FORMATION OF REFLECTIVE SKILLS IN THE PROFESSIONAL DEVELOPMENT OF STUDENTS, FUTURE TEACHERS

Elena Todorova, Todorka Terzieva

Abstract. This study presents a pedagogical model for mastering and developing reflective professional competencies of students, future teachers. The focus is on the intellectual and cognitive aspects of teaching practice. The report describes in detail the successive stages of the process of developing reflective skills in computer science education for master's degree students, majoring in "Computer Science and Information Technology Education in Schools".

Key Words: *reflective skills, reflective teaching, reflective learning models.*

Introduction

Reflection is the basis for successful learning for both teachers and students. Developing reflective skills in students and teachers is an important task of education at all levels and across all subjects. The competencies acquired through reflective practice create a strong foundation for continuous improvement in teaching and learning. Achieving excellence in teaching has the greatest impact on student achievement. Moreover, the effect of reflective learning and the promotion of reflective practice in schools is beneficial not only for individual teachers, but also for education as a whole.

In the training of students pursuing teacher education in the bachelor's and master's programs at the Faculty of Mathematics and Informatics (FMI) of Plovdiv University "Paisii Hilendarski," special attention is given to the formation and development of pedagogical reflective skills, which form the foundation of the practical competence of student teachers. The aim of the training is to construct one's own knowledge and transfer it to new situations, and to stimulate reflection on one's own experience. A number of authors analyze the need to develop reflective skills in students who are future teachers [2, 3, 4, 6, 8] In our previous study we presented basic models for the formation and development of reflective skills, emphasizing the main characteristics of each model as well as the concepts underlying their application [4, 5].

Reflective skills are accumulated and developed in the learning process and represent a complex system of knowledge, skills, attitudes, feelings, emotions, self-control, self-development, self-assessment. They should be built upon with

each subsequent stage of purposeful reflective learning. Studies by a number of authors show that the abilities to apply constructive reflection, to reflectively solve problems in pedagogical reality can effectively develop during the training of students [2, 3, 9]. Giving priority in the curriculum to improving reflective thinking skills is crucial, since it not only solves problems and professional growth, but also the skills of citizens for lifelong learning in a rapidly changing world. The teacher's reflective skills are an important component of his professional competence and are also a necessary mechanism for the full realization of all other professional functions and qualities. The teacher's activity is a complex system of diverse interactions at different levels and in different directions. In an environment of lifelong self-learning, the professional development of teachers implies skills for reflective practice and research work. They are expected to:

- continue to systematically reflect on their own experience;
- incorporate the results of academic research and research in their work with students into their teaching;
- evaluate the effectiveness of teaching strategies and modify them accordingly;
- assess their own learning needs, etc.

Reflection on one's own experiences as part of the course and classroom research, critical observation and reflective analysis of teaching practices, are some of the main components of a teacher's professional growth and are crucial for the effective work of a teacher. Reflection helps teachers to understand their context properly and to develop alternative approaches to deal with upcoming problems that may arise in the course of pedagogical practice.

Formation and development of reflective skills – theoretical basis

Significant changes are taking place in our daily lives, affecting both the social and economic spheres of our country. Modern education must create the conditions for developing lifelong learning skills and the ability to understand the nature of the processes and phenomena in the world around us. Teachers are faced with the challenge of adapting their teaching practices to a rapidly changing global society, in which cognitive skills and creativity in particular are becoming increasingly important.

Teaching strategies are essential to effective teaching, providing educators with the tools to engage and support learners in achieving their learning objectives. As educators, it is vital to adapt teaching strategies to meet diverse learners' unique needs and learning styles. Reflective practice is a crucial process that enables individuals to gain deeper insights into their experiences and better understand their strengths and areas for improvement. Through reflective

practice, educators can construct and reconstruct their beliefs and practices, creating their students' best learning environment.

