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Research Article

The effect of word problem formulation on the realistic reactions of prospective primary school teachers

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ABSTRACT

Word problems are frequently used math problems that aim to bridge the gap between school mathematics and real life. As real-life situations usually involve many factors, word problems should not be oversimplified by focusing only on the numerical information provided by word problem statements. Furthermore, students should be expected to solve word problems by incorporating real-life aspects and scenarios to accurately model and solve real-life problems. The study aims to investigate the occurrence of realistic reactions (RRs) among prospective primary school teachers in solving a non-standard word problem. Additionally, four variations of the word problem were designed, differing in their formulation. Consequently, the study examines whether the wording of a non-standard problem, focusing on different levels of personalization, influences the number of RRs among participants. A cohort of 336 prospective primary school teachers participated in the study and were divided into five groups, each solving a different version of the non-standard problem. The results confirmed the initial assumption regarding the effect of personalization on the number of RRs. The paper discusses specific instances of each problem version in detail.

Keywords: mathematics education, word problems, realistic modelling, teacher training

INTRODUCTION

Word problems are one of the most challenging problems in elementary mathematics education. They can be defined as "verbal descriptions of problem situations wherein one or more questions are raised, the answer to which can be obtained by the application of mathematical operations to numerical data available in the problem statement. "(Verschaffel et al., 2000, p. IX).

There are several purposes for incorporating word problems into teaching mathematics (Dewolf et al., 2011; Verschaffel et al., 2000). One purpose is to prepare students for solving quantitative situations in everyday life. The disposition to use mathematics in daily situations is often referred to as mathematical literacy, which is defined as "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements, and to engage with mathematics in ways that meet their needs" (OECD, 2010). Therefore, word problems should reflect scenarios that students can imagine (hypothetical situations) or have real experience with. However, the educational reality does not entirely fulfil this requirement, as some research indicates that many word problems used in school mathematics do not accurately depict problems encountered in real-world situations (Nesher, 1980; Reusser & Stebler, 1997). The other purpose is to learn a new mathematical concept by implementing and solving carefully designed or selected word problems. Tackling a specific problem may necessitate knowledge of a mathematical concept that students have not yet acquired (Posner et al., 1982). In this context, the process of solving these problems is guided by a teacher, which leads to the discovery of a new mathematical concept.

Word problems in elementary mathematics, particularly arithmetic, are categorized according to specific criteria. One approach to categorizing word problems is based on the information provided in the problem statement. Kilienė (2021) discusses the validity of word problem formulations, distinguishing between standard and problematic problems. Standard problems give the optimal amount of information necessary to answer the question, allowing for correct modelling and resolution using arithmetic operations with the given numbers (Jiménez & Verschaffel, 2014). Problematic word problems contain insufficient or excessive information necessary to reach a solution. These problematic word problems are also referred to as non-standard problems (Verschaffel et al., 2000), which include unsolvable word problems, problems with multiple solutions, problems that include the solution within the problem statement, and problems with extraneous information (Jiménez & Verschaffel, 2014). Reusser and Stebler (1997) identify unsolvable problems, indeterminate problems, problems with more than one feasible solution, and problems that can only be solved through estimation as non-standard problems. A specific type of non-standard problem also includes those that require the consideration of real-world knowledge (Kılıç & Şahinkaya, 2022).

LITERATURE REVIEW

One of the objectives of using word problems in school mathematics is to develop children's mathematical literacy skills. This objective aligns with the need for mathematics in a changing world, as outlined in the *Principles and Standards for School Mathematics* (NCTM, 2000), particularly addressing mathematics for life, the workplace, and the scientific and technical community, as well as recognizing mathematics as a part of our cultural heritage. One of the primary practices for achieving mathematical literacy is engaging children in mathematical modelling, which is part of the process of solving word problems. This process involves creating an internal representation of the situation described in the problem, transforming that representation into mathematical language, conducting appropriate calculations, evaluating the accuracy of those calculations, and interpreting the results obtained (Verschaffel et al., 2000). To be a successful problem-solver, one must perform calculations accurately while also having a solid understanding of the situation informed by common sense. Otherwise, the problem-solving process may deteriorate into a mechanical procedure where pupils apply this pattern repeatedly without regard for the relevance of the results to the problem statement or the question posed (Verschaffel et al., 1994).

