

DIGITAL TOOLS AND DIDACTIC COMPETENCE IN INFORMATICS: A QUALITATIVE ANALYSIS OF PRE-SERVICE TEACHERS' REFLECTIONS

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Abstract

The implementation of the new curricular reform in Slovakia (2023) introduces fundamental challenges to informatics education, where the use of modern digital and educational tools becomes a key element starting from the primary education level. This study analyses pre-service teachers' reflections following the completion of the master's level course *Visual Programming Languages*, focusing on their perceived readiness to teach informatics in their future practice. Utilizing a qualitative research design, the study addresses the following key thematic areas: the evolution of professional attitudes toward teaching informatics in primary education, the extent of prior exposure to educational programming and robotics tools, the development of perceived didactic competence, and the perceived congruence between course content and the national curricular reform. Qualitative content analysis was conducted. Data were collected through initial interviews and subsequent written reflections of master's students (N=25) enrolled in the course. This research material was processed through a systematic color-coding scheme and synthesized into a conceptual map. Although the pre-service teachers' knowledge of the Ozobot tool was fragmented and accompanied by concerns regarding its practical application due to technical issues, they declared high levels of didactic confidence when working within the new environments of Emil 3, Emil 4, Blue-bot, and the Living Workbook. Furthermore, the analysis confirms a robust alignment of the didactics of skills instruction within the course with the national reform, specifically through the enhancement of digital, metacognitive, and soft skills. The Visual Programming Languages course has proven to be a valuable source of practical tools and teaching resources for future teachers. Thanks to this targeted didactic training, future teachers reflect on their own readiness to equip students with the computer skills necessary for their future careers and lifelong learning.

Keywords: *Pre-service teachers, visual programming languages, curricular reform, qualitative content analysis, didactic self-efficacy.*

1. Introduction

The integration of educational robotics and visual programming into the teaching process provides an optimal foundation for the development of cognitive skills such as navigating digital interfaces, spatial visualization, and the ability to solve problems effectively. Through these activities, critical and algorithmic thinking are specifically developed in the context of primary education (Erumit et al., 2025). The Children's Programming Languages course provides future teachers with valuable practical experience with current technologies and educational tools, which they can subsequently apply in computer science instruction or when implementing the STEAM concept in other subjects (Raxmatova & To'raqulova, 2023). During the course, students become familiar with tools such as Robot Emil 3 (Blaho, et al., 2018), Robot Emil 4 (Kalaš, et al., 2021), Living Workbook, Blue-bot, Ozobot Evo, Ozobot Ari, and the Ozoblockly environment. The instruction itself is delivered using hands-on learning (Kanapathy, & Azhari, 2024) and flipped classroom methods (Tsimerman, 2014). This practical approach is complemented by an in-depth analysis of the didactic and organizational aspects of using these tools. The third key component of the course involves designing one's own educational activities and organizational frameworks that reflect the current conditions and needs of the Slovak public education system.

The use of these digital tools enables the development of computer, algorithmic, and critical thinking skills in students, as well as spatial orientation. These competencies are not only in direct alignment with the new National Curriculum (2023) but also constitute an essential prerequisite for students' future professional careers. Moreover, in the context of the current digital era, the content and objectives of computer science are becoming equally meaningful and applicable for both girls and boys (Ulbrich, 2025).

2. Design and methods

During the winter semester of 2025/2026, a study was conducted on a sample of 25 female master’s students at the Faculty of Education, Comenius University. The main objective was to assess their perceived competence in teaching computer science using the tools they were introduced to in the course, at the elementary school level after completing the course Visual Programming Languages. Using written reflections as a data source, the study examined the development of the participants’ professional identity and their ability to identify the key skills that their future pupils would acquire. The analytical process involved systematic open coding (Hendl, 2023) of the collected data, which was subsequently categorized and visualized using concept maps. The contents of these concept maps represent claims and categories consistently identified by more than half of the research participants.

