PROSPECTIVE TEACHERS’ PREPAREDNESS TO DEVELOP MATHEMATICS LITERACY AS A PRECONDITION OF EFFECTIVE PRACTICE

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Abstract

In the context of the extensive curriculum reform of initial education documents, the issue of defining mathematical literacy and its relation to other literacy developed in mathematics teaching (e.g., digital literacy) is again very topical. An important prerequisite is that prospective teachers also know how to develop mathematical literacy among their pupils and what activities are more and less appropriate for it. The aim of the paper is to identify the preparedness of prospective primary teachers to include these activities in their mathematics teaching – how they are able to work with chosen problems in mathematics lessons. The theoretical starting point was the concept of self-efficacy as a prerequisite for well-conducted teaching. The research part of the paper was based on the questionnaire Teachers’ Self-Efficacy Scale (TSES). In our case, a 24-item version was applied, that is recommended for trainee students who were supposed to evaluate the claims on a 9-point scale, from “nothing” to “a great deal” (Tschannen-Moran & Woolfolk Hoy, 2001). The two main research questions were set up: What is the evaluation of self-efficacy for mathematics literacy development among the respondents in the areas of research? and Are there any differences in prospective teachers’ evaluation by study groups? The questionnaire survey was attended by 68 full-time students of elementary school teacher program and elementary school and special education teacher program at the Faculty of Education of Palacky University Olomouc in the academic year 2018/2019. The paper summarizes results from five items of the questionnaire directly related to the preparedness of prospective teachers to develop pupils’ mathematical literacy such as helping students to critical thinking, convincing students that they can be successful in mathematics, showing students the practical use of the learned knowledge, verifying that the pupils understand the subject matter and supporting pupils’ creativity. Obtain results were positive – students have high self-efficacy level for developing students mathematics literacy. Results were compared according to the student's membership in the study group, and Fisher's combinatorial test was used to analyze the results.

Keywords: mathematical literacy, digital literacy, teacher, preparedness, Teachers’ Self-Efficacy Scale, mathematics.

1 INTRODUCTION

Literacy and its individual types or components are one of the most frequently used concepts of current education. Among the basic literacy is also mathematics literacy, which emphasizes various mathematical situations and contexts, mathematical content and individual mathematical competencies, which increased interest in the Czech Republic in relation to participation in international research Program for International Student Assessment (PISA), who learns the knowledge and especially the skills of pupils in mathematics needed for good practice in modern society. Thus, by its conception, it emphasizes the importance of education as a preparation for real life and explores their ability to solve everyday life situations by understanding basic concepts and principles. That is why the focus of research on pupils’ literacy is discussed [1], [2].

1.1 The mathematical literacy background

There are currently a number of definitions or definitions for mathematical literacy that focus on its various aspects. The PISA-based definition is most widespread: "Mathematical literacy is an individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen" [3, p. 84].

How and how pupils will be able to apply their education to new real-life situations is determined by the way of teaching that enables them to acquire mathematical literacy. Methods and forms of work
are the keys to literacy. The company assumes that teachers in mathematics classes devote enough time and understanding of the importance of mathematics for everyday life. The learner can then apply what the calculator no longer: experiment, analyze, discover, organize, argue, decide, and especially learn new things. Teaching towards creativity and focusing on the development of pupils' personalities will give them good prospects for future life.

There are many methods a teacher can choose from. Choosing methods and forms of work is needed to take into account the learning situation, educational objectives, characteristics of the pupils and the preferences of the teacher itself, in such a way that the learning process is effective and its outcome is best for each of our pupils. Pupils need to be given the opportunity to seek, experiment and speculate to defend their solutions to problems. Great effort should be made by teachers to create their own very rich inventory of methods and forms of work [4], [5], [6].

According to [1], a teacher who seeks to increase the relevance and quality of mathematics teaching must also seek and try new approaches. It can be assisted by collections of tasks that include tasks of a similar nature to those found in PISA investigations. In their creation, the authors based their analysis on the specific difficulties encountered by Czech pupils in solving test questions from international surveys.