Research into the relevance of students' solutions to posted word problems has shown that they adopt certain problem-solving strategies while neglecting to consider the context of these problems, which leads to unrealistic mathematical modelling (Reusser & Stebler, 1997; Verschaffel et al., 1994). The cause of this unrealistic modelling may stem from a lack of understanding of the problem situation and the stereotypical way of dealing with word problems in mathematics classes. This applies to all types of word problems, with a specific category being non-standard word problems, where students should use their common sense to find an appropriate solution. Numerous research studies have demonstrated a tendency for students to exclude realistic considerations when solving word problems (Verschaffel et al., 2000). Realistic considerations in solving word problems can be described as the application of knowledge about the real world within the problem-solving process to arrive at a meaningful solution that would work in a real-life scenario (Wisenöcker et al., 2024). In some cases, the application of knowledge about the real world may even point out the absurdity of the stated problem. It may be considered an upgrade to a commonly implemented problem-solving process, in which not much attention is paid to the context due to a great focus on the given numbers, identification of the corresponding arithmetic operation, and the correct calculation. Several studies were conducted in elementary school settings with nonsensical word problems–problems that could not be solved using the given information. Results from elementary school pupils in different countries have shown that many pupils perform random arithmetic operations to solve these problems without understanding the situation (Baruk, 1985; Radatz, 1983, 1984; Reusser, 1988; Bransford & Stein, 1993). Similarly, studies with elementary students on solving non-standard word problems requiring realistic considerations indicate that most students solve word problems in a manner that does not reflect reality (Kılıç & Şahinkaya, 2022; Renkl, 1999, as cited in Verschaffel et al., 2000). The number of realistic responses does not appear to differ between elementary and secondary school students (Reusser & Stebler, 1997). Comparable results in favor of omitting realistic considerations were obtained in middle school settings with word problems that required not only one of four arithmetic operations but also a step described by Polya (1945) as "looking back", thus reflecting on the contextual aspects of the problem–considering real-life conditions (Cai & Silver, 1995; Carpenter et al., 1983; Greer, 1993; Reusser & Stebler, 1997; Säljö & Wyndhamn, 1990; Silver, 1986; Silver et al., 1993; Verschaffel et al., 1994, 1999b; Yoshida et al. 1997). The body of research asserts that students suffer from stereotypical procedures learned in school mathematics and automatically avoid critical considerations regarding their real-world knowledge (e.g., Foong & Koay, 1997; Koay & Foong, 1996; Reusser & Stebler, 1997; Verschaffel et al., 2000). This phenomenon is also described as "the suspension of sense-making" (Reusser & Stebler, 1997; Schoenfeld, 1991; Verschaffel et al., 2000). For instance, students assume that the problem concerns the concept of proportionality without reflecting on the real-life context, such as the relationship between the height and age of a child (Markovitz et al., 1984).

