Integrating Realism in Mathematical Problem Solving: Insights from *Stand and Deliver*

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Abstract: Solving contextual math problems has been a central activity in mathematics education for decades, as they are believed to meet the requirements of being meaningful to students due to their contextual relevance and enable them to engage in deep learning characterized by the use of higher-order skills. Deep learning is activated when students are not provided with a clear computational procedure to follow, which is the case with some nonstandard word problems. Inspired by the movie Stand and Deliver, the paper focuses on using realistic considerations in solving math problems by presenting a modification of a word problem extracted from the movie and discussing didactical nuances of using realistic and open-ended approaches in mathematics. Moreover, the paper presents a study on pre-service primary teachers (N=54) focusing on using realistic considerations in solving a nonstandard word problem and their ratings of solutions to a similar word problem. The findings confirmed that most prospective teachers tend to disregard realistic considerations when solving math problems and prefer solutions that do not incorporate potential external real-life experiences.

Keywords: Mathematics education. Contextual problems. Realistic considerations.

INTRODUCTION

Problem-solving is a general teaching and learning method in mathematics education. It occurs when students are confronted by a mathematical problem for which they have no known solution (Chirinda, 2021; Schoenfeld, 2013). Specific problems in mathematics education are word problems designed to model real-life situations, enabling students to apply abstract mathematics in solving these problem situations. A word problem can be defined as a verbally described problem situation that the reader is somewhat familiar with, where one or more questions are posed. Answers to these questions can be found through applying mathematical operations to numerical data or logical deduction (Greer et al., 2002; Verschaffel et al., 2014). Several purposes of utilizing word problems within mathematics education have been stated in the literature (Verschaffel

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et al., 2000). Generally, solving word problems by students demonstrates that mathematics is not just about rote learning, but can also relate to real-life situations. Stressing the embodiment of mathematics in real-life situations may help students better understand the role and importance of mathematics in the world. Solving word problems also teaches students about mathematics as a language that can be used to translate a problem situation and subsequently manipulate data to solve the problem.

Word problems are considered one of the most challenging tasks in mathematics education (Tomková, 2012). Using challenging tasks in mathematics education accords with *Principles and Standards for School Mathematics* (NCTM, 2000, p. 52), particularly requiring teachers to provide students with "frequent opportunities to formulate, grapple with, and solve complex problems that involve a significant amount of effort." Solving complex problems is a reasonable requirement of the school curriculum, as solving complex problems is considered one of the essential skills for the 21st century (Gray, 2016). By solving complex problems, pupils may improve text comprehension, cognitive analysis, cognitive planning, computational procedures, and conceptual understanding (Uchida & Kawashima, 2008; Fuchs et al., 2015; Saridakis & Doukakis, 2020).

Contextual Problems in Mathematics Education

Effective teaching of mathematics requires using such content that students can relate to and find applicable in real-life situations (Posner et al., 1982). Therefore, the more realistic the situation described in a word problem is, the better it may serve for learning mathematics. However, incorporating a realistic approach to teaching mathematics isn't automatically straightforward (Sethole, 2004). The realistic approach is characterized by considering various factors in solving a contextual math problem; thus, the problem's solution is dependent on contextual factors taken into consideration during the problem-solving process.

The realistic approach contrasts with the traditional approach of solving contextual math problems, which is typical for mathematical modeling using only given data and denying any speculations regarding reality. However, to simulate the problem-solving process as it usually occurs in real life, students should be encouraged to consider many real-life aspects of the problem situation and to use various strategies in solving these problems. Contextual problems that offer more than one interpretation or whose solution can be altered based on considered aspects of the situation are called "problematic from a realistic point of view" (Verschaffel et al., 1997). Another term for these realistic problems is "ill-defined" problems, referring to solving problems in the real world where some information is missing (Costello, 2022). Realistic math problems refer to meaningful contextual situations and demand students to use their real-life knowledge together with applying mathematical principles and concepts. Additionally, considering multiple aspects

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requires students to use a deep level of thinking or higher-order thinking skills, which makes these problems more challenging than traditionally used closed problems that require an exact solving procedure from students (Vessonen et al., 2024). As a result, many positive effects of using realistic math problems in teaching mathematics have been identified, such as increased logical, critical, and creative thinking (Dhayanti et al., 2018; Ismunandar et al., 2020; Samura et al., 2022) and problem-solving skills (Nugraheni & Marsigit, 2021; Uyen et al., 2021).

