Levels of Authenticity of Word Problems in Turkish Mathematics Textbooks

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Abstract

Textbooks are the most important component of the intended curriculum and have a crucial role in the teaching of mathematics. The extensive use of word problems in mathematics textbooks provides strong clues about the learning/teaching opportunities available to students/teachers. The authenticity levels of the problems in textbooks, which are the basic materials of mathematics courses, affects students' problem solving skills. Based on the fact that students' reasoning and solving skills can be developed more effectively through authentic problems, this study analyzed the authenticity levels of a total of 486 word problems in a mathematics textbook used extensively at the 5th grade level in Turkiye according to a two-phase model. In the model developed by Vicente and Manchado (2017), word problems are examined first in terms of event, question, purpose, existence and specificity of the information, and then in three different levels, characterized as poor-fit, stereotyped and good-fit. The word problems in the 5th grade Turkish mathematics textbook are organized by the learning domains of numbers&operations, geometric shapes&quantities, algebraic thinking and statistics&probability. Non-parametric statistics are used for the significance of differences in the level of authenticity of word problems and learning domains. The results indicated that the word problems in statistics&probability were mostly at the good-fit and stereotyped level (39.8% and 47.7% respectively). On the other hand, the proportion of good-fit problems in numbers&quantities, geometric shapes&quantities and algebraic reasoning is quite low (19.4% in numbers&quantities, 6.4% in geometric shapes & quantities and 13.5% in algebraic reasoning). Moreover, statistically significant differences are found between the three levels of authenticity and the four learning domains. The results are discussed in the context of the design of authenticity of word problems in mathematics textbooks.

Keywords: word problems, authenticity, mathematics textbook

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Introduction

Although there is a consensus on the importance of relating school mathematics to daily life, little is known about how and to what extent this actually happens in classrooms (Gainsburg, 2008). One of the most commonly used tools for this purpose in mathematics lessons is word problems. As in many countries, the updated mathematics curriculum in Turkey and, consequently, mathematics textbooks emphasize the use of authentic word problems that enable mathematical content to be related to daily life situations (Ministry of National Education [MoNE], 2024).

Authentic Word Problems in Mathematics Textbook

Word problems are used extensively in mathematics classes because they provide opportunities and facilitate the connection of mathematical knowledge and concepts to everyday situations. Verschaffel et al. (2000) generally consider word problems as verbal introductions to problem situations. While word problems serve as a bridge between mathematical content and daily life, Chapman (2006) emphasizes the contributions of such problems to the development of students' critical thinking and problem-solving skills. However, Vicente and Manchado (2017) point out that the tasks or problems solved in mathematics classes contain abstract information disconnected from concrete contexts.

Word problems are used extensively in mathematics textbooks because they make it easier to relate mathematical content to daily life. Although the main reason for including word problems in textbooks is to make concepts and operations more meaningful and relate them to real life, this approach has turned into a direction dominated by unreality and repetition (Vos, 2018). Using real or realistic word problems in mathematics textbooks can make mathematical content more meaningful. However, Verschaffel et al. (2000) point out that word problems that are far from authenticity can lead students to use unrealistic thinking in solving tasks. School mathematics, and therefore mathematics textbooks, are full of problems with unrealistic contexts and standard applications. Enriching problems in terms of authenticity can make an important contribution to solving this problem. This is because working with authentic problems can make students' perception of mathematics more meaningful and interesting (Hernandez-Martinez & Vos, 2018). At the same time, problems and/or tasks that are rich in realism also contribute to students' problem-solving and reasoning skills. Palm (2008) points out that originality offers a broad framework of opportunities to integrate both mathematical content and students' participation in meaningful learning situations.

The purpose of this study is to examine the levels of authenticity of word problems in a widely used 5th grade mathematics textbook in Turkey according to learning domains. The authenticity levels of the 486 word problems in the textbook were analyzed according to a two-stage model. The word problems were first evaluated in terms of event, question, purpose, presence and specificity of information, and then in terms of three different authenticity levels: poor-fit, stereotypical, and good -fit.

