 4; SD = 0.98) (Figure 1). Based on previous research indicating the unpopularity of music improvisation activities among teachers (Byo, 1999; Gruenhagen & Whitcomb, 2014), but nevertheless revealing a sufficient level of engagement with such activities (Orman, 2002; Whitcomb, 2007), we inferred that teachers do occasionally perform music improvisation activities. None of the respondents indicated that they do not include music improvisation activities in their teaching process, which is an encouraging finding.

Figure 1

Frequency of music improvisation activities in music lessons



RQ 1.2: Are there differences in the frequency of music improvisation activities in music lessons in the fourth and fifth grade between classroom and subject teachers?

No studies were found in the literature examining differences in the frequency of music improvisation activities between classroom teachers and subject teachers, although some research suggests that classroom teachers feel uncomfortable teaching music (King, 2018; Seddon & Biasutti, 2008; Stunell 2010; Vitale, 2020). Related to this, we were interested in whether classroom teachers are therefore also less likely to engage in music improvisation activities than subject teachers. However, no statistical differences were found between classroom and subject teachers in the frequency of implementing improvisation activities in music lessons ($U = 432.5$; $p = .688$; $p > .05$). It is assumed that the results are a reflection of the small sample size, but they may indicate a broader problem of the absence of music improvisation activities in music lessons, independent of the teaching specialisation or educational background.

RQ 1.3: Which types of music improvisation activities do teachers most frequently implement in music lessons in the fourth and fifth grade?

The literature review revealed different results on the popularity of different types of improvisation. While Whitcomb (2007) cites the most frequent use of rhythmic and melodic call-and-response activities, Koutsoupidou (2005) points out that teachers most frequently perform improvisation activities on instruments, while vocal improvisation is the least frequent. It was therefore assumed that rhythmic and instrumental improvisation are the more frequently performed types of improvisation compared to melodic and vocal improvisation. The teachers surveyed (N = 66) rated the frequency of each type of music improvisation activity on a six-point rating scale (1 – never, 2 – very rarely or once per marking period, 3 – rarely or 2–3 times per marking period, 4 – occasionally or once per month, 5 – very frequently or 2–3 times per month, 6 – always or every lesson). The findings presented in Table 1 indicate that, on average, both the classroom and the subject teachers occasionally implement various types of music improvisation activities: instrumental (Me = 4.00; SD = 0.93), vocal (Me = 4.00; SD = 1.10), rhythmic (Me = 4.00; SD = 1.07) and melodic (Me = 4.00; SD = 1.08). Based on the arithmetic mean, it is evident that rhythmic improvisation is nevertheless the most frequent type of music improvisation activity (M = 4.21; SD = 1.07) compared to the others. This result is consistent with previous scientific findings, but suggests that only rhythmic improvisation is more popular.

Table 1

Descriptive statistics on the frequency of performing types of music improvisation activities

	instrumental improvisation	vocal improvisation	rhythmic improvisation	melodic improvisation
M	3.70	3.76	**4.21**	3.71
Me	4.00	4.00	4.00	4.00
Mo	4	4	4	4
SD	0.93	1.10	1.07	1.08

Given the results, we were interested to see whether there were statistically significant differences in the frequency with which each type of music improvisation was included. Due to the small sample size and the non-normal distribution of the data, we used the non-parametric Friedman test, which showed statistically significant differences in the frequency of inclusion of each type of music improvisation ($\chi^2(3) = 18.308$, $p < .001$). The Friedman test mean ranks are presented in Table 2. Further analysis by performing the Wilcoxon Signed Ranks test showed that the teachers include rhythmic improvisation statistically significantly more often than melodic, instrumental and vocal improvisation (see Table 3).

Table 2

Friedman test mean ranks

Types of music improvisation activity	Mean rank
Instrumental improvisation	2.26
Vocal improvisation	2.46
Rhythmic improvisation	**2.96**
Melodic improvisation	2.32

Table 3

Wilcoxon Signed Rank test – pairwise comparisons of types of music improvisation activities

Type of music improvisation – pairs	Z	*p*
Vocal/instrumental	-.729	.466
Melodic/rhythmic	-3.729	**<.001**
Rhythmic/instrumental	-3.892	**<.001**
Melodic/vocal	-2.190	.827
Melodic/instrumental	-.119	.905
Rhythmic/vocal	-3.163	**.002**

RQ 2.1: What proportion of teachers feel fully competent to execute music improvisation activities?