To illustrate the difference between the traditional approach and realistic approach in solving word problems, let's consider the following math problem for primary school pupils: *A rope is used to fence a triangular area by drawing it around three distinct poles that are 7 ft, 10 ft, and 15 ft apart. What length of rope do we need to use?* (For more examples of realistic problems, see Verschaffel et al. (2000). Typically, pupils would solve the problem by creating a mathematical model of the situation, where the poles are modeled by the vertices of the triangle, and the lengths of the triangle's sides are added to find the triangle's perimeter of 32 feet. Although this solution seems correct, it would not be satisfactory in a real situation, as it assumes a rope that is not long enough to go around the poles while tying its ends. In contrast, a realistic solution to the question might be: "Because the lengths of the three sides add up to 32 feet, to tie the rope around the poles, we would need a rope longer than 32 feet." or "Depends on how many times we turn the rope around each pole and how thick each pole is." Such answers are referred to as realistic answers, realistic reactions, or solutions arrived at using realistic considerations.

Most of the studies on realistic math problems reported that students might tend to exclude realistic considerations when solving problems that are problematic from a real point of view (Verschaffel et al., 1994; Verschaffel et al., 1997; Inoue, 2005). The reason might be grounded in how math problems are usually solved and elaborated within a classroom (Greer, 1997). This is also due to traditional textbooks, which typically contain closed problems and do not encourage students to apply much of their real-life knowledge (Stigler et al., 1986; De Corte & Verschaffel, 1987; Schoenfeld, 1991; Tárraga-Mínguez et al., 2021; Kilienė, 2021). Fortunately, even if this tendency occurs, it can be mediated by implementing a proper teaching intervention (Verschaffel & De Corte, 1997; Renkl, 1999; Sepeng & Webb, 2012).

Along with the described realistic approach to solving word problems, realism in mathematical problem solving is present when solving word problems leads to multiple correct solutions regardless of the realistic considerations. This is explained by the fact that real-life problems can usually be solved in many ways. Math problems commonly having more than one correct answer are called "open-ended", although the term of open-endedness seems ambiguously defined by various authors (Bingölbali & Bingölbali, 2021). The opposites of these problems are closed math problems (also referred to as traditional problems) that are solved in only one way (Bahar & Maker, 2015). As closed math problems are those typically occurring in math textbooks, it is vital to have a strategy for transforming these problems into open-ended problems. One strategy

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is to provide students with less quantitative information in the problem. Let's illustrate this modification in the following example:

Original Closed Word Problem: *Cinderella was told by her stepmother to bake 11 pies. As she baked them, two of them got burned. How many edible pies can she serve to her stepmother?*

Modified Word Problem: *Cinderella was told by her stepmother to bake 11 pies. As she baked them, some of them got burned. How many edible pies can she serve to her stepmother?*

The original word problem asks students to solve it using the correct application of an arithmetic operation; in this case, subtracting 2 from 11. Solving such problems aims to teach students to interpret the situation and subtract one number from another mathematically. On the other hand, the modified version of the problem gives students some ambiguity. As they do not know the number of burned pies, they cannot answer the question using a straightforward arithmetic calculation. Exploring a solution to the modified problem necessitates a systematic approach, achievable through appropriate tools, such as tables. This encourages contemplation of more options and the relationship between two quantities, thereby contributing to the development of algebraic thinking (Russell et al., 2011).

The second strategy involves altering the question itself or employing additional questions to target various mathematical abilities of students. This implies that rather than simply asking students to solve a problem, a teacher might utilize different verbs that would change or enhance the richness of the task, such as asking students to explain, compare, prove, apply, construct, describe, and so on. Additionally, new questions may also focus on the actual aspects of the problem situation. Furthermore, metacognitive strategies, such as "What-If" questions, may be utilized to deepen inquiry (Payadnya et al., 2021).

Original closed word problem: *Cinderella was told by her stepmother to bake 11 pies. As she baked them, two of them got burned. How many edible pies can she serve to her stepmother?*

Modified word problem: *Cinderella was told by her stepmother to bake 11 pies. As she baked them, two of them got burned.*

- *a) How many edible pies can she serve to her stepmother?*
- *b) How many pies would she burn if she were told to make 22 pies? Explain your reasoning.*
- *c) How long would it take her to bake 11 pies if she can bake up to two loads at once?*
- *d) What do you think? Why does her stepmother need so many pies? How many people can she host if each guest should receive at least one-sixth of a pie?*

The third strategy is to provide students with the solution to the original problem and ask them to work towards the data that were initially stated but remain unknown for now.

