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# Teachers' Attitudes Towards Mathematics Problem-Solving

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Despite the importance of teaching students how to solve math problems and how to transfer problem-solving skills to solve problems in new and unknown situations, research on teachers' attitudes towards solving math problems is still scarce. The aim of the present research was to investigate teachers' attitudes towards solving math problems in a convenience sample of 312 Slovenian primary school teachers. Participants solved a written questionnaire with 17 questions, which aimed to measure their attitude towards different aspects related to problem-solving, such as (1) the feasibility of the objectives related to problem-solving in the Slovenian mathematics program, (2) the use of mathematical problems in different phases of the lessons, (3) the effects of the use of problem-solving on students, and (4) the conditions necessary for solving problems in mathematics. Through the Principal Component Analysis, we validated the questionnaire and the reliability of the instrument was very good. The results show that teachers have a positive attitude towards solving math problems. In particular, teachers recognize the importance of including problem-solving in their regular math lessons. Teachers believe that problem-solving is important for improving students' mathematical knowledge and allows the transfer of knowledge to solve new and unfamiliar problems. Furthermore, the participants believe that the objectives related to problem-solving in Slovenian national curricula are important and should be considered in normal mathematics lessons. Hence, having a more positive attitude towards mathematics problem-solving might encourage teachers to use problem-solving in their regular classes.

Keywords: attitudes, mathematics, problem-solving, teachers, teaching

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## INTRODUCTION

Problem-solving in mathematics is a complex process (Kaur, 1997), which can be used to solve everyday problems (Phonapichat et al., 2014; Saputro et al., 2018), and represents the heart of mathematics education (Sari et al., 2019; Suarsana et al., 2019; Tambychik & Meerah, 2010). Problem-solving in mathematics is a process which requires the use of mathematical skills, knowledge and competencies in new and unfamiliar situations (Freitag, 2014). The importance of solving mathematical problems has been studied extensively and it has been stated that the development of problem-solving competence is the most important goal in teaching mathematics (Marchiș, 2013).

Problem-solving is a learning process performed by students (Sudarsono et al., 2022), which resembles the steps of scientific research and involves a research approach (Sari et al., 2019; Tambunan, 2019). Since several problem-solving strategies are learned in mathematics and are then transferred and applied in other situations that require problem-solving (Gunawan et al., 2020; Sari et al., 2019), it is important that educational research explores it in great detail. In particular, students might use problem-solving skills to critically analyze information, discuss data, and make decisions (Riyadi et al., 2021).

Despite the importance of solving math problems, some research has shown that some teachers do not fully understand what it is (Chirinda & Barmby, 2018; cf. Khoshaim, 2020). This fact raises questions about whether math teachers use problem-solving in their classrooms and what their attitude is towards it. More specifically, teachers' beliefs about solving mathematical problems can influence the teaching process and, consequently, also the beliefs of their students (Yorulmaz et al., 2021). Despite the importance of solving math problems, few studies have investigated teachers' attitudes towards it, especially in primary schools. Among the studies on the subject, Chirinda and Barmby (2018) conducted a qualitative study involving 31 secondary school teachers from 20 South African schools. Their study revealed that some participants had a partial understanding of teaching math problem solving and preferred a more traditional teaching method. Furthermore, these teachers believed that solving math problems was merely demonstrating examples for students and providing them with practical exercises to work on. The actual teaching of the teachers interviewed did not encourage the math problem-solving process.

Similarly, the research by Harisman and colleagues (2019) is also qualitative and aims at investigating the attitudes of secondary school math teachers towards problem-solving. The authors found that teachers had different attitudes towards solving math problems, mainly good (teachers are nervous when tackling math problem-solving), very good (teachers are somewhat afraid of dealing with math problem-solving), and excellent (teachers like problem-solving).

Deringöl's study (2018) investigated the beliefs of potential classroom teachers about math problems. Teachers' beliefs regarding solving math problems have been shown to be moderately positively correlated to their beliefs about self-efficacy in posing math problems. More recently, research by Yorulmaz and colleagues (2021) explored the

metacognitive awareness and mathematical problem-solving beliefs of prospective primary school teachers through several tools, including the "Mathematical Problem-Solving Belief Scale", developed by Kloosterman and Stage (1992). This scale includes several beliefs, including the belief that you can solve math problems which take time, the effort required to solve them, etc. Research results by Yorulmaz and colleagues (2021) indicate that teachers' beliefs about solving math problems were average.