We believe that training students to develop reflective skills is a very important process that must be systematically cultivated. The primary goal is the purposeful and active development of reflective skills among students training to become teachers, as well as their mastery of models for reflective analysis and self-assessment. There is a contradiction between the pursuit of better and more in-depth reflective assessment and a poorly developed mechanism of reflective control. This is also linked to one's attitude toward personal experience, as well as the understanding and rationalization of the true significance of independent educational and professional growth [7]. A minimalist understanding of reflective practice in education is that it refers to the process by which a teacher examines their own teaching methods, determines what works best in teaching students, and considers the ethical implications of teaching procedures. In a broader sense, one can consider the organizational, social, and technological context in which teaching takes place [10].

To develop reflective practical skills and implement reflective practices in the educational process, a number of authors propose various models for training students and future teachers [1, 3, 4, 5, 11]. Each teacher determines which model is appropriate for a specific situation, bearing in mind that different models foster different reflective skills: Gibbs's cycle is suitable for teachers who do not have sufficiently developed reflective skills, while Farrell's and Cortagen-Vasalos's models are recommended for teachers familiar with reflective practice. Johns' model for structured reflection [5] was originally developed for use in the context of nursing, but is relevant for use in other contexts. It can assist with reflection and analysis of more complex decision making, as well as being useful when learning how to reflect. Johns formulates a lot of questions, which help to follow certain consistence in reflection process, in the model of structured reflection. Johns also suggested that involving someone else (e.g., a supervisor or mentor) to support you in your reflection can make your reflection more powerful than if you engage in reflection by yourself.

The integrated reflective cycle is one of the tremendous reflection models that can assist you in learning from your own experiences. This model was developed by Bassot in 2013 that draws out 4 stages of introspection that can help individuals in analyzing the different aspects of situations. This model is inspired by different ranges of models such as Gibbs' reflective cycle and offers some similar characteristics to the model. The four stages of the cycle are Experience, Reflection on Action, Theory and Preparation [11]. This model will assist you in analyzing your feelings and how these feelings impacted the outcome of your experience.

Self-reflecting or teamwork reflection is becoming an important source of learning in various professions including software development teams, where continuous improvement enhances code quality and collaboration. After a thorough review of various models of reflective learning and an examination of their specific features, with the aim of developing reflective skills in computer science education for students who are future teachers, we settled on the 5R framework. The 5R framework for reflection was developed by Bain et al. in 2002 and guides students and teachers in reflecting on their experiences [11]. The 5R model provides a structured framework for analyzing experiences. It facilitates critical reflection on the experience by focusing on five key stages for making sense of the learning experience. It also guides students to describe the situation, express their reactions, connect it to previous experiences, analyze the causes, and plan for improvements. The 5R framework represents **Reporting, Responding, Relating, Reasoning, and Reconstructing** the experience to present it in an engaging reflection. Bain works to achieve two important purposes through this model:

- To support teachers and students in understanding what is involved in serious reflection.
- To enhance the ability of students and teachers to assess their reflective writing through the 5 levels of R proposed by Bain et al. [8]

The model is flexible and can be used both to organize the thought process and to design learning activities as part of the process of developing reflective skills.

The 5R model in the professional development of students, future teachers

In this study, we adapt the 5R model for developing cognitive reflection and self-reflection in the education of students, future teachers of computer science and information technology. Below we describe in detail the successive stages of the process of developing reflective skills in computer science education for master's degree students, majoring in "Computer Science and Information Technology Education in Schools." Effective computer science teachers need to continually develop in-depth content knowledge of computer science-related disciplines. They are required to demonstrate mastery of computer science concepts in the classes they teach and to integrate these concepts with appropriate practices, including computational thinking. We apply the main stages of the 5R model to form skills for analysis, synthesis, classification and development of critical thinking, by formulating basic learning activities in the education of students in informatics. Computer science (CS) teachers require a specialized blend of technical expertise, pedagogical knowledge, and the ability to foster an inclusive, innovative environment. Effective CS educators move beyond just

teaching coding to developing computational thinking, which involves algorithms, data analysis, and understanding the social impacts of technology.

Some stages, such as Reporting and Responding, may overlap, allowing the model to be adapted for the purposes of computer science education. The questions and specific learning activities associated with each stage serve as a guide, but it is not necessary to use all of them – the important thing is that they support critical reflection on the experience.