The credit for this unfortunate phenomenon is often ascribed to the traditional methods of delivering mathematical instructions in schools, where the problem-solving process for word problems is reduced to selecting the appropriate arithmetic operation (Palm, 2008; Verschaffel et al., 1994). Educational materials, such as textbooks, frequently restrict the variability of word problems to specific types, which can shape students' expectations and behavior when tackling them (De Corte & Verschaffel, 1987; De Corte et al., 1985; Kilienė, 2021; Schoenfeld, 1991; Stern, 1992; Stigler et al., 1986; Tárraga-Mínguez et al., 2021). Moreover, the culture of traditional school mathematics influences the development of beliefs regarding word problems (Bonotto, 2002), and it may negatively impact students' sense-making abilities (Greer, 1997; Radatz, 1983). Solving standard word problems teaches students that all word problems are solvable, that every piece of numerical information is relevant to the problem-solving process, and that the statement contains all essential information (Reusser & Stebler, 1997). Nesher's (1980) study demonstrated how the environment of school mathematics and the conventions of word problem-solving hinder fifth graders' ability to incorporate realistic considerations when solving word problems despite their familiarity with the context presented in the problems. Specifically, the study emphasizes the formalism of problem-solving knowledge, where bringing elements together equates to adding numbers. The rigidity of the classroom climate regarding the conventional approach to working with word problems creates a disconnect between how students operate in school mathematics and their everyday reality outside of school (Gravemeijer, 1997). Generally, students influenced by stereotypical problem-solving processes that rely on minimal alterations of standard and non-standard problems may come to believe that every word problem is solvable, that there is only one correct numerical answer, that calculation is always necessary, and that all numbers provided in a problem must be utilized (Jiménez & Verschaffel, 2014).

Numerous studies have examined the factors influencing students' realistic mathematical modelling. Reusser and Stebler (1997) demonstrated that the likelihood of employing realistic mathematical modelling to solve word problems may be directly proportional to students' academic ability. Similarly, Säljö and Wyndhamn (1990) discovered that students with high academic ability are more inclined to reject formal mathematical procedures during collaborative work, favoring realistic considerations instead, as the discussion and argumentation among group members can lead to new perspectives and approaches in the problem-solving process (English & Lesh, 2003). However, only certain academic abilities are likely to predict success in solving realistic word problems (Fitzpatrick et al., 2020). Mellone et al. (2017) hypothesized about the influence of rewording, anticipating an increase in the authenticity of word problems and a positive impact on students' realistic considerations. The study revealed a positive effect only in the case of one non-standard problem (the so-called "bus problem") addressed by dyads that reworded the problem. In addition to grouping students, altering the problem statement or how the problem is presented may affect the rate of demonstrating a realistic reaction (RR). For instance, Kirkland and McNeil (2021) investigated the effect of "yes/no questions" on the frequency of RRs, finding that this formulation is positively linked to increased sense-making when tackling realistic problems. Reusser and Stebler (1997) found that adding a contextual sentence (e.g., "think about the problem carefully before you answer" or "make a sketch") may increase the frequency of students' RRs when solving word problems that are problematic from a realistic perspective. In contrast to this study, Yoshida et al. (1997) found no significant effect of a warning included with a word problem, which aimed to raise students' awareness of the problem's complexity, on the occurrence of RRs among students. Additionally, no impact was found from incorporating representative illustrations with non-standard problems, as students predominantly concentrated on the text of the word problems (Dewolf et al., 2013). Conversely, a significant effect of scaffolding in increasing the percentage of RRs was identified in a study conducted by Verschaffel et al. (1999a; as cited in Verschaffel et al., 2000). Van Dooren et al. (2019)

found that embedding word problems in a humorous setting may lead to more realistic considerations by sixth-grade pupils. Gadanidis et al. (2004) concluded that humor can foster a positive attitude towards mathematics and mathematics education, which may further assist pupils in recognizing the connection between everyday life and word problems (Teslow, 1995). Another way of increasing RRs among students involves engaging them with materials relevant to their everyday lives–the actual artefacts. Bonotto (2006, 2010) demonstrated that primary school students include reality aspects when tackling math problems framed within the context of restaurant menus and price lists. Defranco and Curcio (1997) discovered that exposing students to the real-world version of word problems significantly boosts the number of realistic responses. A real-world version of a word problem may enhance the significance of the problem-solving process for students by providing them with a pragmatic goal (Inoue, 2002). It can be assumed that activities such as role-playing may also enhance the significance of the problems presented and, consequently, the frequency of RRs. Real-life artefacts and activities are more closely connected to everyday life than the formal mathematics tasks and activities in the classroom. Therefore, it can be concluded that the so-called informal mathematics learning environment, utilizing real artefacts as sources of mathematical problems (such as a TV guide), may elicit more realistic responses in solving math problems than the formal mathematics learning setting (Bonotto, 2003).