Method

This study is a quantitative study that examines the authenticity of word problems in the most widely published and intensively used mathematics textbook for 5th grade students in Turkey. The topics in this textbook are organized under four learning areas: numbers and quantities, geometric shapes and quantities, algebraic thinking and statistics and probability. The

authenticity of the arithmetic word problems in these four learning domains was examined comparatively.

Data Collection

In Turkey, textbooks are reviewed and approved by the relevant units of the Ministry of National Education (MoNE) in a centralized system. The data for this study were obtained from a 5th grade textbook designed according to the middle school mathematics curriculum updated in 2024 and widely used in schools in Turkey. The word problems in the textbook and their corresponding learning domains are presented in Table 1.

Table 1
Word Problems Examined and Learning Domains

Learning Domains	Word problems examined
Numbers&quantities	185
Geometric shapes&quantities	124
Algebraic thinking	89
Statistics&probability	88
Total	486

Data Analysis

In this study, the model developed by Vicente and Manchado (2017) was used to assess the authenticity of word problems in mathematics textbooks. Palm and Burman (2004) identified a total of nine aspects for evaluating the authenticity of word problems: event, question, purpose in the figurative context, data/information, language, availability of solution strategies, external tools, guidance and solution requirements.

They developed a binary evaluation model in which "1" points are given for dimensions that fully simulate each of these aspects and "0" points for those that do not. Vicente and Manchado (2017) expanded this evaluation system to a three-point scale. In this study, the authenticity of the word problem was examined in five dimensions: event, question, purpose, existence, and specificity of the information. If the probability of encountering the word problem outside of school is very high, it is given a score of "2"; if the probability of encountering it outside of school is low, it is given a score of "1"; and if it is impossible, it is given a score of "0". Accordingly, the authenticity levels of word problems are divided into three categories: poor-fit, stereotyped, and good-fit.

Good-fit problems: At this level, the above five aspects are well simulated, and the total score that can be obtained is between 9 and 10.

Stereotyped problems: Although the above five aspects are not well simulated in problems of this level, the total score that can be obtained is between 5 and 8.

Poor-fit problems: In problems of this level, the above five aspects are simulated in a weak form, and the maximum total score that can be obtained is 4.

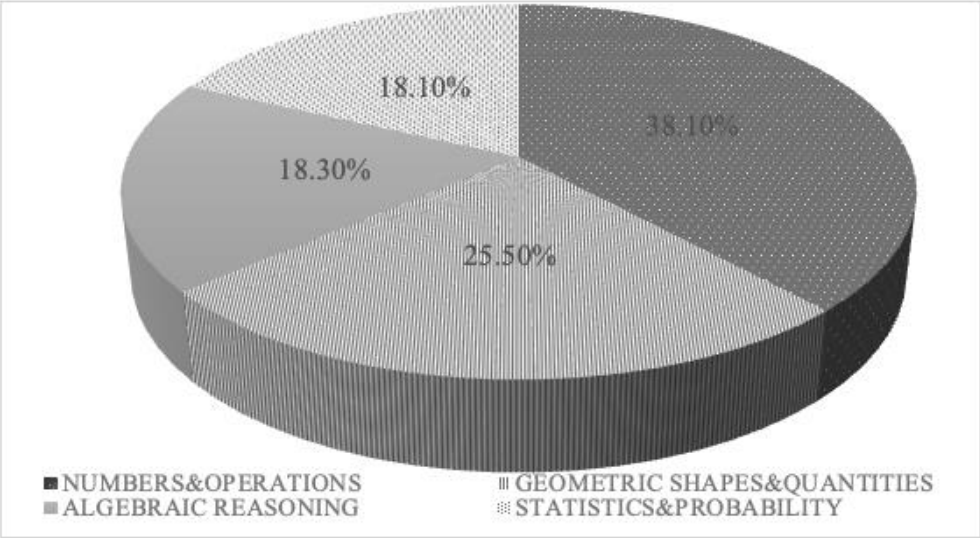
However, chi-square statistics from nonparametric statistics were also used to analyze the levels of authenticity of the word problems in the Turkish 5th grade mathematics textbook in terms of learning areas and levels of authenticity.

