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EFFECTIVENESS OF THE SELECTED TOPICS IN SECONDARY SCHOOL MATHEMATICS TEXTBOOK WITH A REALISTIC APPROACH

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Abstract

The Selected Topics in Secondary School Mathematics Textbook, with a realistic approach, is considered essential teaching material for Mathematics Education students at Adzkia University. This quantitative study utilized a one-group pretest-posttest design to assess the effectiveness of this textbook, using pretest and posttest data from 13 students. The methodologies applied include N-Gain analysis and the Wilcoxon Signed Rank test. The textbook demonstrated high effectiveness with an N-Gain score of 0.81 and a significance value of p = 0.001 (Wilcoxon test). These findings suggest that instructors of other courses should also consider developing textbooks that use a realistic approach.

Keywords: textbook, selected topics in mathematics, n-gain, Wilcoxon test

Abstrak

Buku ajar Kapita Selekta Matematika Sekolah Menengah dengan pendekatan realistik dianggap sebagai materi pengajaran yang penting bagi mahasiswa Pendidikan Matematika di Universitas Adzkia. Penelitian kuantitatif ini menggunakan desain one-group pretest-posttest untuk mengukur efektivitas buku ajar tersebut menggunakan data pretest dan posttest dari 13 mahasiswa. Metodologi yang diterapkan meliputi analisis N-Gain dan uji Wilcoxon Signed Rank. Hasil dari penelitian ini menunjukkan efektivitas yang tinggi dari buku ajar, dengan N-Gain rata-rata sebesar $81{,}15\%$ dan p-value $0{,}001$ dari uji Wilcoxon, mengindikasikan adanya perbedaan signifikan dalam hasil belajar sebelum dan sesudah penggunaan buku ajar. Temuan ini menyarankan agar dosen pengampu mata kuliah lainnya juga mempertimbangkan pengembangan buku ajar yang menggunakan pendekatan realistik.

Kata kunci: buku ajar; kapita selekta matematika; n-gain; uji wilcoxon

INTRODUCTION

Education plays a crucial role in enhancing students' analytical and critical thinking skills, particularly in mathematics, which is often viewed as a challenging and abstract subject (Al Ayyubi et al., 2024; Catacutan et al., 2023). In higher education, specifically for prospective mathematics teachers, the 'Selected Topics in Secondary School Mathematics' textbook is a pivotal resource to prepare them for complex teaching scenarios (Rahayu, 2021). However, many students still struggle to apply mathematical concepts accurately due to conventional teaching methods that prioritize rote memorization (Gufron & Junaedi, 2024). Consequently, innovative learning tools are necessary to bridge the gap between theoretical knowledge and practical application, allowing students to deepen their understanding through active participation (Kütük & Su Bergil, 2021).

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The Realistic Approach is considered effective because it bridges abstract ideas with real-world applications, thereby enhancing students' comprehension and motivation (Romberg, 2016; Safari & Syafawani, 2025; Susanti, 2025). Previous studies have consistently shown that this approach boosts problem-solving abilities and critical thinking (Abramovich et al., 2019; Lestari et al., 2023; Siswantari et al., 2025). By presenting contextual problems relevant to daily life, the realistic approach encourages active engagement and supports the development of conceptual understanding, which leads to substantial improvements in academic performance (Sinaga, 2023; Afsari et al., 2021).

(Imran et al., 2024; Daulay et al., 2021). However, few studies examine the effectiveness of realistic approach-based textbooks at the university level, especially in Indonesia. Addressing this gap, this study aims to assess the effectiveness of the 'Selected Topics in Secondary School Mathematics Textbook' developed with a realistic approach. Utilizing a pretest-posttest design and N-Gain analysis, this research provides empirical evidence on how such learning materials can enhance students' conceptual understanding and overall academic performance in higher education contexts.

High-quality instructional materials, such as textbooks, play a critical role in delivering content effectively (Barbosa & Maldonado, 2011; Kumar et al., 2023; Imran et al., 2024; Daulay et al., 2021). However, few studies examine the effectiveness of realistic approach-based textbooks at the university level, especially in Indonesia. Addressing this gap, this study aims to assess the effectiveness of the 'Selected Topics in Secondary School Mathematics Textbook' developed with a realistic approach. Utilizing a pretest-posttest design and N-Gain analysis (Pinem et al., 2021), this research provides empirical evidence on how such learning materials can enhance students' conceptual understanding and overall academic performance in higher education contexts.

