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THE ROLE OF GEOGEBRA SOFTWARE IN CONCEPTUAL UNDERSTANDING AND ENGAGEMENT AMONG SECONDARY SCHOOL STUDENT

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ABSTRACT

This study aims to identify the impact of GeoGebra software on conceptual understanding and engagement in the topic of Functions and Quadratic Equations in One Variable in high school. The study was conducted in a quasi-experimental design with 60 students at a secondary school in Muallim district. The study results were analyzed using descriptive statistics, inference, and the Pearson Correlation. Descriptive analysis indicates that students have a strong grasp of the topic taught, particularly showing high conceptual understanding and maximum engagement in interactive activities. Inference statistics reveal a significant difference in conceptual understanding levels between the treatment and control groups among Level Four students regarding Quadratic Functions and Equations in a Variable. In addition, there were significant differences in student engagement between the treatment and control groups. There is a significant relationship between the level of student engagement and students' conceptual understanding of Quadratic Functions and Equations in One Variable for both groups. In conclusion, using GeoGebra software has an impact on the relationship between understanding the concept and involving students in learning the topic of Quadratic Functions and Equations in a Variable.

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1. INTRODUCTION

The use of GeoGebra software-based technology can help students improve their mathematical skills (Mohd Saad et al., 2023; Santos-Trigo, 2019). The use of GeoGebra gives students more opportunities to visualise geometry concepts, which often helps low-achieving students. Its use can be accessed online and is widely used to explore mathematical concepts and ideas. Zulnaidi et al. (2020) found that the use of GeoGebra software can clearly explain concepts in the subtopics of three subjects, which are geometry, algebra, and calculus, and increases student engagement through interactive engagement, problem-solving skills, interest, and feedback in the classroom. Nzaramyimana et al. (2021) argues that incorporating GeoGebra into instruction supports students in comprehending complex mathematical concepts and conducting detailed analyses of diverse graphs. For example, Hamzah and Hidayat (2022) stated that students can use GeoGebra software to explain the graph for the highest power polynomial function, domain and range, maximum point or minimum point, and the intersection of lines for an equation. Many studies conclude that GeoGebra software is an effective tool in the teaching and learning process, especially in geometry (Hidayat & Wardat, 2023; Malatjie & Machaba, 2019; Yohannes & Chen, 2023). For example, students are inert in the conventional teaching and learning process and not given enough opportunity to study from various sources and activities, restricting their interest and learning to improve their understanding, build their self-learning abilities, and communicate with one another in class. Learning environments controlled by the lecturer also affect students' affective engagement, such as interest and achievement orientation, and behavioural engagement, such as attentiveness and diligence.

Conceptual understanding is fundamental in developing thinking skills to solve learning problems through principles, laws, and theories from facts, incidents, and experiences (Yatim et al., 2022). Students' ability to abstract mathematical concepts varies in determining mathematical objectives and identifying which problems they face (Amelia et al., 2020; Shroff et al., 2019). However, the findings of research studies state that most students need help to understand mathematical concepts clearly (Chang et al., 2022; Hamzah et al., 2021; Yoon et al., 2021). Students who need clarification about concepts will have problems connecting to concepts linked to the concept being learned (Putri & Wardika, 2020). Suppose a student has a misconception when expressing a mathematical idea. In that case, they have been through information processing, memorising, or interpreting, leading to an incorrect understanding of the concept. For example, students cannot distinguish between quadratic expressions and quadratic functions (Utami & Jupri, 2021). The teachers did not provide opportunities for the students to connect the idea of functions and quadratic equations in one variable in level four in the context of daily life because students acted as the primary audience for the emphases on mathematical relationships in the classroom. Thus, the ability to make connections between mathematical issues, understand the connections between concept representations, and use mathematical ideas in other contexts still needs to be realised.