RQ1: Which of the educational tools presented in the course were already known to students prior to its commencement?

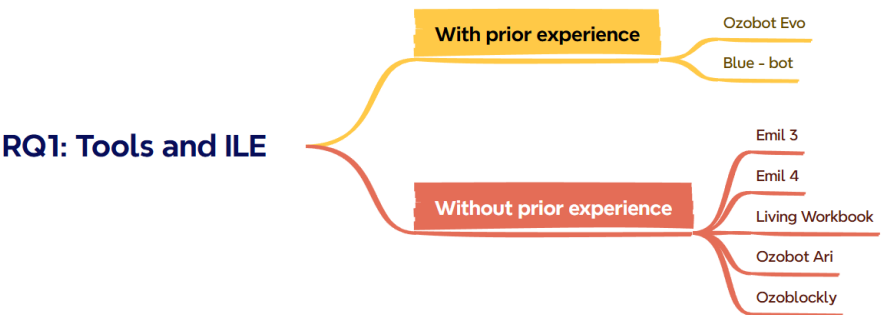
RQ2: Which tools and ILE (Interactive learning environment) do students feel competent to implement in their future practice?

RQ3: To what extent is the course content perceived as aligned with the objectives of the Slovak national curricular reform?

3. Findings

Analysis of interviews with master’s students confirms that their perceived self-efficacy in the field of computer science is negatively influenced by past negative experiences and concerns about high cognitive demands. A problematic issue is the feeling of insufficient competence in teaching skills to students in an appropriate manner, which is exacerbated by a lack of opportunities to work with current educational robotics tools. Respondents also question the technical equipment of public schools and their own ability to ensure the functionality of the technology. This local perspective aligns with the global trend described in the article *We Believe in STEAM Education, but We Need Support*, where Spyropoulou et al. (2025) highlight an identical discrepancy between confidence in the STEAM concept and the actual need for methodological and technical support for teachers.

Figure 1. Content and categories in relation to RQ1.



The students were already familiar with tools such as Ozobot Evo and the Blue-bot robot, as they had previously encountered them in other subjects during their bachelor's studies. In contrast, the interactive learning environments Emil 3, Emil 4, and the Living Workbook were novel to them, as were Ozobot Ari and the Ozoblockly extension.

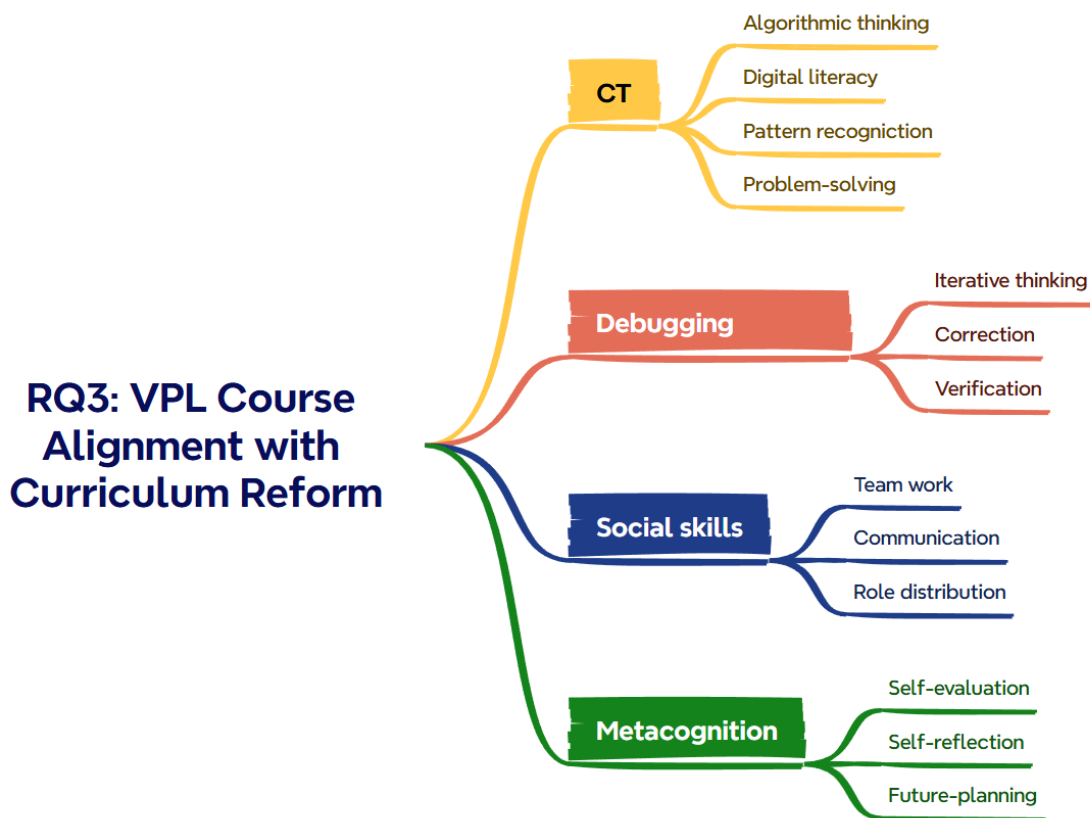
Figure 2. Content and categories in relation to RQ2.