Results

First, the distribution of word problems in the Turkish mathematics 5th grade textbook according to learning domains was examined (Figure 1). Figure 1 shows that 38.1% of the total word problems analyzed belong to numbers & operations, 25.5% to geometric shapes & quantities, 18.3% to algebraic reasoning, and 18.1% to statistics & probability.

Figure 1

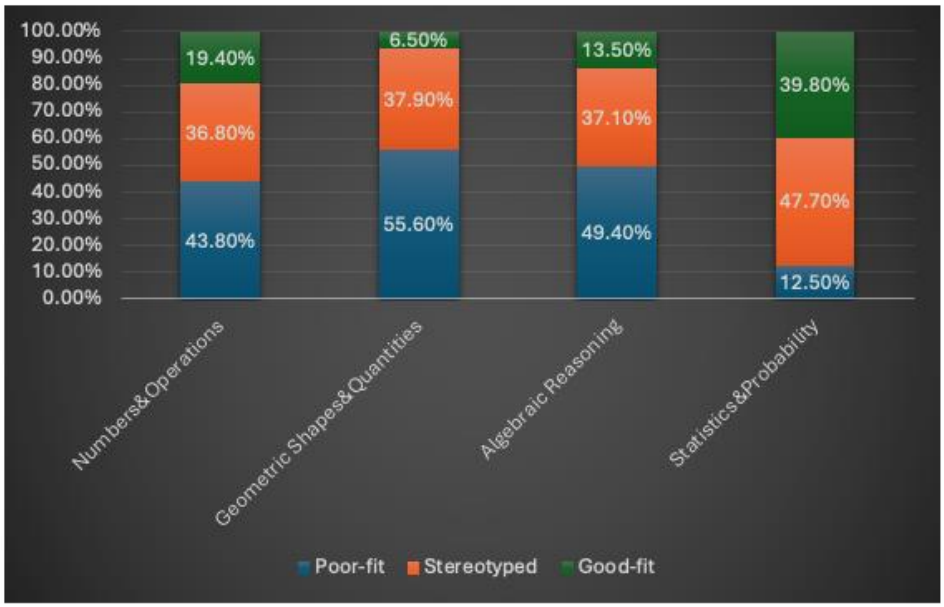
Distribution of Word Problems According to Learning Domains



Of the total 486 word problems examined in the mathematics textbook, 42.2% (n = 205) were poor-fit, 39.1% (n = 190) were stereotyped, and only 18.7% (n = 91) were good-fit. Therefore, it was determined that the authenticity of the word problems in Turkish mathematics textbooks remained at a low level. The distribution of the authenticity levels of these problems in the textbook according to learning domains is shown in Figure 2.

Figure 2

Authenticity Level Proportions of Word Problems by Learning Domains



The highest levels of authenticity in word problems are found in the field of statistics and probability (Figure 2). Of the word problems in this domain, 39.8% are at the good-fit level, 47.7% are at the stereotyped level, and only 12.5% are at the lowest level, poor-fit. Except for statistics and probability, the authenticity of word problems in the remaining learning domain remains low. Approximately half of the word problems in the remaining three learning domains are at the poor-fit level. The lowest levels of authenticity in the word problems in the textbook are in geometric shapes & quantities. Only 6.4% of the word problems in this learning domain are at the good-fit level.