METHODS

This research utilized a One Group Pretest-Posttest design (Fauziyah & Anugraheni, 2020), as shown in Figure 1, to assess the effectiveness of the Selected Topics in Secondary School Mathematics Textbook that incorporates a Realistic Approach in improving students' understanding of mathematical concepts. The design was selected because it enables the measurement of changes in learning outcomes by comparing pretest and posttest scores within the same group. This approach is considered efficient for determining the direct effects

of the intervention, which involves the implementation of the textbook with a realistic teaching strategy.

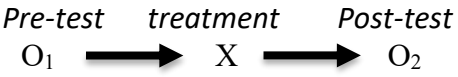

Figure 1. Design of Research

Figure 1 shows that this research was conducted in a single classroom. In this study design, the participants first took a pretest to examine their prior knowledge of the topic to be learned. Following this, they underwent an intervention in which the Selected Topics in Secondary School Mathematics Textbook with a Realistic Approach was used throughout the teaching sessions, which were conducted over four consecutive meetings. After the instructional period, a posttest was administered to evaluate improvements in students' conceptual understanding of mathematics. The differences in scores between the pretest and posttest were then analyzed to measure the textbook's effectiveness. The research instruments included two essay questions related to quadratic functions, administered during both the pretest and posttest. The instrument utilized in this study designed to measure students' depth of conceptual understanding rather than rote memorization. Although the number of items was limited, each question required complex problem-solving steps relevant to the realistic approach. Before implementation, the test instrument underwent content validity testing by two experts in mathematics education to ensure alignment with the learning objectives and material coverage. The inputs from the experts were used to revise the language and structure of the questions, ensuring the instrument was valid for data collection.

The participants in this study were 13 undergraduate students from the Mathematics Education Department at Adzkia University. Subjects were chosen based on the criteria that they had completed prerequisite courses relevant to Selected Topics in Secondary School Mathematics and were committed to actively participating in all stages of the study. This study tested the following hypotheses:

H_0: There is no significant difference in student learning outcomes before and after the use of the textbook.

H_1: There is a significant difference in student learning outcomes before and after the use of the textbook.

In this research, a series of tests were performed to evaluate the effectiveness of the Selected Topics in Secondary School Mathematics Textbook, specifically on the topic of quadratic functions, including:

1. Gain and N-gain tests, which aim to measure the level of enhancement achieved by students before and after using the textbook. The formula used to calculate the gain is as follows (Ramadhani & Amudi, 2020):

$$gain = (posttest\ score) - (pretest\ score)$$

For the N-gain test, the formula used is :

$$N - gain(g) = \frac{score_{posttest} - score_{pretest}}{score_{max} - score_{pretest}}$$

The effectiveness of the textbook, assessed through factor g based on N-gain criteria, is presented in Table 1.

Table 1. Criteria of N-Gain

N-gain	Criteria
$0{,}7 \leq N - gain \leq 1$	High
$0{,}3 \leq N - gain < 0{,}7$	Medium
$N - gain < 0{,}3$	Low

Table 2. Interpretation of Effectiveness Categories N-Gain (Triyono et al., 2024)

Persentase N-gain (%)	Interpretation
< 40	Ineffective
$40 - 55$	Less Effective
$56 - 75$	Effective Enough
> 75	Effective

2. Paired Sample T-test, referenced by (Saputra et al., 2022), is used to assess whether there is a significant difference in the average scores before and after using the Selected Topics in Secondary School Mathematics Textbook on quadratic functions material. This test can only be conducted if the following two criteria are met:
   a. Normality testing is performed using IBM SPSS Statistics 27 with the Kolmogorov-Smirnov method (Fajrianti & Meilana, 2022), which is the initial step before conducting the Paired Sample T-test to check the normality of the pre-test and post-test data. Data is considered normal if the $p - value > 0{,}05$, while a value less than this indicates that the data do not follow a normal distribution.
   b. Homogeneity testing is also conducted with IBM SPSS Statistics 27, using the Levene Test (Sianturi, 2022) as a prerequisite for the Paired Sample T-test, to

ensure homogeneity of the pre-test and post-test data. Data are deemed homogenous if the significance from the Levene test is more than 0.05, and considered not homogenous if the significance is less than that.