Based on previous studies highlighting the importance of improvisation experiences in education and professional development (Koutsoupidou, 2005; Schmidt, 2019; Whitcomb, 2007), it was foreseen that at least half of the teachers would feel fully competent to execute music improvisation activities. The results of the present study showed that 51.5% (f = 34) of the surveyed teachers (N = 66) feel fully competent and 25.8% (f = 17) feel sufficiently competent to execute music improvisation activities when following someone else's precise instructions, while 15 of the teachers (f % = 22.7) do not feel sufficiently competent to execute music improvisation activities.

RQ 2.2: Are there differences in the sense of competence to execute music improvisation activities between classroom and subject teachers?

No studies were found in the literature comparing the sense of competence to perform music improvisation activities between classroom teachers and subject teachers. Given the scientific findings showing that classroom teachers feel uncomfortable teaching music, mainly due to insufficient musical experiences during their education (King, 2018; Stunell, 2010; Vitale, 2020), it was hypothesised that classroom teachers feel less competent to perform music improvisation activities than subject teachers. When the difference in sense of competence between classroom and subject teachers was examined, it was found that more than a third of the classroom teachers surveyed (f % = 41.3%) and three-quarters of the subject teachers (f % = 75.0%) feel fully competent to carry out music improvisation activities (see Table 4). After conducting a Mann-Whitney U test, it was found that there are statistically significant differences between the classroom and subject teachers in their sense of competence to execute music improvisation activities ($U = 315.5$; $p = .027$; $p < .05$). The results indicate that subject teachers feel fully competent to carry out music improvisation activities to a greater extent than classroom teachers.

Table 4

Percentage of the teachers' sense of competence to execute music improvisation activities – comparison between classroom and subject teachers

Teaching specialisation	Do you feel competent enough to execute music improvisation activities?	*f*	*f* %
Classroom teacher	Yes, completely.	**19**	**41.3**
	Yes, if I am following someone else's precise instructions.	15	32.6
	No.	12	26.1
	Total	46	100.0
Subject teacher	Yes, completely.	**15**	**75.0**
	Yes, if I am following someone else's precise instructions.	2	10.0
	No.	3	15.0
	Total	20	100.0

RQ 2.3: Is there a correlation between the frequency of music improvisation activities in music lessons and teachers' sense of competence to execute music improvisation activities?

Spearman's rank correlation coefficient was calculated to determine the relationship between the frequency of music improvisation activities and the teachers' sense of competence to execute such activities in the classroom. The value of the coefficient ($\rho = 0.33$) indicates a statistically significant weak correlation between the two variables ($p = .003$). The results show that teachers who feel competent to execute music improvisation activities are also more likely to implement such activities in their music lessons. The literature suggests that a sense of competence contributes significantly to the frequency of music improvisation activities in music lessons (Odena, 2001; Rubenstein et al., 2013; Sak, 2004).

RQ 3.1: What reasons do teachers give for the infrequent implementation of music improvisation activities in music lessons in the fourth and fifth grade?

The teachers who indicated in the questionnaire that they rarely or never execute music improvisation activities (n = 19) gave reasons for this. Of these teachers, 57.9% indicated that the reason for not including music improvisation activities often is a lack of time, followed by a lack of knowledge to undertake such activities (f % = 52.6%) and a lack of self-confidence (f % = 42.1%). None of the respondents indicated a lack of motivation to do so, or that they consider such activities irrelevant for the musical development of their students. Just under a quarter of the teachers (f % = 21.1%) indicated that the reason for executing an insufficient quantity of music improvisation activities was a lack of student interest, while one respondent also mentioned behavioural problems and student restlessness. The literature also suggests that a lack of improvisation experience (Bernhard & Stringham, 2016; Gruenhagen & Whitcomb, 2014) and a lack of time are key factors for the lack of implementation of music improvisation activities in music lessons (Russell-Bowie, 2009; Wiggins & Wiggins, 2008).

RQ 3.2: What solutions do teachers suggest for the more frequent inclusion of music improvisation activities in music lessons in the fourth and fifth grade?

Both the classroom and the subject teachers surveyed identify solutions for the more frequent inclusion of music improvisation activities in additional teacher training in this area, with a focus on an increased offer of quality seminars and Slovenian literature, as well as changes in lesson planning. They believe that the curriculum for the subject of music should be looser, with more broadly formulated learning objectives that allow greater scope for the introduction of improvisational content. They also cite cross-curricular connections as a way of encouraging such activities. Some propose increasing the number of weekly music lessons. Difficulties with problematic student behaviour are also mentioned, and teachers cite the establishment of better discipline, the development of student etiquette and more independent work by students as solutions. One of the solutions highlighted is to have an adequately sized classroom and a sufficient number and range of instruments, as this makes it easier to carry out improvisation activities. Some of the teachers state that this is simply the teacher's decision, thus highlighting the teacher's own initiative. Based on the results obtained, we can summarise that much of the responsibility for the frequency of the implementation of improvisation activities rests with the teachers themselves and their own desire. An adequate classroom size and a sufficiently large range of instruments is undoubtedly a facilitating factor, as is a certain amount of flexibility in the planning of music lessons, but it is up to the teachers themselves to understand and perceive the value of implementing music improvisation activities for the benefit of the students. Particularly in the Slovenian context, insufficient training is available on implementing music improvisation activities; therefore, more professional training and literature on the topic might be considered.