From the abovementioned studies, it might be implied that there are some factors that have not yet been included, for example, teachers' beliefs about national mathematical programs/syllabi (cf. Handal, 2003), which could influence teachers' decisions to use problem-solving during math lessons. For example, the Slovenian mathematics curriculum for primary schools (Učni načrt, 2011) considers problem-solving an essential aspect of teaching and learning mathematics. Therefore, teachers are required to deal with problem-solving in their classrooms, and math problem solving is part of their regular classes. However, it is not clear what the attitudes of Slovenian primary school teachers are towards solving mathematics problems.

The purpose of this research is to answer the question above. We wish to further deepen teachers' beliefs about the feasibility of the contents of the national mathematics curriculum in Slovenian primary schools, thus expanding the available literature on the subject. Addressing this question is urgent, since a negative teacher's attitude toward problem-solving might lead teachers to avoid using it in their regular mathematics classes, thus limiting students' development of problem-solving skills.

## Empirical Work

### Aims of the research

With the present research, we wished to understand teachers' attitudes towards problem-solving in mathematics, thus we aimed to understand their attitudes towards (1) knowledge, (2) problem-solving in mathematics, and (3) the effective possibility to realize the problem-solving related objectives in the Slovenian national program of mathematics. In particular, our research questions are the following:

RQ1: What do mathematics teachers think about the importance of problem-solving in the Slovenian program of mathematics and its implementation in the teaching practice?

RQ2: What are the teachers' opinions about the usage of mathematical problems in the various phases of the mathematical lesson?

RQ3: What are the teachers' opinions about the effects that using mathematical problems has on students?

RQ4: Which are the conditions that need to be fulfilled for an effective solving of mathematical problems?

## METHOD

In the present research, the descriptive quantitative non-experimental research method was used.

**Sample**

In the present research, a convenience sample of 312 primary school teachers was considered. Participants were included in the research after having completed specific courses offered by the *Zavod Republike Slovenije za Šolstvo*. The sample is composed of teachers from different Slovenian regions (Coastal-Karst, Gorizia, Upper Carniola, Central Slovenia, Drava, Savinja), teaching in grades 1 to 5. In the sample, teachers of different ages, working experiences, and instruction were included.

There were 84 (26.9%) teachers from the 1st grade of schooling, 56 (17.9%) teachers from the 2nd grade of schooling, 63 (20.2%) teachers from the 3rd year of schooling, 54 (17.3%) teachers from the 4th grade and 55 (17.6%) teachers from the 5th year of schooling. The number of teachers involved in the study represents 5% of the whole population of teachers (SURS, 2014), thus representing a good sample (cf. Krejcie & Morgan, 1970).

There were 311 (99.7%) female teachers, while only one (.3%) teacher was male. The distribution of teachers between genders is considered similar to the distribution in the entire teacher population (see SURS, 2014).

Among teachers in the sample, 209 (66.8%) had a university education, 97 (31.1%) had a higher non-university education, 5 (1.6%) had a master's or doctorate degree, while only 1 (.3%) teacher had a secondary school education.

In Table 1, we present the frequencies and percentage frequencies of teachers with different years of service. The modal class of years of service is "More than 20 years" ($n$=149; 47.9%).

Table 1
Teachers' years of service

| Years of service | *f* | *f*% |
|---|---|---|
| Less than 5 years | 35 | 11.2 |
| From 5 to 10 years | 34 | 10.9 |
| From 11 to 20 years | 93 | 29.8 |
| More than 20 years | 149 | 47.9 |

**Instrument**

To measure teachers' attitudes towards mathematics problem-solving and answer our research questions, we developed a questionnaire. It is composed of closed-type questions, with which we gathered data about teachers' (1) classes, (2) levels of education, (3) years of service, and (4) gender. The core of the questionnaire is a 17-items instrument, which was created to measure teachers' opinions about students' mathematical knowledge and their attitudes towards problem-solving in mathematics. The questions were created to measure four constructs:

- the importance of mathematics problems in the Slovenian mathematical program and their implementation in the teaching practice;

- the usage of mathematical problems in different lesson phases;
- the effects of using problem-solving for the students;
- the conditions needed to solve problems in mathematics.