In the Malaysian context, understanding functions and quadratic equations in one variable is an essential component frequently questioned in the National examination. Most students still need help finding the topic of quadratic equations (Baring & Alegre, 2019). The results of the study by Septian et al. (2020) show that students with low achievement are relatively weak in the domain of quadratic equations, which makes it more challenging to answer correct problem-solving questions, numerical questions, draw graphs, and determine maximum and minimum points on public examinations (Mutambara et al., 2019). Ozkan and Topsakal (2021) stated that students who lack potential and are not motivated in mathematics classes show negative behaviours when being bored, not interested, or not having fun would disrupt the teacher's instruction in the classroom. Recent years have seen teaching approaches play an important role in engaging students' interest in mathematical concepts (Attard & Holmes, 2022). Modernised teaching can combine the best elements of conventional teaching and e-learning by promoting collaborative learning alongside a computing platform in the form of an online e-learning medium with practical ways of visuals and graphs and drawing three-dimensional shapes using pencils and compasses (Putra et al., 2021; Sahni, 2019; Zulnaidi et al., 2020). For example, students are inert in the conventional teaching and learning process and not given enough opportunity to study from various sources and activities, restricting their interest and learning to improve their understanding, build their self-learning abilities, and communicate with one another in class. Learning environments controlled by the lecturer also affect students' affective engagement, such as interest and achievement orientation, and behavioural engagement, such as attentiveness and diligence (Santiago & Alves, 2022; Selvanathan et al., 2020).

However, according to the researcher's understanding, only some prior studies examine the effects of using GeoGebra software on students' conceptual understanding and engagement in functions and quadratic equations in one variable in secondary school students. According to Nasir et al. (2022), student engagement activities can improve conceptual understanding and problem-solving through actively participating, which is frequently stimulated by techniques such as cooperative group problem-solving, forecasting the results of class demonstrations, reviewing for understanding followed by discussion and feedback, and contextual problem scenarios where students must synthesise principles to obtain the solutions. Therefore, this study examines the impact of using GeoGebra software on secondary school conceptual understanding and student engagement. Using GeoGebra software will likely increase students' active involvement in learning, especially in solving problems or preparing tasks provided by the teachers. On the other hand, the use of conventional method-based teaching techniques only involves one-way teaching, i.e., teacher-centred teaching, where students only receive information and instruction from the teacher instead of performing activities that can increase their knowledge.

The following questions are included in this research: (1) what is the conceptual understanding level for quadratic functions and equations in one variable among level four students? (2) what is the engagement level for quadratic functions and equations in one variable among level four students? (3) what is the difference in student's conceptual understanding level for the topic of quadratic functions and equations for the control group and treatment group on the post-test for the topic of quadratic functions and equations in one variable among level four students? (4) what is the difference in the level of student engagement between the control group and the treatment group on the post-test for the topic of quadratic functions and equations in one variable among level four students? and (5) what is the relationship between student engagement and student conceptual understanding of quadratic functions and equations for control groups and treatment groups for quadratic functions and equations in one variable among level four students?

The following includes the hypothesis of this research: (1) there is significant difference in the level of conceptual understanding between the control and treatment groups on the post-test; (2) there is significant difference in the level of engagement between the control group and the treatment groups on the post-test; and (3) there is significant relationship between student engagement and student conceptual understanding.

2. METHOD

2.1. Research Design

This study employs a quantitative technique (Creswell, 2021) and a quasi-experimental design. According to Leavy (2022), quasi-experimental designs take advantage of natural settings or groupings; hence, subjects are not randomly assigned. Quasi-experimental studies aim to determine whether a specific treatment influence outcome. This study's quasi-experimental design was chosen based on practical and ethical issues. By utilizing pre-existing natural groups or situations, quasi-experiments do not require subject assignment at random. This study emphasizes comparing the impact of GeoGebra software on learning outcomes to conventional teaching techniques. Quasi-experimental approach, researchers can give the intervention to the treatment group while withholding it from the control group. By contrasting the outcomes of the two groups, pre-test and post-tests, it is possible to assess the effectiveness of the treatment. Despite some inherent drawbacks, such as the absence of random assignment, quasi-experimental designs still provide insightful information about the effects of interventions in real-world settings. This decision in design enables an ethical and valuable analysis of how the GeoGebra software may affect student learning outcomes. This effect is tested by administering a specific intervention to one group while administering it to another and then comparing the results of both groups. Table 1 shows the control and treatment groups, and shows the pretest-post-test non-equivalent groups design.