[7] notes that the choice of the topic includes tasks with a wide range of situations and contexts, ranging from purely mathematical tasks to tasks where the mathematical context is not obvious at first sight. To solve problems, you need to follow the mathematical content that is needed to formulate the mathematical nature of the problem. It is necessary to discuss the solution, compare the result of solving a mathematical problem with reality, what is possible in practice and what is not, even if it is the result of a mathematical task. Greater attention should be paid to the tasks in which the estimates of results, the creation of hypotheses and their verification, graphics solutions, using pictures are applied. The development of mathematical literacy is enhanced by the teacher's respect for pupils' solutions, even if they are not optimal or completely correct. It is the discussion of the pupil's thought processes and their correction in the sense of the right conclusions that significantly develop mathematical literacy.

1.2 Teacher’s self-efficacy

But there is a question here: If teachers have methods and forms to develop pupil mathematical literacy, why do Czech pupils achieve low PISA results? The answer may not be related to objective educational elements, but to the subjective perception of self-efficacy of future teachers. A subjectively perceived efficacy is a concept first used by [8] in his social and cognitive theory, and it can be characterized as the way in which a person evaluates his/her own capabilities for a particular activity. According to [9] research aimed at the subjective perception of teacher self-efficacy in various levels and types of schools suggest that teachers with a high level of perceived self-efficacy:

- Choose more demanding teaching methods compared with teachers convinced about weak professional self-efficacy;
- Better resist external pressures;
- Have a tendency to assign problem-solving tasks rather than tasks based on reproducing knowledge;
- Take more time to guide their students to correct answers to various questions, for example when students are unable to answer at the beginning;
- Use group work more frequently compared with teachers with a low degree of self-efficacy;
- Pay greater attention to weaker students compared with teachers with a low degree of self-efficacy.

It can therefore be said that a teacher who seeks to lead pupils to seek, experiment and speculate, and who systematically supports the pupils' autonomy and discussion, will certainly achieve better results than the one who will only teach the pupils rules and procedures on how to tasks. The aim of the paper is to analyze the perception of self-readiness of future mathematics teachers to lead the teaching in this way and thus to develop the mathematical literacy of pupils.
2 METHODOLOGY

2.1 Research instrument

Several methods are used to measure teachers’ self-efficacy, but there is no one method that would be preferred by experts. The reason is that different methods follow different components of self-efficacy and also focus on specific areas of interest of a particular research (specific subjects, areas) [10].

For example, [11] believed that perception of personal efficacy differs in different situations to which the teacher is exposed and also in different disciplines - otherwise the teacher perceives his potential in explaining the new subject matter, otherwise in the assessment of pupil performance; otherwise it will be perceived by a math teacher and otherwise by a Czech language teacher. Therefore, he created a 30-item questionnaire called Teacher Efficacy Scale (TES), which contained seven subcategories with a 9-point scale. The questionnaire identifies self-efficacy in influencing decisions, influencing school resources, organizational, maintaining discipline, involving parents in school life, involving colleagues and other educational organizations, and creating a positive school climate.

Perhaps the most widespread version of self-efficacy questionnaire is from Ohio State University [12] and is based on the previous Bandura’s test: Teachers’ Sense of Efficacy Scale (TSES). This test aims at exploring three main areas: effectiveness in learning strategies, efficiency in class management, and effectiveness in engaging pupils in learning.

The research part of the paper was based on the questionnaire TSES. In our case, a 24-item version was applied, that is recommended for trainee students who were supposed to evaluate the claims on a 9-point scale, from “nothing” to “a great deal.”

2.2 Research sample

The TSES instrument was applied at the beginning of academic year 2018/2019 among prospective mathematics teachers that studies mathematical disciplines at the Department of Mathematics, Faculty of Education, Palacky University in Olomouc. The pilot research involved a total of 68 students in the full-time form of study. There were 46 elementary school teacher program (ESTP) participants and 22 elementary school and special education teacher program (ESSETP) participants.

2.3 Research questions

In the context of the objective of the paper, the questionnaire was evaluated on two basic levels – overall results and results by the form of study. Regarding these levels, the following research questions were formulated:

(RQ1) What is the evaluation of self-efficacy for mathematics literacy development among the respondents in the areas of research?