Participants in the study indicated the level to which they agreed with the statements on the scale from 1 ("Completely disagree") to 5 ("Completely agree").

The validity of the instrument was checked with the factor analysis (Strauss & Smith, 2009). Initially, the factorability of the 17 items was examined. The Kaiser-Meyer-Olkinov (*KMO*) measure of sampling adequacy was very good, with a total *KMO*=.849 (Hadi et al., 2016). The Bartlett's test of sphericity was significant ($\chi^2(136) = 1528.414$; $p<.001$). These two factors indicate that the factor analysis was deemed suitable for all 17 items of the questionnaire.

The factor analysis extracted four factors, which explained a total of 56.13% of the variance. In Table 2, we present the eigenvalues, the percentage of explained variance, and the cumulative percentage of the explained variance.

Solutions for the components were examined using the varimax rotation of the factor loading matrix. The factor loading matrix for this final solution is presented in Table 3 (only loading greater or equal to .300 are shown; Thurstone, 1947).

The first factor is related to the importance of solving problems in mathematics classes and achieving the goals of the Slovenian program of mathematics. The second factor is related to the usefulness of solving mathematical problems in all the phases of the learning process. The third factor is related to the consequences of solving mathematical problems for students. The fourth factor is related to the conditions needed to solve problems in mathematics.

Table 2
Eigenvalues, percentage of explained variance, and cumulative percentage of explained variance

| Factor | Initial eigenvalues | | |
|---|---|---|---|
| | Eigenvalue | % of explained variance | Cumulative % |
| 1 | 5.194 | 30.55 | 30.55 |
| 2 | 1.815 | 10.68 | 41.23 |
| 3 | 1.418 | 8.34 | 49.57 |
| 4 | 1.116 | 6.57 | 56.13 |
| 5 | 0.912 | 5.36 | 61.50 |
| 6 | 0.833 | 4.90 | 66.40 |
| 7 | 0.750 | 4.41 | 70.81 |
| 8 | 0.699 | 4.11 | 74.92 |
| 9 | 0.654 | 3.85 | 78.77 |
| 10 | 0.598 | 3.52 | 82.28 |
| 11 | 0.549 | 3.23 | 85.51 |
| 12 | 0.522 | 3.07 | 88.58 |
| 13 | 0.448 | 2.63 | 91.21 |
| 14 | 0.419 | 2.47 | 93.68 |
| 15 | 0.385 | 2.27 | 95.94 |
| 16 | 0.373 | 2.19 | 98.14 |
| 17 | 0.317 | 1.86 | 100.00 |

With these items, we wanted to encompass the four dimensions involved in the solving of mathematical problems in teaching practice: (1) the importance of problem-solving in the Slovenian program of mathematics and their implementation in the teaching practice, (2) the usage of mathematical problems in the various phases of mathematical lessons, (3) the effects of using mathematical problems on students, and (4) the conditions that need to be fulfilled for an effective solving of mathematical problems. The factor analysis confirmed these four factors.

The first factor explains 30.55% of the variance (cf. Abdi & Williams, 2010). The second factor explains 10.68% of the variance, the third explains 8.34% of it and the fourth factor explains 6.57% of the variance. The four factors explain 56.13% of the variance, which is more than the commonly recommended 50% (Beavers et al., 2013). Therefore, considering the abovementioned results, the instrument is considered to be valid.

The reliability of the instrument was checked by using the Cronbach's alpha coefficient and it was found that the instrument has very good reliability ($\alpha$=.826; cf. Gliem & Gliem, 2003).

The objectivity of the instrument was guaranteed, since closed-type questions were used. In the phase of data collection, clear indications were provided.