To activate pupils' real-world knowledge, teachers must engage them in activities demonstrating how mathematics can be applied in everyday life (Foong & Koay, 1997). This also requires that teachers are familiar with a realistic approach to solving word problems and are willing to move beyond traditional methods of presenting these problems, which may initially cause conflicts between what is mathematically correct and what is practical in real-life situations (Zahner, 2012). Furthermore, teachers should possess optimal mathematical, didactical, and real-life knowledge (Sevinc & Lesh, 2022). Unfortunately, research indicates that teachers often adhere to a conventional approach to word problem-solving. Verschaffel et al. (1997) found that pre-service teachers do not approach non-standard word problems with realistic considerations and do not appreciate RRs from students. More positive results were obtained in studies conducted on Chinese prospective teachers who were asked to solve non-standard problems and evaluate students' realistic solutions (Chen et al., 2011; Xu, 2005, as cited in Depaepe et al., 2015). This suggests that teachers approach realistic problems and students' solutions differently worldwide, presumably based on different curricula they have been taught for years, and in which they have been professionally trained. The findings of Verschaffel et al.'s (1997) study were consistent with those of Aksoy et al. (2015), who reported that most pre-service primary school teachers applied non-realistic approaches to solving non-standard word problems. Nevertheless, various rates of RRs were observed among distinct categories of non-standard word problems. Dayal and Chandra (2016) investigated a small group of in-service primary teachers and their responses to non-standard and nonsensical word problems. The results indicated that most teachers (65%) could identify the nonsensical nature of the questions, but only 9–12% of participants exhibited RRs to non-standard word problems. Thus, it is evident that teachers require adequate training to enhance their ability to recognize non-standard problems and foster realistic considerations of their students (Bonotto, 2010; Ho & Hedberg, 2005).

The present study aims to find out more about the phenomenon of realistic considerations in mathematics education. Specifically, the study aims to reveal the association between the RRs of prospective primary school teachers in solving word problems and the way these problems are formulated.

METHODS

The aim was to investigate whether pre-service primary school teachers could recognize a given non-standard problem as problematic from a real-world perspective and, if so, how the word problem's wording affects the rate at which they approach solving it using realistic considerations. Therefore, the initial task was to create a non-standard problem that could be tackled from a realistic standpoint. Regarding the designed problem, the first research question was posed:

1. What percentage of pre-service primary teachers solve the designed non-standard word problem using realistic considerations?

Subsequently, four versions of the problem, differing in their wording, were designed based on Inoue's (2002) distinction between problems that establish ambiguous goals (general formulation) and pragmatic goals (personalized formulation) for problem solvers (Tarim & Öktem, 2014). In the study, the path towards increasing levels of pragmatic goals was identified through the rising degree of personalization of word problems, based on the wording of the problems (Palm, 2008). As the personalization of word problems may help individuals to more easily mentally represent the problem with their existing knowledge (Davis-Dorsey et al., 1991), the study hypothesizes that increasing levels of personalization in word problems affect the number of RRs from participants. This results in the second research question:

2. How do different types of word problem formulation affect the rate of using realistic considerations among pre-service primary school teachers?

Material

The designed non-standard word problem used in the study resembles a word problem presented by Greer (1993) and other researchers in the original or adapted form. Therefore, the following designed problem can be deemed reliable regarding its relevance to real-world problems.

A triangular area with poles at its vertices has been surrounded by a rope. The distances between the individual poles are 7, 11, and 15 meters. What is the length of the rope?