If the data are neither normal nor homogenous, the analysis proceeds with a non-parametric statistical test, namely the Wilcoxon Signed-Rank Test (Nida & Julianingsih, 2023). Rejection of H_0 and acceptance of H_1 occur if $p - value < 0{,}05$.

RESULTS AND DISCUSSION

The study conducted with students from the Mathematics Education program at Adzkia University, focusing on the Selected Topics in Secondary School Mathematics course specifically on quadratic functions, utilized a textbook with a realistic approach. Data from pretests and posttests assessing student learning outcomes are presented in the following Table 3. This approach allowed for a detailed analysis of the educational impacts of realistic teaching methods on students' understanding and application of mathematical concepts.

Table 3. Descriptive Statistics for Pretest and Posttest Results

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Pretest	13	37.50	62.50	50.9615	8.00641	64.103
Postest	13	62.50	100.00	89.8077	13.16805	173.397
Valid N (listwise)	13					

As illustrated in Table 3, there is a clear significant improvement in student performance from the pretest to the posttest, both in terms of the average scores and the range of scores. The average increased from 50.9615 to 89.8077, and the maximum score range expanded from 62.50 in the pretest to 100 in the posttest. The increased variability of scores, as indicated by higher standard deviations and variance in the posttest, suggests that while many students showed improvement, there was also a greater variation in the extent of their improvement, with some students excelling significantly, thereby elevating the overall average.

The analysis results indicate that the low average pretest score with low variance suggests that students' initial understanding of the material was limited and relatively homogeneous, with most students having a similar level of knowledge before the learning process. However, after using the Selected Topics in Secondary School Mathematics Textbook with a realistic approach, there was a significant rise in the average posttest score, indicating

that this approach effectively enhanced students' overall learning outcomes. This significant improvement demonstrates that students were able to connect abstract mathematical concepts to real-life conditions, permitting them to comprehend the material more deeply and meaningfully.

Although there was a significant improve in the average posttest score, the high variance in posttest scores reveals that there were individual differences in students' levels of understanding. This indicates that not all students experienced the same level of improvement, even though the teaching method was generally effective. Some students showed very high improvement, while others experienced more moderate gains, resulting in a wider distribution of scores. These findings suggest that the realistic approach was generally effective in enhancing conceptual understanding, but a more adaptive and personalized teaching strategy is needed to accommodate individual differences in learning pace and style. Therefore, a more varied teaching method and targeted interventions are necessary to bridge the understanding gap and ensure that all students benefit optimally from this approach.

The data from the pretests and posttests were examined using the N-gain formula, yielding the following results.

Table 4. N-Gain Score

No	Name	Pretest	Postest	N Gain Score	N-Gain Criterion
1	AO	50	87,5	0,75	High
2	AF	62,5	95	0,87	High
3	GAM	62,5	90	0,73	High
4	ANJ	50	100	1	High
5	APY	50	100	1	High
6	PM	50	87,5	0,75	High
7	WAA	50	87,5	0,75	High
8	RF	50	100	1	High
9	SPY	50	95	0,9	High
10	PPY	37,5	62,5	0,4	Medium
11	N	50	100	1	High
12	RH	62,5	100	1	High
13	SA	37,5	62,5	0,4	Medium

According to Table 4, the analysis of N-Gain results shows that 11 students are in the High N-Gain criterion with rating range from 0.73 to 1, indicating a very significant improvement. Among them, 5 students achieved the maximum N-Gain score of 1, which suggests that they were able to attain perfect posttest scores after using the realistic

approach in learning. This result demonstrates remarkable effectiveness in connecting abstract concepts to real-life contexts, facilitating students' comprehension of the content being taught. On the other hand, 2 students fall into the Medium N-Gain criterion with a score of 0.4, which reflects a moderate improvement, although not as high as the other group. These students had relatively low pretest scores (37.5), indicating that their initial understanding of the material was limited. Nevertheless, all students showed an improvement in understanding after using the Selected Topics in Secondary School Mathematics Textbook with a realistic approach. Importantly, none of the students were in the Low N-Gain criterion, which indicates that this approach is effective for all levels of initial ability. The distribution of N-Gain scores is illustrated in the following figure.