Conclusion

The aim of this study was to investigate the frequency of music improvisation activities in the fourth and fifth grade of primary school by comparing classroom teachers and subject teachers. It was found that both groups of teachers implement music improvisation activities occasionally in their music lessons. It would be interesting to study the frequency of music improvisation activities using a more qualitative research approach, as this would provide an insight into the structure of improvisation activities and the definition of such activities from the teachers' perspective, which would provide a holistic picture of the implementation of music improvisation in music lessons. No differences were found between classroom teachers and subject teachers in the frequency of improvisation activities. It is assumed that different results would have been obtained if the sample had been larger and more balanced according to the teachers' teaching specialisation. It would be beneficial to conduct research on the implementation of music improvisation by music teachers at every grade level in primary school, comparing the practices of classroom teachers and subject teachers. This would provide a broader perspective on the implementation of improvisation in primary school. It would also be worth examining differences in the frequency of music improvisation activities according to the three primary school periods (grades 1–3, 4–6 and 7–9, respectively). According to the teachers surveyed in the present research, the most popular type of improvisation is rhythmic improvisation. To elaborate these results, an in-depth survey should be carried out asking teachers about the specific improvisation activities (e.g., call-and-response, continuation of a musical motif, etc.) that they execute in the music classroom. Only about half of the teachers surveyed feel fully competent to carry out music improvisation activities, which points to possible improvements in the content of university education and in the provision of professional development. It was found that subject teachers feel more competent to carry out music improvisation activities than classroom teachers, which can be linked to the different structure of university education of the two groups: many classroom teaching students have not acquired any musical experience by the time they start their studies, whereas an entrance test for musical aptitude is compulsory for entry to the music education programme and requires a basic mastery of singing and playing an instrument as well as fundamental music-theoretical concepts. The sense of competence in performing improvisation activities is thus likely to reflect the overall structure of teachers' musical skills and knowledge, which may vary considerably between classroom and subject teachers. The results of the study also show that a greater sense of competence is associated with a higher level of implementation of improvisation activities in music lessons. Interestingly, although a higher percentage of subject teachers felt competent to execute music improvisation activities, they did not implement these activities to a greater extent in their music lessons than classroom teachers. We believe that a larger sample would have yielded different results. In addition to insufficient time, teachers cited a lack of knowledge about improvisation and a lack of confidence as reasons for the infrequent inclusion of improvisation activities. An increased emphasis on music improvisation activities during studies and, in particular, a greater offer of professional training and literature in Slovenian on the subject could significantly change the perception of music improvisation and consequently encourage teachers to implement improvisation more frequently in their music lessons. Teachers themselves also cite the need for additional training, along with changes in planning music lessons.

The study was limited to a small sample size, so the findings cannot be generalised to the entire Slovenian population of classroom and subject teachers who teach music in the fourth and fifth grade. Moreover, when interpreting the results, it should be borne in mind that the answers are an expression of teachers' subjective assessment and opinion, which is not necessarily a representation of the real situation. Given the number of teachers who failed to adequately complete the questionnaire, it is evident that only those who were enthusiastic and willing to participate did so.

The present research provides a current insight into the frequency of the implementation of music improvisation activities in music lessons in the fourth and fifth grade of primary school, but the results are not generalisable due to the small sample size. As more than ten years have passed since the last major research on the state of musical creativity in music lessons at the classroom level of primary education in Slovenia (Črčinovič Rozman, 2009), there is a need for up-to-date research that includes both quantitative and qualitative research approaches and addresses the implementation of music improvisation across the whole primary education vertical.

Disclosure statement

The authors have no conflict of interest to declare.

References

Alperson, P. (1984). On musical improvisation. *The Journal of Aesthetics and Art Criticism, 43*(1), 17–29. https://doi.org/10.2307/430189

Azzara, C. D. (1999). An aural approach to improvisation. *Music Educators Journal, 86*(3), 21–25. https://www.doi.org/10.2307/3399555

Azzara, C. D. (2002). Improvisation. In R. Colwell, & C. Richardson (Eds.), *The new handbook of research on music teaching and learning* (pp. 171–187). Oxford University Press.