The word problem was then named "general existing", which refers to the neutral tone of the statement and the past tense in which the problem was formulated. To increase the personalization of the problem, the problem was modified in its wording to the following four problems (see **Table 1**).

Table 1. Modifications of the designed word problem

Type	Word problem
General potential	*A triangular area with poles at its vertices must be surrounded by a rope. The distances between the individual poles are 7, 11, and 15 meters. What is the length of rope that should be purchased?*
Personal potential	*Imagine a triangular area with poles at its vertices that you must surround with a rope. The distances between the individual poles are 7, 11, and 15 meters. What is the length of rope that you will need to purchase?*
Personal potential-choice	*Imagine a triangular area with poles at its vertices that you must surround with a rope. The distances between the individual poles are 7, 11, and 15 meters. What length of rope will you buy if the store sells ropes that are 33m, 40m, and 50m long?*
Personal potential-prompt	*Imagine a triangular area with poles at its vertices that you must surround with a rope. The distances between the individual poles are 7, 11, and 15 meters. What is the length of rope that you will need to purchase? Solve as in real life.*

Each of these types was named based on its linguistic specifics. The "general potential" type differs from the "general existing" type by the state of the rope, where the GP type indicates that the rope has been used, whereas the GE type expresses the necessity for it. This was considered a different level of personalization, as the problem-solver may see the GE type as a real challenge for them and may envision themselves in the problem situation. To achieve greater personalization, three additional types of word problems were created: "personal potential", "personal potential-choice", and "personal potential-prompt". All of them explicitly encourage the problem-solver to imagine the problem situation they need to solve (the GE type can be considered an implicit suggestion). Individually, the PP type and PP-choice type differ in the phrasing of the question. It was hypothesized that offering options in the PP-choice type may evoke a real-life experience of products being sold in specific packaging. As Carotenuto et al. (2021) noted, a multiple-choice question may serve as an adjunct to the informational component of a word problem, as Gerofsky (1996) described. The options were designed so that one aligns with the typical solution (without realistic considerations), and the other may align with a solution that takes real-life factors into account. The highest form of the problem personalization was the "personal potential-prompt" type, which was identical to the PP type, except the final prompt exactly told the problem-solver to solve the problem as in real life.

Participants

The study sample consisted of 336 prospective primary school teachers (331 females and 5 males) from a university in Slovakia. Selected participants were in their first year of study. Their ages ranged from 19 to 21 years. All participants were informed about the purpose of the study and agreed to the use of their solutions, which were anonymized. Participants were randomly assigned to one of the five problem modifications. The word problems were distributed to participants at the start of their mathematics class, and participants were assured that their solutions would not affect their assessment. The instructions provided before solving the problems were minimal, urging students to read the problem statement carefully and inviting them to explain their answers. The solving process had no fixed time limit, and participants submitted their answers after completing the task.

Data Analysis

According to Greer's (1993) study and Verschaffel et al.'s (1994) study, participants' answers were analyzed for the activation of realistic considerations by distinguishing between RRs and non-realistic reactions (NRs) based on their calculations and additional comments that would show evidence of their realistic considerations. When a participant provided a non-realistic answer but accompanied it with a realistic comment, the answer was scored as the RR. When computations were incorrect and no realistic comments were presented, the answer was scored as a NR. To assess inter-rater reliability, the data were presented to an additional independent rater, who coded all responses, resulting in 100% agreement. The study's independent variable was the formulations of word problems, while the dependent variable was dichotomous: RR or non-realistic reaction. Data from participants solving five versions of the word problem were examined and compared using STATISTICA 11 software. The null hypothesis H_0 for statistical testing was formulated as follows: *There is no difference in the distribution of RR and NR solutions between the word problems with the different personalization levels*. Six statistical tests were conducted to examine the differences between the designed categories and determine whether the presumed increasing level yields statistically significant differences among the variations of the word problem. As the object was to compare independent groups' RR/NR proportions (categorical data), 2 × 2 contingency tables were built, and Pearson's Chi-square test of independence or Fisher's exact test was performed based on the cell counts (Agresti, 2007). If all expected cell counts were ≥ 5, Pearson's Chi-square test of independence was used. If any expected count was < 5 or any cell contained zero, we used Fisher's exact test. Effect size was expressed as the odds ratio with a 95% confidence interval.