Table 3
Factor loading matrix with the varimax rotation

| Variable | Factor | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 12. The objectives of the Slovenian program of mathematics regarding problem-solving are important. | 0.754 | | | |
| 10. It is necessary to include problem-solving in mathematics lessons. | 0.728 | | | |
| 11. The objectives of the Slovenian program of mathematics regarding problem-solving are feasible. | 0.727 | | | |
| 15. Through problem-solving, students gain a deeper, higher quality, and more connected knowledge. | 0.693 | | | |
| 17. Problem-solving is an important objective of mathematics classes. | 0.680 | | | |
| 9. Solving mathematical problems leads to new knowledge and abilities which can be used by students in different situations. | 0.676 | | | |
| 16. I teach students strategies (different ways) for solving mathematical problems. | 0.572 | 0.359 | | |
| 14. In teaching mathematics, I look towards and experiment more efficient ways of teaching it. | 0.521 | 0.402 | | |
| 6. I teach students who are able to solve mathematical problems. | 0.459 | | | |
| 2. Students gain new mathematical knowledge by solving mathematical problems. | | 0.800 | | |
| 1. Students strengthen their knowledge by solving mathematical problems. | | 0.716 | | |
| 3. Solving mathematical problems is an efficient method for testing students' prior knowledge. | | 0.567 | 0.415 | |
| 4. Mathematical problems evoke in the individual the need to solve them. | | | 0.766 | |
| 5. The knowledge acquired by solving problems is permanent. | | | 0.715 | |
| 13. Solving mathematical problems enhances their attitude towards mathematics. | 0.399 | | 0.597 | |
| 7. Students need to gain basic mathematical knowledge in order to solve mathematical problems. | | | | 0.871 |
| 8. A deep mathematical knowledge is needed for an efficient solution of mathematical problems. | | | | 0.858 |

**Procedure**

The data were collected through a questionnaire. Before solving the questionnaire, teachers received written instructions. Participants were the teachers teaching in the first two instructional periods who collaborated in seminars organized by the Slovenian Institute of Schooling (*Zavod Republike Slovenije za Šolstvo, ZRSŠ*). The data were collected in June and July 2019.

**Data analysis**

The data were analyzed using the SPSS statistical program. Once the instrument was validated through Principal Component Analysis (*PCA*) and the reliability was calculated through the Cronbach's alpha coefficient, the data were analyzed with the aid of descriptive statistics. In particular, we computed the means, standard deviations, minimums, and maximums of singular items of the instrument and singular constructs, identified through the *PCA*. The means between 3 and 4 indicate that teachers somewhat agree with the statement, while the means greater than 4 indicate a strong agreement with the statement and they would be interpreted as teachers giving more importance to the statement.

**FINDINGS**

The analysis of teachers' attitudes towards problem-solving in mathematics clarifies their opinions about students' knowledge and the importance and feasibility of the problem-solving-related goals in the Slovenian program of mathematics. In Table 4, we present the means, standard deviations, minimums, and maximums of the answers to the questionnaire.

Teachers believe that problem-solving is an important goal in the mathematics classroom ($M$=4.25; $SD$=.66) and that it is useful to strengthen students' knowledge ($M$=4.21; $SD$=.68). It enables the transfer, which means that students learn abilities that can be used in new situations ($M$=4.13; $SD$=.69). Moreover, through problem-solving, students have a deeper and connected knowledge ($M$=4.08; $SD$=.66). The teachers also believe that the aims of the Slovenian program of mathematics related to the problem-solving are important ($M$=4.15; $SD$=.60) and that it is necessary to include problem-solving in regular mathematics classrooms ($M$=4.12; $SD$=.71) with adequate strategies ($M$=4.16; $SD$=.72) and effective teaching methods ($M$=4.12; $SD$=.64).

Considering the four constructs, Table 5 presents the means, standard deviations, maximums, and minimums. As we might notice, teachers evaluated the importance of solving mathematical problems as the highest ($M$=4.08; $SD$=.46), followed by the usage of mathematical problems ($M$=3.90; $SD$=.57), the effects of using mathematical problems on students ($M$=3.73; $SD$=.64), and lastly, the conditions to solve mathematical problems ($M$=3.72; $SD$=.77).