Beegle, A. (2010). A classroom-based study of small-group planned improvisation with fifth-grade children. *Journal of Research in Music Education, 58*(3), 219–239. https://www.doi.org/10.1177/0022429410379916

Bell, C. L. (2003). Beginning the dialogue: Teachers respond to the National Standards in Music. *Bulletin of the Council for Research in Music Education, 156*, 31–42.

Berkowitz, A. L. (2010). *The improvising mind: Cognition and creativity in the musical moment.* Oxford University Press.

Bernhard, H. C., & Stringham, D. A. (2016). A national survey of music education majors' confidence in teaching improvisation. *International Journal of Music Education*, *34*(4), 383–390. https://doi.org/10.1177/0255761415619069

Borota, B. (2013). *Glasbene dejavnosti in vsebine* [Musical activities and content]. Univerzitetna založba Annales.

Brdnik Juhart, P., & Sicherl Kafol, B. (2021). Music teachers' perception of music teaching at the stage of early adolescence. *Center for Educational Policy Studies Journal, 11*(3), 97–118.

Brophy, T. S. (2002). Toward improving music teacher education. *Arts Education Policy Review, 104*(2), 3–8.

Brophy, T. S. (2005). A longitudinal study of selected characteristics of children's melodic improvisations. *Journal of Research in Music Education, 53*(2), 120–133. https://doi.org/10.2307/3345513

Burnard, P., & Boyack, J. (2013). Engaging interactively with children's group improvisation. In P. Burnard, & R. Murphy (Eds.), *Teaching music creatively* (pp. 25–36). Routledge.

Byo, S. J. (1999). Classroom teachers' and music specialists' perceived ability to implement the National Standards for Music Education. *Journal of Research in Music Education, 47*, 111–123. https://www.doi.org/10.2307/3345717

Campbell, P. S. (2009). Learning to improvise music, improvising to learn music. In G. Solis, & B. Nettl (Eds.), *Musical improvisation: Art, education, and society* (pp. 119–142). University of Illinois Press.

Chandler, M. D. (2018). Improvisation in elementary general music: A review of the literature. *Update: Applications of Research in Music Education, 37*(1), 1–7. https://doi.org/10.1177/8755123318763002

Coulson, A. N., & Burke, B. M. (2013). Creativity in the elementary music classroom: A study of students' perceptions. *International Journal of Music Education, 31*(4), 428–441. https://www.doi.org/10.1177/0255761413495760

Črčinovič Rozman, J. (2009). Musical creativity in Slovenian elementary schools. *Educational Research, 51*(1), 61–76. https://doi.org/10.1080/00131880802704749

Diaz Abrahan, V., Justel, N., & Shifres, F. (2022). Musical improvisation: A mixed methods study on social interactions in younger and older adults. *Nordic Journal of Music Therapy, 32*(1), 48–66. https://doi.org/10.1080/08098131.2022.2055115

Edmund, D. C., & Keller, E. C. (2019). Guiding principles for improvisation in the general music classroom. *Journal of General Music Education, 33*(2), 68–73. https://doi.org/10.1177/1048371319885361

Gruenhagen, L. M., & Whitcomb, R. (2014). Improvisational practices in elementary general music classrooms. *Journal of Research in Music Education, 61*(4), 379–395. https://www.doi.org/10.1177/0022429413508586

Guilbault, D. M. (2009). The effects of harmonic accompaniment on the tonal improvisations of students in first through sixth grade. *Journal of Research in Music Education, 57*(2), 81–91. https://www.doi.org/10.1177/0022429409337201

Hargreaves, D. J. (1999). Developing musical creativity in the social world. *Bulletin of the Council for Research in Music Education, 142*, 22–34.

Hickey, M. (2009). Can improvisation be "taught"? A call for free improvisation in our schools. *International Journal of Music Education, 27*(4), 285–299. https://doi.org/10.1177/0255761409345442

Hickey, M., & Schmidt, C. (2019). The effect of professional development on music teachers' improvisation and composition activities. *Bulletin of the Council for Research in Music Education, 222*, 27–43. https://doi.org/10.5406/bulcouresmusedu.222.0027

Higgins, L., & Mantie, R. (2013). Improvisation as ability, culture, and experience. *Music Educators Journal, 100*(2), 38–44. https://doi.org/10.1177/0027432113498097

Holden, H., & Button, S. W. (2006). The teaching of music in the primary school by the non-music specialist. *The British journal of music education, 23*(1), 23–38. https://www.doi.org/10.1017/S0265051705006728

Juriševič, M. (2011). Postgraduate students' perception of creativity in the research process. *Center for Educational Policy Studies Journal, 1*(1), 169–190.

King, F. (2018). Music activities delivered by primary school generalist teachers in Victoria: Informing teaching practice. *Australian Journal of Teacher Education, 43*(4), 175–186.