Alongside the statistical analysis, a qualitative study of the obtained answers was conducted to identify realistic considerations of participants.

RESULTS

The data revealed no RRs among participants solving the "general existing" problem type or the "general potential" problem type (see **Table 2**). This aligns with previous studies investigating performance in demonstrating RRs when solving "the rope problem", as summarized by Verschaffel et al. (2000), who found that 0–8% of all solutions involved RRs. A similar outcome was observed in a more recent study by Krawitz et al. (2016), in which fifth graders solved an adapted version of the problem, yielding approximately 6.5% of realistic responses. Mellone et al. (2017) also utilized an adaptation of "the rope problem" with fifth graders; however, no RRs were noted.

Table 2. The absolute and relative scores for the proposed categories

	General existing		General potential		Personal potential		Personal potential-choice		Personal potential-prompt	
RR	0	0%	0	0%	8	11.27%	13	18.57%	21	27.63%
NR	56	100%	53	100%	63	88.73%	57	81.43%	65	72.37%

Given that there were no recorded RRs for the "general existing" type and the "general potential" type, no further statistical testing for these two types was performed. Six statistical tests were conducted to examine the differences between the proposed types (see **Table 3**, **Table 4**, and **Table 5**).

Table 3. Statistical analysis of the problem's personalization

Compared types		Statistical test used	Results	
General potential	Personal potential	Fisher's exact test	p = .010	Statistical significance
	Personal potential-choice	Fisher's exact test	p = .0005	Statistical significance
	Personal potential-prompt	Fisher's exact test	p = .000016	Statistical significance

Table 4. Statistical analysis of the multiple-choice and prompt

Compared types		Statistical test used	Results	
Personal potential	Personal potential-choice	Pearson's Chi-square test of independence	χ^2 (df = 1, N = 141) = 1.48, p = .223	No statistical significance
	Personal potential-prompt	Pearson's Chi-square test of independence	χ^2 (df = 1, N = 157) = 4.47, p = .035	Statistical significance

Table 5. Statistical analysis of the added prompt against the multiple-choice type

Compared types		Statistical test used	Results	
Personal potential-choice	Personal potential-prompt	Pearson's Chi-square test of independence	χ^2 (df=1, N = 156) = .77, p = .378	No statistical significance

Investigating differences between the "general potential" type and the "personal potential", "personal potential-choice", and "personal potential-prompt" types revealed that the way the problem was formulated–where participants were asked to envision themselves in the problematic situation–influenced the emergence of RRs.

Investigating differences between the "personal potential" type and the "personal potential-choice" and "personal potential-prompt" types revealed that the multiple-choice type did not affect the number of realistic responses. Still, the number of realistic responses to the problem supplemented with the prompt was statistically significant compared to the problem without the prompt. The phi (φ) coefficient was calculated to assess the association's strength. The effect size was $\varphi = 0.169$, suggesting a small association based on Cohen's (1988) guidelines ($\varphi \approx 0.10$ = small, $\varphi \approx 0.30$ = medium, $\varphi \approx 0.50$ = large). While the relationship is statistically significant, the effect size indicates that the practical significance of this association is relatively weak. Consequently, the prompt in the word problem, which aimed to solve the problem as in real life, had a weak effect on the use of RRs among participants.

Investigating the difference between the "personal potential-choice" type and the "personal potential-prompt" type revealed no statistical significance, which means that the prompt and the multiple-choice activated comparable numbers of realistic responses.