Table 4
Descriptive statistics of the answers to the questionnaire

| Item | | *M* | *SD* | *min* | *max* |
|---|---|---|---|---|---|
| 1. | Students strengthen their knowledge by solving mathematical problems. | 4.21 | 0.68 | 2 | 5 |
| 2. | Students gain new mathematical knowledge by solving mathematical problems. | 3.91 | 0.72 | 2 | 5 |
| 3. | Solving mathematical problems is an efficient method of testing students' prior knowledge. | 3.58 | 0.85 | 1 | 5 |
| 4. | Mathematical problems evoke in the individual the need to solve them. | 3.51 | 0.88 | 1 | 5 |
| 5. | The knowledge acquired by solving problems is permanent. | 3.85 | 0.85 | 1 | 5 |
| 6. | I teach students who are able to solve mathematical problems. | 3.85 | 0.72 | 1 | 5 |
| 7. | Students need to gain basic mathematical knowledge in order to solve mathematical problems. | 3.91 | 0.91 | 1 | 5 |
| 8. | A deep mathematical knowledge is needed for an efficient solution of mathematical problems. | 3.52 | 0.84 | 1 | 5 |
| 9. | Solving mathematical problems leads to new knowledge and abilities which can be used by students in different situations. | 4.13 | 0.69 | 1 | 5 |
| 10. | It is necessary to include problem-solving in mathematics lessons. | 4.12 | 0.71 | 1 | 5 |
| 11. | The objectives of the Slovenian program of mathematics regarding problem-solving are feasible. | 3.98 | 0.64 | 2 | 5 |
| 12. | The objectives of the Slovenian program of mathematics regarding problem-solving are important. | 4.15 | 0.60 | 2 | 5 |
| 13. | Solving mathematical problems enhances their attitude towards mathematics. | 3.51 | 0.84 | 1 | 5 |
| 14. | In teaching mathematics, I look towards and experiment more efficient ways of teaching it. | 4.02 | 0.64 | 2 | 5 |
| 15. | Through problem-solving, students gain a deeper, higher quality, and more connected knowledge. | 4.08 | 0.66 | 2 | 5 |
| 16. | I teach students strategies (different ways) for solving mathematical problems. | 4.16 | 0.72 | 2 | 5 |
| 17. | Problem-solving is an important objective of mathematics classes. | 4.25 | 0.66 | 3 | 5 |

Table 5
Descriptive statistics of the four constructs.

| Construct | *M* | *SD* | *min* | *max* |
|---|---|---|---|---|
| The importance of problem-solving in the Slovenian program of mathematics and its implementation in the teaching practice. | 4.08 | 0.46 | 2.33 | 5.00 |
| The usage of mathematical problems in the various phases of mathematics lessons. | 3.90 | 0.57 | 1.67 | 5.00 |
| The effects of using mathematical problems on students. | 3.73 | 0.64 | 1.33 | 5.00 |
| The conditions that need to be fulfilled for an effective solving of mathematical problems. | 3.72 | 0.77 | 1.00 | 5.00 |

## DISCUSSION AND CONCLUSIONS

Problem-solving in mathematics is a key element (Sari et al., 2019; Tambychik & Meerah, 2010), necessary to solve everyday problems (Phonapichat et al., 2014; Saputro et al., 2018) and to cope with new and unknown situations (Freitag, 2014). However, research has shown that teachers face several problems as they face and fear them (Chirinda & Barmby, 2018; Khoshaim, 2020). Since teachers' attitudes toward problem-solving may influence students' beliefs about it (Yorulmaz et al., 2021), it is important to thoroughly investigate teachers' attitudes toward the use of problem-solving during normal math lessons and what are, in their opinion, the benefits of using it.

In the literature, we may encounter some qualitative studies which aim to explore teachers' views on problem-solving in mathematics (Chirinda & Barmby, 2018; Harisman et al., 2019), as well as some quantitative approaches to answering the questions regarding the aforementioned problem (Deringöl, 2018; Yorulmaz et al., 2021). However, current literature on teachers' attitudes to problem-solving is still sparse, particularly regarding teachers' views on the feasibility of problem-solving goals of national primary school mathematics programs.