(RQ2) Are there any differences in prospective teachers’ evaluation by form of study?

The research questions were tested using the chi-square and Fisher’s combinatorial test; the p-value was calculated at a significance level of .05.

3 RESULTS

The objective of the study was achieved by means of the TSES questionnaire, which was adapted to fit the needs of prospective mathematics teaching and converted into an electronic format. The paper summarizes results from five items of the questionnaire directly related to the preparedness of future teachers to develop pupils' mathematical literacy.

In the first item, the respondents assessed the degree to which they are able to help students thinking critically. The second item focused on their ability to show students that they can be successful in mathematics. The third item focused on the respondents' qualities for showing students the practical use of the learned knowledge. In the fourth item, the respondents indicated their ability to verify students understanding of subject matter. In the final item, the respondents expressed their ability to support students' creativity.
3.1 Overall results

In all items examined show a predominance of positive self-efficacy in this area. In the first item, examining the level of preparedness for the development of critical thinking pupils, 8.82% responses were negative, 22.06% responses were neutral, and 69.12% responses were positive. The second item, aimed at helping students to experience success, was 1.47% negative responses, 10.29% neutral responses, and 88.24% positive responses.

![Figure 1. Overall results.](image)

The third item focused on the respondents’ qualities for showing students the practical use of the learned knowledge were 4.41% responses negative, 8.83% responses neutral and 86.76% positive responses. There was even no negative response, 1.47% neutral responses, and 98.53% positive responses in the fourth item. In that item, respondents indicated their ability to verify students of the subject matter. There were only 1.47% negative, 2.94 neutral, and 95.59% positive responses in the final respondents’ opinion on their ability to support students’ creativity (Fig. 1).

3.2 Results by the form of study

It can be seen from Figure 2 that the responses of the respondents of the individual groups did not differ significantly. Positive responses were found in both groups. Especially in the items 4 and 5, where the ESSETP students reported only positive assessments are interesting.

![Figure 2. Responses of ESTP and ESSETP groups.](image)
Zero and alternative hypotheses were defined in order to verify the second research question in the items examined:

\[ H_0: \text{Prospective teachers' responses do not vary by the form of study.} \]

\[ H_a: \text{Prospective teachers' responses vary by the form of study.} \]

Fisher's combinatorial test was used to calculate the \( p \)-value for each item. As a result, the null hypothesis was not rejected in any items, because the \( p \)-value was .3168 in the first item, 1 in the second item, .2234 in the third item and 1 in the fourth and fifth items. It can be seen that \( p \)-value did not exceed the determined level of significance of .05. Therefore there is no statistically significant difference between the ESTP and ESSETP groups.

4 CONCLUSIONS

The results of the research showed that prospective mathematics teachers stated a high level of self-efficacy in areas focused on the development of mathematical literacy. Prospective teachers are most prepared to verify their students understanding of the mathematical subject matter; they are prepared to support students' creativity in mathematics and to show students that they can be successful in mathematics. They are less preparing for demonstrations of mathematics in a real situation and have a lower level of preparation to lead pupils to critical thinking.

If these results continue to emerge, we can say that they can have a positive impact on undergraduate teacher training and can be a positive starting point for improving mathematics teaching.

This result can be summarized as very positive, because if students underestimate their abilities, then it is more likely that they will not make enough effort to reach the goal and give up even at the slightest obstacle. However, as a limit of these results, it should be pointed out that the risk also offers overestimation of one's own abilities. In the short term, overestimation can motivate performance, but if overestimation is long-term and unrealistic, then it does not motivate the students to discuss the subject matter carefully and to complement the gaps. The result could be an inevitable failure.

ACKNOWLEDGEMENTS

The paper was written under the support of the Internal grant of Faculty of Education, Palacky University Olomouc: From subjective implicit theories of education to teaching knowledge. The process of constitution of a cognitive framework sciences education in the national and international context and the Operational Program Research, Development and Education project The support of teachers in practice as a tool of the development of key competencies (No. CZ.02.3.68/0.0/0.0/16_011/0000660).

REFERENCES