Koutsoupidou, T. (2005). Improvisation in the English primary music classroom: Teachers' perceptions and practices. *Music Education Research, 7*(3), 363–381. https://doi.org/10.1080/14613800500324432

Lanier, M. A. (2022). Experiences of musical improvisation: Self-individuation and participatory sense-making. *Update: Applications of Research in Music Education, 41*(3), 68–77. https://doi.org/10.1177/87551233221104654

Larsson, C., & Georgii-Hemming, E. (2019). Improvisation in general music education: A literature review. *British Journal of Music Education, 36*(1), 49–67. https://www.doi.org/10.1017/S026505171800013X

Madura Ward-Steinman, P. (2007). Confidence in teaching improvisation according to the K-12 achievement standards. *Bulletin of the Council for Research in Music Education, 172*, 25–40.

Markelj, P. (2014). *Vključevanje glasbene ustvarjalnosti v pouk glasbene umetnosti na razredni stopnji* [Integrating musical creativity into classroom music teaching] [Bachelor thesis, Univerza v Mariboru, Pedagoška fakulteta].

Ministrstvo za šolstvo in šport in Zavod Republike Slovenije za šolstvo [Ministry of Education and Sport and the Institute of Education of the Republic of Slovenia]. (2011). *Učni načrt: program osnovna šola; glasbena vzgoja* [Curriculum: Primary School Programme; Music Education]. Ministry of Education of the Republic of Slovenia and National Education Institute Slovenia.

Monk, A. (2013). Symbolic interactionism in music education: Eight strategies for collaborative improvisation. *Music Educators Journal, 99*(3), 76–81. https://doi.org/10.1177/0027432112467823

Montouri, A. (2003). The complexity of improvisation and the improvisation of complexity. *Human Relations, 56*(2), 237–255. https://doi.org/10.1177/0018726703056002893

Mullet, D., Willerson, A., Lamb, K., & Kettler, T. (2016). Examining teacher perceptions of creativity: A systematic review of the literature. *Thinking Skills and Creativity, 21*, 9–30. https://doi.org/10.1016/j.tsc.2016.05.001

Navarro Ramón, L., & Chacón-López, H. (2021). The impact of musical improvisation on children's creative thinking. *Thinking Skills and Creativity, 40*, Article 100839. https://doi.org/10.1016/j.tsc.2021.100839

Nettl, B. (1974). Thoughts on improvisation: A comparative approach. *The Musical Quarterly, 60*(1), 1–19.

Ng, H. H. (2018). Collective free music improvisation as a sociocommunicative endeavor: A literature review. *Update: Applications of Research in Music Education, 37*(2), 1–9. https://doi.org/10.1177/8755123318784109

Nikolaou, E. (2023). Encouraging creativity through music improvisation activities: Pre-service primary general teacher-students' reflections and beliefs. *International Journal of Music Education, OnlineFirst*. https://doi.org/10.1177/02557614231178925

Odena, O. (2001). Developing a framework for the study of teachers' views of creativity in music education. *Goldsmiths Journal of Education, 4*(1), 59–67.

Orman, E. K. (2002). Comparison of the National Standards for Music Education and elementary music specialists' use of class time. J*ournal of Research in Music Education, 50*(2), 155–164. https://www.doi.org/10.2307/3345819

Pesek, A. (1997). *Otroci v svetu glasbe* [Children in the world of music]. Založba Mladinska knjiga.

Poulter, V., & Cook, T. (2019). Teaching music in the early years in schools in challenging circumstances: Developing student teacher competence and confidence through cycles of enactment. *Educational Action Research, 30*(2), 192–208. https://doi.org/10.1080/09650792.2020.1765185

Pravilnik o izobrazbi učiteljev in drugih strokovnih delavcev v izobraževalnem programu osnovne šole [Rules on the educational qualification of teachers and other education staff in the primary school education programme]. (2011). Uradni list RS, št. 109/11, 10/12, 92/12, 49/13, 75/15 in 85/22. http://pisrs.si/Pis.web/pregledPredpisa?id=PRAV10943

Rebne, R., & Saetre, J. H. (2020). Improvisation in primary school settings. In G. Gravem Johansen, K. Holdhus, C. Larsson, & U. MacGlone (Eds.), *Expanding the space for improvisation pedagogy in music: A transdisciplinary approach* (pp. 133–146). Routledge.