With the present research, we wanted to explore teachers' attitudes towards problem-solving in elementary school math classrooms. Our first research question was about teachers' views on problem-solving and its implementation in teaching practice. The teachers involved in our study confirmed the ideas already presented in the international literature on the importance of including problem-solving in mathematics classrooms (Marchiş, 2013; Tambychik & Meerah, 2010). The teachers believed that students were able to solve mathematical problems, so their beliefs about their students' abilities were positive, which is an important fact in teaching mathematics (cf. Stipek et al., 2001). The participants also recognized that solving mathematical problems leads to new knowledge and skills, which can then be used by students in different situations, not only related to mathematics, thus confirming the ideas presented by different researchers (Freitag, 2014; Phonapichat et al., 2014; Saputro et al., 2018). The teachers believe that it is necessary to include problem-solving tasks in normal math lessons and that this type of homework improves students' attitudes towards math. This means that problem-solving could help motivate students to learn mathematics, not only because the problems students encounter could be drawn from real-life situations (cf. McCormick et al., 2015). Considering the problem-solving objectives of the Slovenian national mathematics program for primary schools (Učni načrt, 2011), the teachers in our sample stated that they are important and feasible. Teachers therefore believe that it is possible to achieve the objectives of the national program: they are not impossible to achieve. Teachers also claimed to teach students various strategies for coping with problem-solving tasks and to experiment with different teaching methods to provide these strategies to students. The exploration of these different ways used by teachers was outside the scope of this work, however, further qualitative research could investigate these methods further in order to provide a clearer picture of how teachers deal with these types of problems.

Our second research question reviewed teachers' views on the use of mathematical problems in the various phases of mathematics lessons. The results show that teachers believe that solving math problems is useful (1) for testing students' prior knowledge on a mathematical topic, (2) for gaining new knowledge, and (3) for strengthening their knowledge after learning new topics. Therefore, tackling problem-solving tasks in mathematics lessons is not a mere presentation of some examples of the application of the topics studied (see Chirinda & Barmby, 2018), but it is rather a process that should be present in all stages of learning mathematics.

The third research question aimed to explore teachers' views on the effects that the use of mathematical problems has on students. Teachers believe that through problem-solving students gain deeper, higher quality, and connected knowledge. This means that students not only memorize formulas and procedures, but think critically about situations (McCormick et al., 2015; Saputro et al., 2018). Therefore, in the opinion of the participants in our study, the knowledge that students acquire is permanent. Furthermore, tackling a mathematical problem stimulates students' need to solve it.

Our fourth and final research question was about the conditions to be met in order to effectively solve a mathematical problem. Firstly, the teachers identified students' basic mathematical knowledge as the key element to effectively solving a mathematical problem: without adequate initial knowledge, it is unlikely that they will solve a task correctly. A little less important is deeper mathematical knowledge. Therefore, the teachers believe that basic math skills and knowledge are more important than deeper and more advanced knowledge. This result deserves a broader discussion. More precisely, based on this result, we could speculate on the fact that since teachers believe that basic knowledge of mathematics is required (and it is enough) to solve problems in mathematics, therefore "accessible" to all students, the teachers may be more inclined to propose problem-solving exercises during their lessons.

While having developed a good reliability questionnaire ($\alpha$ = .826), the present research is not without limitations. As an obvious limitation, the results are based solely on the responses of the participants. Future studies could implement our quantitative approach with a qualitative one, in order to observe how the opinions reported are implemented by teachers in their classrooms. Further research is also needed to compare the teachers' attitudes toward problem-solving with those of their students'.

Overall, the present research has shown that teachers have a positive attitude toward problem-solving in math classrooms. This has important implications for teaching as well. Teachers who have a more positive attitude towards problem-solving may be more inclined to use it in their lessons. In particular, teachers recognize that the mathematics problem-solving goals in the national curriculum are feasible and achievable. Therefore, educators may be more inclined to use problem-solving in their mathematics lessons than their colleagues from other countries, who might find problem-solving goals too difficult to achieve at a certain age or school level. Problem-solving, however, is not seen only as a one-off tool, but represents for the teachers included in this study a method that is used throughout the lesson, from assessing students' knowledge before tackling a new topic, to strengthening the mathematical knowledge of their students.

Therefore, educators are encouraged to use problem-solving in various stages of mathematics learning.

Some future work may consider several other variables, such as teachers' attitudes towards mathematics, their mathematical skills, but also affective-motivational factors, such as their fear of solving mathematical problems (cf. Chirinda & Barmby, 2018; Deringöl, 2018; Harisman et al., 2019; Yorulmaz et al., 2021).

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