Original Closed Word Problem: *Cinderella was told by her stepmother to bake 11 pies. As she*

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baked them, two of them got burned. How many edible pies can she serve to her stepmother?

Modified Word Problem: *Cinderella was told by her stepmother to bake some pies. As she baked them, some of them got burned. How many pies was she told to bake, and how many of them got burned if she served 9 edible pies to her stepmother?*

The modified problem does not provide students with all the numerical information. The intention is to enable them to work through the problem and discover multiple solutions or a general solution (the number of pies she was instructed to bake was at least 9, and the number that were burnt was 9 fewer). This method shares similarities with so-called "numberless word problems" or "problems without figures" (Gillan, 1909; Shaw, 1922; Williams & Gillian, 2018; Plank & Dyess, 2022).

Open-ended problems and a realistic approach to addressing these problems are the key ideas of this paper and should also serve as foundational elements in teaching school mathematics. The intersection of these approaches can be illustrated as two perpendicular axes (see Figure 1). The horizontal axis illustrates the degree of intellectual freedom afforded to students when tackling a problem. A closed problem anticipates one specific solution and a clear solving strategy. An open-ended problem allows students to employ a more systematic approach, which promises greater knowledge acquisition. For instance, adding two integers using column addition is a closed problem. In contrast, finding multiple ways to determine the sum of two given integers is an open-ended problem. Similarly, a word problem that requires finding the sum based on quantitative information about two parts is a closed problem, while a word problem that does not provide all the necessary information is considered an open-ended problem. The vertical axis pertains to the context of the problems and how students approach them. The realistic approach demands contexts that are meaningful to students and solving processes that consider real-life aspects of the situation. In contrast, the non-realistic approach involves problems that make little sense and do not typically occur in real life.

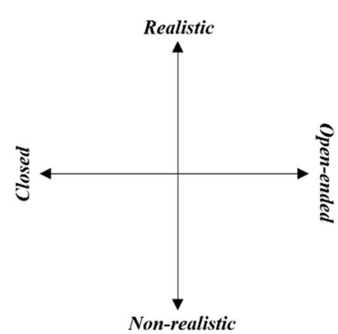

Figure 1. The overlap of realistic and open-ended pedagogy

Incorporating the realistic approach in solving math problems seems beneficial to students, as

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such problems resemble real problems and show the meaning of learning mathematics. Therefore, math instructors should adopt a teaching approach that supports taking real-life variables into account in solving problems, pose problems that cannot be solved straightforwardly, ask their students to devise alternative solutions, and incorporate using "What If" questions to extend the problem situations and activate higher-order thinking processes. Obviously, not all traditional word problems can be easily changed, such that having realistic considerations is an essential part of the solving process. From the previous studies on realistic reactions among students (a few of them described in Verschaffel et al., 2000), it can be assumed that word problems requiring realistic considerations are those that do not post numerical information in such a way that a simple calculation yields the correct answer or that somehow contradicts with a traditional way of thinking about solving math problems. For example, these problems require students' knowledge about out-of-school areas, contradict students' stereotypes about the presence of proportionality in all situations, demand students to check their results within the context, and challenge students to work on projects. Besides that, the realistic approach assumes that numerical information in designed problems reflects reality (Fatmanissa & Qomaria, 2021).

The present study aims to illustrate an example of transforming a seemingly closed problem into an open-ended one by considering realistic elements of the situation. The source of the problem is a scene from the film "Stand and Deliver," which serves as inspiration. To complement scientific research conducted in the realm of the realistic approach to solving mathematical problems (for example, Greer, 1993; Reusser & Stebler, 1997; Verschaffel et al., 2000; Bonotto, 2010; Dewolf et al., 2013; Van Dooren et al., 2019), an additional inquiry involving pre-service primary teachers was conducted, aimed at analyzing their preferred approach to solving a realistic mathematical problem and their preferences in evaluating students' solutions.