Rubenstein, L. D., McCoach, D. B., & Siegle, D. (2013). Teaching for creativity scales: An instrument to examine teachers' perceptions of factors that allow for the teaching of creativity. *Creativity Research Journal, 25*, 324–334. https://www.doi.org/10.1080/10400419.2013.813807

Russell-Bowie, D. (2009). What me? Teach music to my primary class? Challenges to teaching music in primary schools in five countries. *Music Education Research, 11*(1), 23–36. https://www.doi.org/10.1080/14613800802699549

Sak, U. (2004). About creativity, giftedness, and teaching the creatively gifted in the classroom. *Roeper Review, 26*, 216–222. https://www.doi.org/10.1080/02783190409554272

Sawyer, R. K. (1999). Improvised conversations: Music, collaboration, and development. *Psychology of Music, 27*(2), 192–216. https://doi.org/10.1177/0305735699272009

Sawyer, R. K. (2006). Group creativity: Musical performance and collaboration. *Psychology of Music, 34*(2), 148–165. https://doi.org/10.1177/0305735606061850

Seddon, F., & Biasutti, M. (2008). Non-music specialist trainee primary school teachers' confidence in teaching music in the classroom. *Music Education Research, 10*(3), 403–421. https://www.doi.org/10.1080/14613800802280159

Sicherl Kafol, B. (2001). *Celostna glasbena vzgoja: Srce-um-telo* [Integrated music education: Heart-mind-body]. Debora.

Stunell, G. (2010). Not musical? Identity perceptions of generalist primary school teachers in relation to classroom music teaching in England. *Action, Criticism & Theory for Music Education, 9*(2), 79–107.

Šober, A. (2021). *Priprava učiteljev na pouk glasbene umetnosti* [Preparation of teachers for music instruction] [Master's thesis, Univerza na Primorskem, Pedagoška fakulteta].

The Cambridge Academic Content Dictionary. (n.d.). Improvisation. In *The Cambridge Academic Content Dictionary*. Retrieved October 27, 2023, from https://dictionary.cambridge.org/dictionary/english/improvisation

Torres, B. (2018). Extending the discussion: Introductory improvisation applications for elementary educators. *Update: Applications of Research in Music Education, 37*(1), 49–51. https://doi.org/10.1177/8755123318791254

Van der Schyff, D. (2019). Improvisation, enaction, and self-assessment. In D. J. Elliott, M. Silverman, & G. McPherson (Eds.), *The Oxford handbook of philosophical and qualitative assessment in music education* (pp. 318–345). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190265182.013.15

Vitale, J. F. (2020). Exploring the fears of pre-service generalists in the music classroom. In B. W. Andrews (Ed.), *Perspectives on arts education research in Canada, volume 2* (pp. 47–75). Brill. https://doi.org/10.1163/9789004431409_003

Whitcomb, R. (2005). *A description of improvisational activities in elementary general music classrooms in the state of Illinois* [Doctoral dissertation, University of Illinois].

Whitcomb, R. (2007). Improvisation in elementary general music: A survey study. *Kodály Envoy, 34*(1), 5–10.

Whitcomb, R. (2013). Teaching improvisation in elementary general music: Facing fears and fostering creativity. *Music Educators Journal, 99*(3), 43–50. https://doi.org/10.1177/0027432112467648

Wiggins, R. A., & Wiggins, J. (2008). Primary music education in the absence of specialists. *International Journal of Education & the Arts, 9*(12), 1–26. http://www.ijea.org/v9n12/

Wright, R. A., & Kanellopoulos, P. (2010). Informal music learning, improvisation and teacher education. *British Journal of Music Education, 27*(1), 71–87. https://doi.org/10.1017/S0265051709990210

Zakon o osnovni šoli [Primary School Act] (ZOsn). (1996). Uradni list RS, št. 81/06, 102/07, 107/10, 87/11, 40/12 – ZUJF, 63/13, 46/16 – ZOFVI-K, 76/23. http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO448

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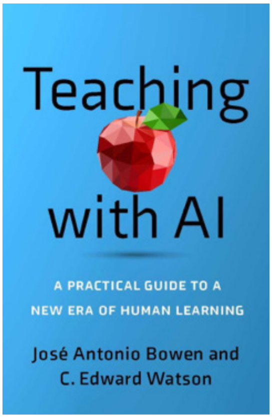
José Antonio Bowen and C. Edward Watson, T*eaching with AI: A Practical Guide to a New Era of Human Learning*, Johns Hopkins University Press, 2024; 270 pp.: ISBN: 978-142-144-922-7

Reviewed by Alenka Žerovnik[1]



Bowen and Watson's book provides a comprehensive and up-to-date understanding of the role of artificial intelligence (AI) in higher education today. The authors combine theoretical insights, empirical data and practical examples in a book aimed primarily at educators and education policy makers. The work encourages systematic, ethical and critical thinking about how AI can be integrated into curricula as a tool for collaboration rather than a threat. The present review discusses the book's main content points, as well as their validity and relevance in the Slovenian context.