The students confirmed their interest in using the Emil 3 and 4, Ozobot Ari, Living Workbook, and Blue-bot tools in practice. Conversely, they expressed concerns about the Ozobot Evo and OzoBlockly, citing technical difficulties encountered during the seminars. At the same time, they expressed uncertainty as to whether they would receive sufficient technical support in real-world school settings if they encountered problems while using these more complex tools.

The content of the course Programming Languages for Children directly reflects the objectives of the current curriculum reform and the new national curriculum in Slovakia. The results of our research confirm that the course successfully focuses on developing the key skills prescribed by the reform for primary education. As demonstrated by the concept map (RQ3), students in the course identified and developed attributes in line with the performance standards of the new National Education Program, primarily computational thinking, collaborative problem-solving, and the ability to work with errors (debugging). A key benefit of the course is the strengthening of metacognition, through which future teachers, via self-reflection and monitoring of their own progress, became aware of the transformative potential of digital technologies. This alignment confirms that the targeted preparation in our course develops the comprehensive teaching competencies essential for modern STEAM education across the entire primary school level.

Figure 3. Content and categories in relation to RQ3.



4. Limitation

The main limitation of the study is the sample size 25 female students and the absence of male participants, which precludes a gender comparison, although it accurately reflects the reality of primary education programs. For a deeper understanding of the issue, longitudinal research is therefore needed in the future to track the transfer of acquired competencies directly into the teaching practice of graduates in elementary school settings.

5. Conclusion

Targeted didactic training enabled the participants to address their initial concerns about the cognitive demands of computer science and replace them with a proactive interest in the subject. The self-confidence of primary education teacher candidates varies depending on the tools used—they report a

high level of didactic competence with Emil 3, Emil 4, Blue-bot, and Living Workbook, while concerns about technical complications persist with Ozobot Evo and Ozoblockly. The analysis also confirmed that the content of the VPL course aligns with the goals of the new curricular reform in Slovakia. The course focuses on developing the key skills prescribed by the new national education program for primary education, particularly computational thinking, collaborative problem-solving, debugging, and the development of metacognitive skills. The study offers important critical insights into the reality of digital transformation in education. It identifies that for the successful implementation of innovations in practice, the isolated development of teaching competencies and mastery of technology alone are insufficient. The paper highlights the necessity of systematic technical support, without which teachers feel uncertain despite high-quality methodological preparation. This finding is a key contribution to the discussion on the sustainability of educational reforms.

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