Reporting – Describes the context of the acquired knowledge and skills.

Fundamental Knowledge and Skills – Proficiency in data structures, algorithms, and binary numbers.

- Knows, compare and contrast fundamental data structures and their uses.
- Reads, understands and explains the values of program objects.
- Reads, understands and explains the results of various operations (arithmetic, logical, etc.).
- Implements and describes the results of operations.
- Understands different ways of describing an algorithm.

Core Learning Activities and Competences:

- Collection, processing, transformation and analysis of digital data in order to develop critical thinking and formulate conclusions.

Responding – Reactions and observations, or personal response to the situation.

Fundamental Knowledge and Skills – Focus on important aspects and reasoned assessment of the situation.

- Analyzes and explains the behavior of simple programs involving basic algorithmic constructs.
- Arranges (groups) primitive and complex data structures.
- Classifies and explains control structures.

Core Learning Activities and Competences:

- Executes a formally described algorithm.
- Analyzes and explains obtained results.
- Determines results from the implementation of standard methods.

Relating – Connecting the experience with already acquired knowledge and skills; Practicing peer mentoring to foster collaboration skills.

Fundamental Knowledge and Skills – Recognizing and defining Computational Problems; Creating Computational Artifacts:

- Compares initial conditions of a problem and input data of a given algorithm.
- Changes the input data, starts the program (executes the algorithm) and analyzes the results.
- Applies ways to implement a branching and cyclic algorithm.

Core Learning Activities and Competences:

- Developing programs and interpreting algorithms.
- Computational Thinking Facilitation: Helping students apply problem-solving skills (decomposition, pattern recognition, abstraction, algorithm design) across subjects.

Reasoning – Reflections on the significant factors and theoretical concepts and the practical results obtained.

Fundamental Knowledge and Skills:

- Understands an algorithm (program) and describes the action and behavior of the program.
- Corrects an algorithm in case of a discrepancy between a formal description and a high-level language program.
- Finds syntax errors in data descriptions and algorithmic constructs.

Core Learning Activities and Competences:

- Interpreting algorithms and explaining the trade-offs associated with different algorithms.
- Evaluates the fit between a problem and input data, intermediate and output results.

Reconstructing – Rethinking and analyzing practice by planning future actions for improvement.

Fundamental Knowledge and Skills:

- Modify and extend short programs with additional modules.
- Modify input data when changing initial conditions.
- Explain obtained results and detect logical errors.
- Evaluate the correspondence between expected and obtained results.

Core Learning Activities and Competences:

- Use and adapt classic algorithms to solve computational problems.

- Evaluate algorithms in terms of their efficiency, correctness, and clarity.
- Analyze a large-scale computational problem and identify generalizable patterns that can be applied to a solution.

Effective computer science teachers must continually develop a deep understanding of the content of computer science-related disciplines. They are required to demonstrate mastery of computer science concepts in the classes they teach and to integrate these concepts with appropriate practices, including computational thinking. When students engage in self-directed learning using reflective assessment, they consider how their work meets established criteria, analyze the effectiveness of their own efforts, and plan for improvement. Reflection is linked to elements that are essential for students' meaningful learning and cognitive development: the development of metacognitive knowledge and skills – the ability to self-learn and self-assess.

Conclusion

The primary task of the modern teacher is to make students accountable for their learning outcomes. To keep pace with current trends in educational practice, teachers must guide their students toward the need to build individual cognitive experience. They must instill in them lifelong learning skills as a way of thinking (each of us being open to new ideas, solutions, skills, or behaviors), as a systematic process focused on the learner themselves and their needs for personal and professional development.

The benefits of cognitive reflection for computer science teachers:

- Better decision-making: It improves the ability to make fact-based decisions in the classroom.
- Better support for students: It improves the ability to understand and support students' diverse needs and learning difficulties.
- Lifelong learning: It helps teachers adapt to the rapidly evolving field of technology.
- Increased self-efficacy: It provides a mechanism through which teachers can build confidence in their ability to teach complex topics in computer science.

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