METHOD

The aim of this paper is to provide an example of how to modify a mathematical word problem into a more realistic one by considering additional factors that were not initially included in the original problem. The original contextual problem was extracted from the film "Stand and Deliver." This biographical film follows Jaime Escalante, a teacher who immigrated to the United States, was employed by a high school in Los Angeles, and chose to teach algebra and calculus to underperforming Latino students, preparing them for college studies. To motivate his students, Jaime's teaching approach consisted of using real-life examples and humor to build a relationship with them. In addition to modifying the problem by using a realistic approach, the study aims to investigate the use of realistic considerations among preservice primary teachers in solving a similar word problem that is problematic from a real point of view, as well as their attitudes towards students' solutions to a similar problem.

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Original Problem and Realistic Approach

Original problem: *Juan has 5-times as many girlfriends as Pedro. Carlos has one girlfriend less than Pedro. If their total number of girlfriends is 20, how many does each gigolo have?*

If translated into mathematical language, the word problem leads to solving a linear equation in a single variable. One notable aspect is the atypical context of the problem. It can be concluded that the context was designed to connect with students' experiences and provide entertainment in the classroom, as doing so generally increases students' motivation (Papanastasiou & Bottiger, 2004; Skinner & Pitzer, 2012). Given that most of the students in the movie were low-attaining, addressing such a realistic problem can enhance their learning (Barnes, 2005).

The idea to modify the math problem originated in the movie itself, as one of the characters notes, "You can't solve it unless you know how many girlfriends they have in common". That notion is not accurately true, as the problem can be solved using a traditional way of doing math as follows: Let's introduce variable x for a number of Pedro's girlfriends. Then, from the word problem, the following equation can be built: $5x+x+(x\text{-}1)=20$. Performing equivalent operations leads us to the conclusion that x equals 3, meaning that Pedro has three girlfriends, Juan has fifteen, and Carlos has two.

As the suggested modification concerns a socially controversial context, the problem may not be educationally appealing. Conversely, monogamy is a socially constructed concept that is not practiced in all societies around the globe. Therefore, discussing a scenario in which a girl has more than one partner may not only expand the math problem but also incorporate a social study topic.

The Realistic Solution to the Problem

Let us consider the case of intersecting sets. As there are three male individuals, their girlfriends can be divided into three sets. If two or three male partners share the same girlfriend, those sets must intersect. Thus, determining the number of common girlfriends requires examining the intersection of sets. The following Venn diagram illustrates three sets with potentially non-empty intersections, where J represents Juan, P represents Pedro, and C represents Carlos (see Figure *2*).

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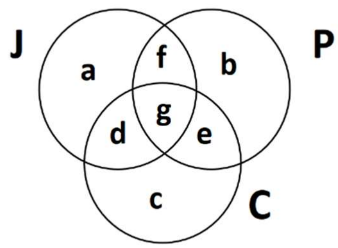

Figure 2. Venn diagram of Juan's, Pedro's, and Carlos's girlfriends

Assuming variables a, b, c, d, e, f, g, visualized in Figure 1 and the earlier described problem, we get the following four equations:

$$a+d+f+g=5x \quad (1)$$

$$b+e+f+g=x \quad (2)$$

$$c+d+e+g=x-1 \quad (3)$$

$$a+b+c+d+e+f+g=20 \quad (4)$$

To discover quantitative relationships between individual subsets, we will solve the first three listed equations for the variables a, b, and c (respectively) and substitute them into the last listed equation. Then we get:

$$a+b+c+d+e+f+g=20$$

$$(5x-d-f-g)+(x-e-f-g)+(x-1-d-e-g)+d+e+f+g=20$$

$$7x-d-e-f-2g=21$$

$$d+e+f+2g=7x-21$$

As 2g is a non-negative number, we obtain the following inequality:

$$7x-21=d+e+f+2g \geq d+e+f+g,$$

which implies further

$$7x \geq 21+d+e+f+g.$$

Because $d+e+f+g$ stands for the number of girlfriends (a non-negative number) who see more than one partner, x must be greater than or equal to 3. In the next step, we shall gradually elaborate on possible alternatives.