The chi-square test for independence was used to assess whether the levels of authenticity differed across the four learning domains. Table 2 shows the distribution of learning domains in the mathematics textbook and the levels of authenticity of the word problems. The result of the chi-square test reveals that there is a significant relationship between word problems and the four learning domain areas (X^2 (6, 486) = 59.16, $p < .05$). This result shows that the levels of authenticity of word problems in the four learning domain areas of the textbook differ significantly from each other.

Table 2

Cross-Tabulation of Authenticity Levels and Learning Domains With Adjusted Residuals

Category	Good-fit	Stereotyped	Poor-fit	Total(n)
Numbers&Quantities (n)	36	68	81	185
%	19.40%	36.80%	43.80%	
Adjusted residual (z)	0.33	-0.83	0.56	
Geometric Shapes&Quantities (n)	8	47	69	124
%	6.40%	37.90%	55.70%	
Adjusted residual (z)	-.4.06	-0.32	3.52	
Algebraic Reasoning (n)	12	33	44	89
%	13.50%	37.10%	49.40%	
Adjusted residual (z)	-1.40	-0.43	1.53	
Statistics&Probability	35	42	11	88
%	39.80%	47.70%	12.50%	
Adjusted residual (z)	5.59	1.83	-6.23	
Total (n)	91	190	205	486

The word problems with the highest level of authenticity were most concentrated in the Statistics & Probability learning area (z = 5.59, 39.80%), while the word problems with the lowest level of authenticity were predominantly found in the Geometric Shapes & Quantities area (z = 3.52, 55.70%). In other words, comparisons between learning domain reveal that Statistics & Probability has more problems designed at both the good-fit (39.80%) and stereotyped (47.70%) levels, while Geometric Shapes & Quantities has more problems designed at the poor-fit (55.70%) level. In this context, it was found that word problems in the Statistics & Probability learning domain were better designed in terms of authenticity, while those in the Geometric Shapes & Quantities domain were weak in this regard. In the areas of algebraic thinking and numbers & operations, there are no significant differences between the levels of authenticity of word problems.

Discussion and Conclusion

This study, which investigates the authenticity levels of word problems in the most widely used mathematics textbook in 5th grade classrooms in Turkey according to learning areas, reveals

some notable findings. When textbooks do not have sufficient and rich content in terms of relating to daily life, the development of the expected skills in students is hindered (Kim, 2004). At the same time, the weak content of textbooks in this regard has important implications for how teachers can shape their lessons. This limits students' opportunities to make sense of real life. The relevant literature shows that operational understanding dominates word problems in school mathematics (Thompson et al., 1994) and that authentic aspects are not sufficiently taken into account (Dewolf et al., 2015). Palm and Burman (2004) also found that high school-level problems in Finland and Sweden are significantly inadequate in simulating real-life contexts, particularly in terms of purpose and data/information characteristics. The results of this study are similar: The results obtained show that a significant portion of the word problems in Turkish textbooks are weak or moderate. In other words, there are very few word problems that are authentic. In other words, more than four out of five word problems in the textbook examined are poor-fit and stereotyped. This result also means that Turkish students may have more limited opportunities for developing their problem-solving skills. In parallel with this, Vicente et al. (2021) report that Spanish textbooks contain a high proportion of stereotypical problems that do not encourage students to think outside of school and poor-fit problems that may hinder their ability to understand the real world.

The second conclusion of the study is that the realism of word problems in textbooks varies according to learning domains. The learning area Statistics & Probability contains more word problems at the good-fit level, while Geometric Shapes & Quantities contains more at the poor-fit level. A more balanced distribution among learning areas will contribute to the textbook offering stronger opportunities to both students and teachers. İncikabı (2025) states that the authenticity of problems can be raised to the desired level of suitability by making adjustments to aspects of textbooks that reduce their level of authenticity.

The results of this study provide some clues for the design of textbooks in terms of the authenticity of problems and/or tasks. In addition, further research is needed on the effects of improving the authenticity of word problems in textbooks on teachers and students.

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