This work is relevant in the Slovenian context as teacher education faculties face the challenge of preparing future teachers for the reality of classrooms where the presence of AI will be unavoidable. The authors present a balanced approach that advocates neither uncritical acceptance nor outright rejection of the technology, but rather encourages thoughtful collaboration with machine learning tools as partners in the learning process. Such an approach is crucial for preparing competent teachers who will be able to navigate the complex world of modern education.

Structurally, the book is divided into three interconnected sections: "Thinking with AI", "Teaching with AI" and "Learning with AI". The first part deals with a basic understanding of how large language models work and their impact on cognitive processes. The authors introduce key concepts such as "hallucinations" of AI, biases in algorithms, and the importance of a critical understanding of the limitations of modern machine learning systems.

The theoretical framework of the book is based on an interdisciplinary approach that combines insights from educational psychology, cognitive

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science and educational technology. The authors' approach to understanding AI goes beyond the technological perspective and includes humanistic aspects of education. Importantly, they emphasise that AI cannot replace key human characteristics such as empathy, creativity and ethical judgement. Instead, they propose a model of collaboration in which technology serves as a tool to enhance human capabilities. This approach is in line with recent research that emphasises the importance of triadic relationships between teachers, students and artificial intelligence.

The authors emphasise "prompt engineering" as a core competency for the future and a foundational competency for all disciplines. Their concept of AI literacy goes beyond technical skills to include problem solving, tool selection, critical evaluation and self-awareness in the use of AI. As a key professional competency, AI literacy should be embedded in all degree programmes to prepare graduates to articulate both their use of AI and the unique human value they themselves contribute. This is in line with current research that views AI literacy as a blend of technical knowledge, ethical judgement, reflection and practical skills.

The second part of the book focuses on practical applications for university teachers. The authors show how AI can serve as a tool for preparing teaching materials, designing discussion questions and creating personalised knowledge assessments. The research they refer to shows that the appropriate use of machine learning tools can increase academic staff productivity by 40%, while improving the quality of teaching. This information is particularly relevant for teacher training faculties where there is a need to optimise teacher training processes with limited resources. The findings on the potential of AI as a tool are also confirmed by student surveys, as the authors note that the use of AI is extremely widespread among students. Students often describe it as a "second brain" or "second teacher" that is always available. The authors point out that AI, when used thoughtfully, also has the potential to reduce educational inequalities, as it can provide personalised feedback, particularly for students who have limited access to mentoring, tutoring or academic support.

The authors address academic integrity in the age of AI by arguing for a shift from punitive measures to the design of "AI-resistant" assignments that promote critical thinking and creativity. Citing research, they note that 75% of US students (and 94% globally) admit to using AI even when it is prohibited. At the same time, 35% of students believe their professors do not know this, and 42% of professors doubt that students use AI at all. These results emphasise the need for the pragmatic, transparent integration of AI rather than attempts at total control.

In the rest of the book, the authors deal in detail with the question of how to design tasks that promote collaboration with artificial intelligence instead of preventing it. They introduce a "reverse engineering" method in which students analyse the responses of AI tools and identify shortcomings and opportunities for improvement. This approach encourages critical thinking and allows students to develop a deeper understanding of both the subject matter and the limitations of the technology. Research cited by the authors in the field of educational psychology confirms that such methods increase student engagement by 25% compared to traditional approaches. The authors also emphasise the importance of reflection and metacognitive processes in the use of AI, which are crucial for the development of student autonomy.

The authors highlight "AI literacy" as a key twenty-first-century competency that encompasses technical understanding, timely design, critical evaluation and ethical judgement. They argue that this competence should be integrated into all degree programmes, not just technical fields. This aligns with recent findings that view AI literacy as part of broader digital citizenship (Sperling et al., 2024). The authors emphasise that AI skills are dynamic and need to evolve with technological advances.

The third part of the book is the most ambitious and innovative, focusing on the design of new types of tasks and assessments that require human effort. The authors propose a shift from preventing fraud to promoting assignments that exceed the capabilities of current AI. The concept of so-called "C-level work prohibition" (average work) presents the provocative premise that all student work should be of higher quality than what AI is capable of producing. Such an approach requires a fundamental redefinition of learning goals and values in higher education. The proposal draws on research showing that current AI systems produce average C-level work (in the context of the US grading system), which means that we need to demand higher standards from students. This section also provides practical guidelines for developing rubrics for grading papers that consider the use of AI in student work. Zawacki-Richter et al. (2019) point out that most research on AI in higher education comes from technological disciplines and focuses primarily on data models and predictive algorithms, while pedagogical, ethical and theoretical dimensions remain under-researched. This gap points to the need for in-depth research into teaching and assessment methods that emphasise metacognition, creativity and other human aspects of learning.