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- If x=3, then we get $21 \geq 21+d+e+f+g$, which implies that no girlfriends can be in common. That leaves us with solution (J,P,C)=(15,3,2).
- If x=4, then we get $24 \geq 21+d+e+f+g$, which means that there are utmost 3 girls who see more than one partner. To find out more, let's substitute x=4 in equations (1), (2), and (3). Then, we get the following system of linear equations:

$$a+d+f+g=20 \qquad (5)$$

$$b+e+f+g=4 \qquad (6)$$

$$c+d+e+g=3 \qquad (7)$$

Because the number of all girlfriends is 20, from (5), we can deduce: $b=c=e=0$. Then, from (6) and (7), we get: $f+g=4$ and $d+g=3$, where the values d, f, g, and a can be found by simple experimentation (see Table 1).

	f	g	d	a
Case 1	4	0	3	13
Case 2	3	1	2	14
Case 3	2	2	1	15
Case 4	1	3	0	16
Case 5	0	4	-1	17

Table 1. Solution of the given problem when x=4

As d cannot be a negative number, there are four available solutions for x=4. However, this results in one solution based on the number of girlfriends each gigolo is supposed to have: (J,P,C)=(20,4,3).

- If $x \geq 5$, we deduce from (1) that Juan has more than or exactly 25 girlfriends, which contradicts the information that there are 20 girlfriends altogether.

Addressing problems that involve the intersection of sets can be challenging for students (Manurung et al., 2017). Although pupils formally study the intersection and union of sets during secondary education, they may become informally acquainted with these concepts even before starting elementary school (Šimčíková & Tomková, 2012). The difficulties associated with problems involving the intersection of sets can be mitigated when students engage with them through various activities and tasks. A real-world context that students are familiar with can also encourage them to be more receptive when tackling such problems.

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The Study of Using Realistic Considerations Among Pre-service Primary Teachers

To provide more than just a pedagogical approach to using word problems that require realistic considerations in mathematics education, this paper presents an inquiry into how pre-service primary school teachers engage with a realistic word problem. Furthermore, the study aims to evaluate how these teachers in training assess three potential solutions to a similar word problem (see Table 2). The discussed "gigolo problem" focused on the possible intersection of three sets. To ensure consistency, the following word problem was solved by the participants:

> Carl has 5 friends, and Georges has 6 friends. Carl and Georges decide to have a party together. They invite all their friends. All their friends are present. How many friends are there at the party?

This problem and its modification have been previously utilised in numerous other studies on the realistic approach to mathematics education (Reusser & Stebler, 1997; Verschaffel et al., 1997; Yoshida et al., 1997; Verschaffel & De Corte, 1997; Tarim & Öktem, 2014; Aksoy et al., 2015; Kılıç & Şahinkaya, 2022).

The second task for the participants was to rate three potential solutions to a modified problem. The modification was done by changing the names of individuals from the problem and the number of their friends. Participants were asked to comment and rate these solutions on a scale of 1-7 (a greater number means a better rating).

Potential solution 1	Carl's number of friends and George's number of friends are added together to find out the total number of friends at the party.
Potential solution 2	As in "Potential solution 1", but including two more friends (Carl and George).
Potential solution 3	Carl and George are friends as well, and they may have some common friends.

Table 2. Potential solutions to the problem presented to participants

The study was conducted on 54 participants (53 females and 1 male, the average age being 34.3 years). The sample was skewed due to the consistent prevalence of women teachers in Slovakia. Therefore, the gender distribution of the sample reflects the gender distribution of primary teachers in Slovakia. About 75% of the participants had a professional working experience in education; however, none as a schoolteacher.

The word problem and the potential solutions were shared among participants in digital form through an online platform survey. Participants recorded their solutions and were offered the opportunity to provide a supporting comment. Following the collection of data, coding was conducted on an ad hoc basis.

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RESULTS

The responses of the pre-service teachers encompassed three main approaches to understanding the problem (see Table 3). Some solutions featured a numerical error. For the purposes of the study, all responses that were substantiated and could be attributed to a specific solving strategy were included. Three responses were excluded as no solving strategy was discerned.

	Strategy description	All answers	Realistic answers
S1	Carl has 5 friends; George has 6 friends. Therefore, the situation involves two groups of people: Carl's group (6 friends) and George's group (7 friends). Then, the total number of friends is 13.	30	6
S2	Carl has 5 friends; George has 6 friends. If these two groups of friends are added together, the total number of friends is 11 (excluding Carl and George).	27	7
S3	Carl has 5 friends; George has 6 friends. Apparently, Carl and George are friends. Therefore, there is Carl, his 4 other friends, George, and his 5 other friends at the party. The total number of friends is 11.	4	0

Table 3. Pre-service teachers‘ solving strategies

Realistic answers were those that indicated the possibility of more than one correct solution or questioned the clarity of the problem's formulation. This approach was similar to that of Aksoy et al. (2015), who considered the realistic answer to be the one asserting that it is impossible to know the exact number of friends. Consequently, the total percentage of realistic reactions was 24%. Apparently, the majority of answers did not consider the possibility of Carl and George having common friends. Also, participants preferred to work arithmetically only with the given quantitative information without contemplating other possible situations.