A qualitative examination of the responses was carried out alongside the statistical analysis, focusing on students' explanations for their RRs to the problem. Realistic responses from all versions were examined, resulting in 42 RRs, of which written explanations backed 37. These explanations were categorized into three groups: "to make sure" (19 instances), "around the poles" (13 cases), and "to tie the rope" (5 instances). The collected data suggest at least two real-world aspects to consider when addressing the presented problem. This data shows that most RRs stemmed from participants instinctively opting for a longer rope without a clear justification for their choice. This can be attributed to the lack of sophistication in the planning phase or the prevalence of mathematics instruction throughout their schooling years, which did not require students to explain and justify their problem-solving processes.

DISCUSSION

The study examined the effect of wording in a non-standard word problem on the frequency of RRs among prospective primary school teachers. It confirmed previous findings (Aksoy et al., 2015; Dayal & Chandra, 2016) regarding pre-service primary school teachers' tendency to overlook realistic considerations when solving word problems. Despite this, the study revealed several opportunities to enhance the number of RRs in solving word problems. In particular, the results indicated that personalizing a word problem increases the number of RRs. This personalization was achieved through two different formulations of the word problem. The first formulation explicitly asked participants to imagine the situation, while the second formulation additionally requested participants to solve the problem as they would in real life. Furthermore, the results confirmed increased RRs when a multiple-choice question was present alongside the personalized word problem. However, the multiple-choice question alone did not affect the number of RRs, which may be an enrichment of Große's (2017) findings. The personalization and direct prompts were the only factors compared to the traditional word problem formulation, which, when presented to students, may cause them to function as passive bystanders. An additional difference was found between the formulation that asks participants to imagine the situation and the one that directly prompts them to solve the problem as if it were in real life. Referring to the hypothesis presented in the data analysis section, the results indicate that enhancing the level of personalization in the word problem, as suggested by the study, increases the number of RRs from participants; however, not all levels show significant differences. Consequently, the results suggest a particular sequence in word problem formulation regarding the expected RRs. Although most participants responded to the question without drawing on their real-life knowledge, the findings revealed that certain types of prompts or contextual sentences may increase the frequency of realistic responses, aligning with the findings of Reusser and Stebler (1997).

It is necessary to state that the obtained results are limited to the cohort, the non-standard problem, and the type of prompt used in the study. Krawitz et al. (2018) argue that utilizing realistic considerations relies on the ease with which students can observe real aspects of the problem in its statement. Several studies included prompts intended to investigate whether they affect the rate at which students use realistic considerations in problem-solving. Yoshida et al. (1997) used additional written instructions that informed students about the presence of difficult or even unsolvable problems in the test. The study revealed only a non-significant difference in favor of the group that received the instruction. Wisenöcker et al. (2024) used reality-based prompts, and their effect on eliciting RRs was assessed. The conclusion was that prompts designed to encourage reality-based considerations did not influence the frequency of RRs, whereas prompts aimed at selecting the correct arithmetic operation hindered RRs. Wisenöcker et al. (2024) employed different non-standard problems and a different type of reality-based prompts than those used in this study, which may have led to ambiguous findings. The results of this study suggest that a multiple-choice question may have a positive effect on RRs, which contradicts the findings of Carotenuto et al. (2021). Their study revealed that, among the high percentage of NRs to a non-standard word problem, removing the multiple-choice question reduced the frequency of non-realistic responses. Consequently, it can be concluded that the factors influencing RRs are not easily determined, as different studies employ differing materials under varying circumstances. Furthermore, according to Inoue's (2005) commentary, the ultimate reason for the use of non-realistic answers can be ascertained only through a qualitative analysis of students' thinking, as non-realistic solutions may arise from a suspension of sense-making or a conformist approach developed during their education.