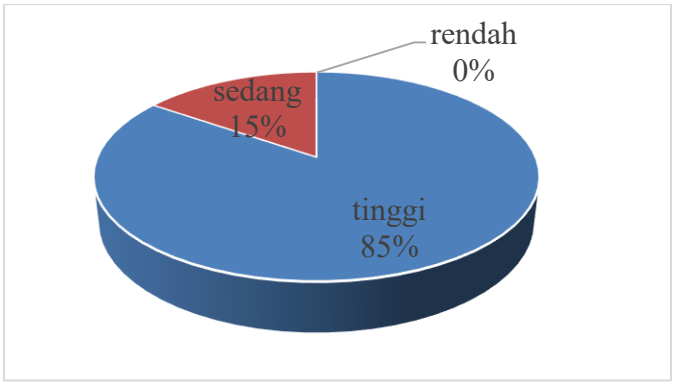

Figure 2. Student Percentage Using N-gain Criteria

As depicted in Figure 2, it is evident that 85% of students achieved a high N-gain score, 15% achieved a medium N-gain score, and notably, no students fell into the low N-gain criterion. The average N-gain scores are detailed in the following table. This distribution highlights the effectiveness of the instructional methods used, demonstrating substantial improvement in most students' performance.

Table 5. Average N-gain Score

Data	N	Average		Interpretation
		N-gain	%N-gain	
Pretest and Posttest Scores	13	0,8115	81,15%	Effective

According to Table 5, the analysis results indicate that the use of the Selected Topics in Secondary School Mathematics Textbook with a realistic approach is generally effective in enhancing students' learning outcomes. This is evidenced by the average N-Gain Percentage

of 81.15%, which falls under the "Effective" category according to Table 2 of N-Gain interpretation, where N-Gain Percentage > 75% is categorized as "Effective". These findings demonstrate that, overall, students' comprehension significantly enhanced after using the textbook with a realistic approach. Overall, the average N-Gain Percentage of 81.15% reflects that the Selected Topics in Secondary School Mathematics Textbook with a realistic approach is effective in assisting students in making the connection between abstract mathematical concepts and real-life conditions. This improvement in understanding occurred across all students, indicating that this approach is effective for different levels of prior knowledge, regardless of whether they had a strong or weak initial understanding.

In general, the high average N-Gain Percentage indicates that the realistic approach not only improves overall learning outcomes but also enhances conceptual understanding and motivates students to learn more actively and meaningfully. By connecting mathematical concepts to practical applications in daily life, this approach effectively develops students' critical and analytical thinking skills.

In order to ascertain whether there is a significant difference between before and after the use of the Selected Topics in Secondary School Mathematics Textbook, a t-test will be conducted. Before proceeding with the paired sample t-test, the normality of the pre-test and post-test scores was first verified. Given the sample size of 13 data points, the Shapiro-Wilk normality test was employed to evaluate the average values of the pre-test and post-test. The results of this test can be observed in the SPSS 27 output illustrated in the figure below.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.317	13	<,001	.795	13	.006
Postest	.277	13	.007	.745	13	.002

a. Lilliefors Significance Correction

Figure 4. Results of the Normality Test

Based on Figure 4, the results from the Shapiro Wilk statistical test for the pretest and posttest are 0.795 and 0.745, respectively, with significance values of 0.006 and 0.002, both below the threshold of 0.05. This implies that the pretest and posttest data do not follow a normal distribution. Due to the non-normal distribution of the data, the paired sample t-test

is not applicable; therefore, further statistical analysis is conducted using non-parametric methods, including the Wilcoxon Signed-Rank Test. The results of the Wilcoxon Signed-Rank Test can be seen in the following figure.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The median of differences between Pretest and Postest equals 0.	Related-Samples Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.

a. The significance level is ,050.

b. Asymptotic significance is displayed.