The rating of three potential solution strategies revealed different preferences among participants (see Figure 3).

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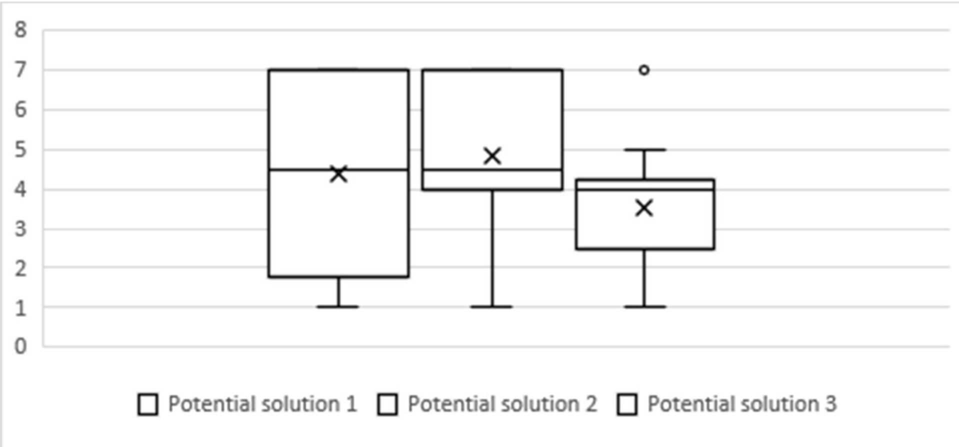

Figure 3. Boxplot illustrating participants' ratings of three different solutions.

The potential solution 1 (see Table 2), which corresponds with the participants' strategy 2 (see Table 3), earned an average score of 4.59 (SD=2.23, N=54, Mdn=5, Mode=7). The potential solution 2 (see Table 2), which corresponds with the most frequently used participants' strategy 1 (see Table 3), earned an average score of 4.98 (SD=2, N=54, Mdn=5, Mode=7). The potential solution 3 (see Table 2), which involved a subjective but realistic approach, earned an average score of 3.78 (SD=2.02, N=54, Mdn=4, Mode=3).

For a more detailed statistical analysis, the data sets representing ratings of three potential solutions were tested for normality using the Shapiro-Wilk test. The results did not show normality among these data sets (PS1: W=.85383, p=.00001; PS2: W=.84628, p=.00001; PS3: W=.89884, p=.00026). Based on the normality test results, the Wilcoxon Matched-Pairs Signed-Rank Test was conducted to compare the ratings of three potential solutions (PS1 vs. PS2, PS1 vs. PS3, PS2 vs. PS3). The results are summarized in the following table (see Table 4).

Variables	Test Statistic (T)	Z-Score	p-Value	Interpretation
PS2 PS3	146.0000	3.256	0.0011	Statistically significant difference; ratings between solutions are meaningfully different. The effect size seems strong.
PS1 PS3	197.0000	2.137	0.0326	Statistically significant difference; participants rated the solutions differently. The effect size seems moderately strong.
PS1 PS2	306.0000	0.935	0.3496	There is no statistically significant difference; ratings appear similar between solutions.

Table 4. The results of the Wilcoxon test of potential solutions

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The collected data and tests conducted revealed that pre-service teachers ranked the proposed potential solutions differently. Differences were discovered between potential strategy 1 and potential strategy 3, as well as between potential strategy 2 and potential strategy 3. This indicates that pre-service teachers did not value the strategy involving real-life aspects as much as the strategies that relied solely on the word problem statement. This is supported by the comments accompanying the rating of potential strategy 3. Further qualitative analysis of these comments demonstrated that nearly 40% of participants asserted that the word problem statement does not provide information about whether there are any mutual friends; consequently, they deemed the solution incorrect. This suggests a rigidity in how pre-service teachers view word problems, specifically regarding the information presented in the problem statement versus that which stems from external sources, such as real-life experiences.

DISCUSSION AND CONCLUSION

The study aimed to highlight the phenomenon of realism in solving word problems. According to the Principles and Standards for School Mathematics (NCTM, 2000, 14-15), the mathematics curriculum should focus on mathematics "that will prepare students for continued study and for solving problems in a variety of school, home, and work settings." This inevitably includes solving problems based on reality and students' experiences.