Comparing the findings with the literature review, students usually disregard realistic considerations when solving word problems. This behavior mainly stems from the educational system, which imposes socio-contextual situations and norms. Students solve problems according to how they were taught and in a manner that aligns with their expectations for rewards (Reusser & Stebler, 1997). The lack of realistic considerations in mathematics classrooms can be particularly attributed to the scarcity of realistic and non-standard problems found in mathematics textbooks (Depaepe et al., 2009; Gkoris et al., 2013; Tárraga-Mínguez et al., 2021; Vicente et al., 2011). A similar issue can be observed in mathematics examinations. Despite the predominance of standard problems in such assessments, some items necessitate realistic considerations, as reported by national test reports (Carotenuto et al., 2021; Cooper, 1998). Besides the scarcity of non-standard problems, the influence of how students conceive problems can be attributed to their teachers and the way they conceive and treat word problems (Hiebert et al., 1996; Mason & Scrivani, 2004; Verschaffel et al., 1999c). Therefore, there is a clear need for the development of realistic problems and their integration into mathematics lessons (Depaepe et al., 2015; Kılıç & Şahinkaya, 2022), as well as the implementation of didactical principles for solving word problems from a real-world perspective in teachers' training. In the mathematics classroom, students should regularly engage in solving problems that demand deeper reflection, such as division-with-remainder problems (Carpenter et al., 1983; Cooper & Harries, 2003), pseudo-proportion problems (Greer, 1993), problems requiring real-life knowledge (Säljö & Wyndhamn, 1993), nonsensical problems (Baruk, 1985; cited in Verschaffel et al., 2000), addition and subtraction problems that lead to incorrect outcomes if numbers are merely added or subtracted (Verschaffel et al., 1999b), or problems that offer multiple solutions (Kinda, 2006). On the other hand, in a contrasting scenario, students might not recognize that a presented problem is non-standard and may fail to approach it with an open mind and common sense (Kinda, 2006).

Common sense may be activated through frequent engagement with the aforementioned problem types. These problems can be created by altering the context, wording, or nature of standard problems. Educators must devote substantial attention to presenting problems by integrating various factors and fostering an open-minded approach among students, even though not all aspects of reality can and should be modelled (Verschaffel, 2002), considering the task difficulty and the aim of the lesson taught. Previous research indicates that facilitating students' engagement with realistic considerations can be achieved by providing them with tangible real-life artefacts (Bonotto, 2003, 2006, 2010), assigning projects based on real-life scenarios (DeFranco & Curcio, 1997), presenting problems without numerical information (Krawitz et al., 2016), and posing thought-provoking "what if" questions (Payadnya et al., 2021).

CONCLUSION

The study examined the use of realistic considerations by prospective primary school teachers in solving non-standard word problems. It aimed to investigate whether different wordings of the same non-standard word problem affect the number of RRs. The findings indicated that certain ways of presenting the word problem elicit more realistic responses than others. Specifically, participants exhibited more RRs when the wording suggested that they were actors in the scenario or were explicitly instructed to solve it as they would in real life, compared to the traditional problem statement. Additionally, the explicit request for participants to solve the problem as if in real life prompted significantly more realistic responses than simply asking them to imagine the problem situation.

Although the topic of using realistic considerations in solving word problems has been discussed for the last three decades, the fact that participants exhibited a low number of such reactions raises concerns about the current state and trends in mathematics education. In the context of activating realistic considerations in solving non-standard word problems, Schoenfeld (1991) argues that students do not lack a common understanding of the problems; rather, they make sense of the situation based on the reward they receive for approaching word problems in a specific way. The change in students' thoughts about word problems is possible through changes in the classroom climate and the teacher's actions (Verschaffel & De Corte, 1997).

The paper summarizes research findings from previous studies on the issue of activating realistic considerations in solving word problems, suggesting practical implications for eliciting the use of common sense in solving word problems. The findings suggest the need for incorporating a realistic approach in mathematics education and teacher training programs, where the initial seed of change may be planted.

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