Related-Samples Wilcoxon Signed Rank Test Summary

Total N	13
Test Statistic	91.000
Standard Error	14.217
Standardized Test Statistic	3.200
Asymptotic Sig.(2-sided test)	.001

Figure 5. Results of the Wilcoxon Signed Rank Test

Based on Figure 5, it is observed that the Wilcoxon statistical test yielded a result of 91 with a significance value of 0.001, which is below the threshold of 0.05. Consequently, the alternative hypothesis (H_1) is accepted and the null hypothesis (H_0) is rejected. This shows that there is a significant difference in student learning outcomes before and after the use of the the Selected Topics in Secondary School Mathematics Textbook with a Realistic Approach.

The use of the the Selected Topics in Secondary School Mathematics Textbook with a Realistic Approach has positively influenced students' ability to understand and apply mathematical concepts. Students who initially struggled with complex mathematical concepts such as quadratic functions showed marked enhancement in solving mathematical problems after using the textbook based on a realistic approach. This result is consistent with earlier studies indicating that learning methods integrating real-world contexts into the curriculum significantly enhance educational benefits (Tandian et al., 2023).

Additionally, research by Sari & Yustiana (2021) supports this finding by stating that textbooks designed with realistic principles provide more relevant learning contexts, contributing to better concept comprehension compared to traditional learning. This result is further supported by a study by Mawardi et al. (2020), which demonstrates that textbooks

with a realistic approach are effective in enhancing mathematical understanding, indicated by a high effect size of 3.5.

The N-Gain score obtained in this study was 0.81, which is categorized as high effectiveness. This result is notably higher compared to similar findings in recent educational research. For instance, Mawardi et al. (2020) reported N-Gain scores of 0.64 and 0.60 when implementing guided inquiry worksheets, falling into the moderate category. Similarly, (Tandian et al., 2023) obtained an N-Gain of 0.68 (68.19%) in their study utilizing Big Book media, which was also categorized as moderately effective. The superior N-Gain in this study suggests that the specific realistic approach integrated into the 'Selected Topics' textbook is highly effective in optimizing student understanding and outperforms the moderate gains observed in these comparative studies.

Based on these findings, the Selected Topics in Secondary School Mathematics Textbook with a realistic approach can be recommended as an effective learning resource in mathematics education, particularly at the higher education level. This approach is also highly relevant for broader implementation in the mathematics curriculum to help students better understand abstract concepts and relate them to real-life contexts. Overall, these results provide a strong scientific basis for developing instructional materials using a realistic approach in other mathematical topics, thereby enhancing the overall quality of mathematics education in Indonesia.

Despite the positive findings, this study has several limitations that should be acknowledged. First, the sample size was relatively small (N=13) and involved only a single class, which may limit the generalizability of the results to a broader population of mathematics students. Second, the intervention was conducted over a short period (four meetings), which might not fully capture the long-term retention of the concepts learned. Third, the instrument used was limited to two essay questions focused on quadratic functions. Future research is recommended to employ a larger sample size, a longer intervention duration, and a more comprehensive set of instruments covering various mathematical topics to further validate these findings.

CONCLUSION

The conclusion of this study indicates that the use of the selected topics in secondary school mathematics textbook with a realistic approach significantly enhances the learning outcomes of students in the mathematics education program at Adzkia university. Data analysis from the pretest and posttest results shows the average scores increased significantly from 50.9615 to 89.8077, signifying an improvement in students' competencies in the quadratic functions material. Furthermore, the n-gain analysis yielding an average percentage of 81.15% demonstrates that the teaching method implemented in this textbook is highly effective. The interpretation of the N-gain values confirms that the majority of students experienced significant improvements in their abilities following the application of this learning approach in their educational process. Additionally, the results from the Wilcoxon signed rank test, which provided a significance value of 0.001—well below the conventional threshold of 0.05, strengthen the statistical evidence that there is a significant difference in student learning outcomes before and after the textbook's implementation. The acceptance of the alternative hypothesis (H_1) and the rejection of the null hypothesis (H_0) in this test affirm the textbook's success in enhancing students' mathematical understanding and skills.

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