The methodological work is based on a comprehensive analysis of the latest research in the field of educational psychology and educational technology. The authors systematically incorporate empirical findings on the effectiveness of different approaches to integrating AI into education. Their analysis includes more than 200 studies published between 2022 and 2024. They also emphasise the importance of qualitative research that uncovers more complex aspects of the impact of technology on pedagogical processes.

In the context of teacher education, it is particularly important to systematically address the different types of artificial intelligence and their applications in the teaching process. The authors clearly explain the difference between generative models, which create new content, and predictive models, which analyse patterns and use them to predict outcomes. Generative tools raise questions about authorship, bias and the spread of misinformation, while predictive tools, if not properly designed or controlled, can contribute to existing inequalities. Such a systematic approach enables future teachers to not only master the technical aspects of AI tools but also to develop critical thinking about their capabilities and limitations so that they can integrate them into the classroom in thoughtful ways.

The authors also take a critical look at ethical issues related to the use of AI in education, devoting particular attention to data protection, the bias of algorithms and the possible manipulation of learners. Their ethical approach is based on four basic principles: transparency, learner autonomy, fairness and accountability. They propose establishing ethical guidelines for the use of AI in education that cover both technical and pedagogical aspects, and highlight the need to develop ethical awareness among educators as part of regular professional development. One particularly problematic aspect is the unequal access to advanced AI technologies. Although the authors mention the potential of AI for reducing educational inequalities, the fact remains that high-quality machine learning systems require enormous financial resources. Free versions of tools such as ChatGPT 3.5 are significantly less powerful than advanced versions, which may deepen the existing differences between privileged and less privileged students. The authors propose the establishment of national programmes to ensure equal access to high-quality AI tools in education. This topic is particularly relevant in the European context, where different countries have large differences in digital infrastructure.

A critical analysis of the work shows both the advantages and the limitations of the approaches presented. The authors may be too optimistic in their assessment of the willingness of teachers to fundamentally change their practice. The implementation of the proposed solutions requires considerable investment in teacher training and technological infrastructure, which is a challenge for many educational institutions, including in the Slovenian educational context. There is also the issue of cultural differences in the acceptance of technology, which the authors address only superficially. Studies from Asian contexts show different patterns of technology acceptance than those in Western Europe or North America.

Although the authors recognise numerous opportunities for the use of AI in educational processes, they do not claim that such use can be understood as an improvement in all cases. On the contrary, at several points in the book they emphasise the need to develop a critical understanding of AI tools, their capabilities and their limitations. Some studies (which the authors do not mention) point to the possible negative effects of over-reliance on technology, particularly with regard to the development of critical thinking and creativity. Nor should we overlook the possibility of educators relying too much on technological solutions and neglecting the fundamental pedagogical principles and human relationships that remain essential to quality education.

Despite some of the challenges or shortcomings highlighted, the work represents a valuable contribution to understanding the role of AI in education today. It does, however, require critical reading and adaptation to the local context. The authors' suggestions are particularly useful in environments with a well-developed technological infrastructure and a high level of digital literacy among learners and teachers. However, in contexts with limited resources or cultural resistance to technology, a more cautious and gradual implementation of the suggested approaches will be required. Faculties of education need to consider the different contexts in which their graduates will be working.

The book is nonetheless an important resource for the development of programmes that prepare future teachers appropriately for the realities of the twenty-first century. The practical examples of prompts and tasks provided by the authors allow for direct implementation in pedagogical practice, while the theoretical framework provides a deeper understanding of the long-term impact of technological change on education. It is important that teacher education faculties approach the integration of these insights systematically and critically, and ensure that their teaching staff is adequately prepared. This work provides an excellent starting point for the development of curricula that include AI skills as a core competency. The authors also emphasise the need for continuous evaluation and adaptation of pedagogical approaches, which is particularly important in a rapidly changing technological environment.

The authors convincingly show that the integration of AI into education is not just a technical issue but requires a comprehensive pedagogical, ethical and social approach. Their work is a valuable contribution to the literature and an indispensable resource for those preparing educators for the challenges of education today. By linking current technological developments with a nuanced understanding of pedagogical realities and ethical responsibilities, the book provides timely guidance, even if its application requires critical reflection and adaptation to local contexts.

References

Sperling, K., Stenberg, C.-J., McGrath, C., Åkerfeldt, A., Heintz, F., & Stenliden, L. (2024). In search of artificial intelligence (AI) literacy in teacher education: A scoping review. *Computers and Education Open, 6*, Article 100169. https://doi.org/10.1016/j.caeo.2024.100169

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education, 16*(39). https://doi.org/10.1186/s41239-019-0171-0

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