Previous studies have shown that mathematics education often neglects to consider real factors that may impact the solutions to word problems, which are set in specific situations (Verschaffel et al., 2000). The way mathematical abilities and perceptions of the relevance of mathematics to life are shaped is strongly influenced by teachers. This paper examined how pre-service teachers approach a word problem that allows for multiple solutions depending on the solver's approach, particularly how they interpret the problem in relation to reality. Furthermore, the study aimed to investigate how pre-service teachers assessed three different potential solutions to a similar problem. The word problem utilized in the study had been previously employed in other research concerning realistic considerations in solving word problems. Within the context of elementary and early secondary education, 10-20% of students were able to solve this problem using realistic considerations (Verschaffel et al., 1994; Yoshida et al., 1997; Koay & Foong, 1997; Reusser & Stebler, 1997; Renkl, 1997). Aksoy et al. (2015) conducted a study involving the same problem with prospective primary school teachers, revealing that approximately 30% provided realistic answers. Consequently, the results of the present study align with the earlier findings. The ratings of three potential solutions to a similar word problem indicated that pre-service teachers favor solutions that closely align with the problem statement. In other words, a solution that demonstrated an understanding of the situation based on real-life experience received a lower rating than those that adhered strictly to the information stated by the word problem. These results confirmed the earlier findings, revealing that teachers prefer the conventional approach to

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word problems, which also reflects their low appreciation for realistic reactions from students (Verschaffel et al., 1997). Simultaneously, teachers' appreciation for students' realistic reactions seems to be influenced by the training they receive (Xu, 2005; Chen et al., 2011). Therefore, educators should receive sufficient training to enhance their ability to recognise non-standard problems and to appreciate and promote realistic considerations in students (Ho & Hedberg, 2005; Bonotto, 2010). Specifically, teacher development programs should employ a greater number of non-standard problems, and problems leading to multiple solutions – divergent problems. A great emphasis should also be placed on solving methods, particularly working with various graphical representations of the problems. If the problem involves the intersection of sets, as described in the examples provided earlier, teachers could instruct their students on the Venn diagram or other strategies for tackling similar mathematical problems (Prídavková, 2021).

The study was inspired by the movie Stand and Deliver, in which the mathematics teacher does not take into account the realistic considerations of one of his students (not intended to undermine the quality and educational value of the movie – author's comment). Aside from the presented math problem, the movie Stand and Deliver features scenes where fractions are illustrated by cutting an apple, multiplication by 9 is demonstrated using fingers, negative numbers are linked to digging a hole, and other inspirational math scenes. In addition to the mathematical scenes, the movie offers an important commentary on math as an equalizer, a means to combat poverty and racism. Among cinematographic works, several more movies depicting mathematics or inspired by mathematicians have been made, such as A Beautiful Mind, Good Will Hunting, Hidden Figures, The Simpsons, and many others (Polster & Ross, 2012; Knill, 2025). The advantages of employing movies for mathematics education have been recognized for decades (Ficken, 1958), as movies can enhance mathematics education at various levels and serve both mathematical and didactical purposes (NCSCT, 1967). An example of a movie particularly aimed at educating the audience on mathematics is "Donald in Mathmagic Land," created by Walt Disney Productions, which introduces mathematical concepts to children. Another example is the educational series "The Forest Five," produced by Fool Moon, which features episodes designed to teach the youngest viewers various subjects across the curriculum, including mathematics. Movies featuring mathematics serve as dynamic representations that illustrate mathematical concepts or show actors engaging with math. Moreover, scenes from these movies can inspire educators to base their lessons on them. Students can enhance their mathematical understanding by observing how math problems are solved or by watching short movies on specific mathematical concepts (Fahlberg et al., 2007).

Another way of using movies in teaching mathematics is to design math lessons centered around movie scenes that are not explicitly mathematical. Russo & Russo (2020) developed lessons featuring tasks on proportional reasoning based on movie scenes. The findings indicated that students found these lessons enjoyable, leading to learning, and mathematically challenging. This approach to using movies embodies inquiry-based or project-based learning and enhances the

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connection between mathematics and real-world contexts. Such an approach may also prompt students to consider more realistic scenarios when tackling math problems. Therefore, greater emphasis should be placed on educating current and future teachers about the pedagogical opportunities that resources like movies can provide.

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