Table 1. The pretest-post-test non equivalent group design

Group	Pre-Test	Intervention	Post Test
Control	Conceptual understanding test Engagement instrument	GeoGebra	Conceptual understanding test Engagement instrument
Treatment	Conceptual understanding test Engagement instrument	Conventional learning	Conceptual understanding test Engagement instrument

2.2. Sample

The study population included 210 students from six fourth-grade classes at Khir Johari National High School in Muallim district, Perak. A sample of 60 students from two classes was drawn from the population. The study discovered that as many as eight male respondents were in the control group (26.67%). Meanwhile, there were 22 female respondents (73.33%). The treatment group comprised 21 males (70%) and nine women (30%). The research sample was selected through random assignment into groups, ensuring that both groups were nearly identical. This method of random group assignment enabled robust conclusions regarding the cause-and-effect relationship between the independent and dependent variables, such as the impact of GeoGebra software on student engagement, as explored in this study. This approach to experimentation should be applied with care in generalization. Utilizing group random assignment strengthens the argument for causality and facilitates the extension of findings to the broader population, a feature attributed to the randomness of selection. A researcher subsequently subjected the control group to conventional learning and the treatment group to GeoGebra-based instructional techniques. The chosen class consists of fourth-grade students studying Functions and Quadratic Equations in One Variable and using the learning standards in the textbook. Before experimenting, the data collection process began by obtaining permission from Universiti Pendidikan Sultan Idris (UPSI). Informed consent was provided by all participants included in the present work.

2.3. Instruments

The conceptual understanding test instrument in mathematics for quadratic functions and equations in one variable consists of six subjective questions derived from the level four mathematics textbook. This test was created to assess students' grasp of the material using conventional techniques and GeoGebra software to conduct pre and post-testing for treatment and uneven control groups. Six questions are adapted from a level four textbook and provided in bilingual Malay languages and English (Choo et al., 2019). The mark for the comprehension test questions was 40 out of 100 percent. For example, the textbook-adapted test question is "Determine whether is a quadratic expression in one variable or not. From the understanding test, the questions consist of six questions with a total score of 40 marks out of 100. The understanding test marking scheme was adopted and adapted from Minarni et al. (2016). There are five divisions of student performance consisting of the score ranges 80 to 100, which is categorized as Very High; 65 to 79, categorized as High; 50 to 64, categorized as Moderate; 40 to 49, categorized as Low; and 0 to 39, categorized as Very Low. The researcher determined the score divisions for each of the five categories based on the grading system of the Malaysian Examination Board and the Examination Unit of Khir Johari National High School in Muallim district, Perak. The researcher adopted the items for student performance ranging from 49 to 100 marks. In comparison, the scoring for 0 to 39 marks was adapted from modifications of existing student performance assessments.

The engagement instrument was adapted from Shroff et al. (2019). This questionnaire includes four engagement items: interactive engagement, problem-solving skills, interest, and feedback understanding. Interactive engagement, which includes effective interaction, interaction with classmates, and information exchange in multiple media, aids in raising student involvement in the learning process. The response scale for all items represents a five-point Likert scale, i.e., 1. strongly disagree, 2. disagree, 3. Neither agree nor disagree, 4. agree, and 5. strongly agree.

2.4. Data Analysis

The study employed Statistical Package for Social Sciences (SPSS) version 23 to compute frequency, percentage, minimum value, standard deviation, and inferential statistics for each question in the pre-test and post-test of level four students focusing on the conceptual understanding of quadratic functions and equations in one variable. Descriptive and inference analyses were conducted to address the study questions, summarizing data on variables such as means and standard deviations (Pallant, 2020). This study aims to determine the minimum value and standardized percentage to investigate the impact of utilizing GeoGebra software on conceptual understanding and engagement. The minimum score and its interpretation on this five-point Likert scale were adapted from Abu-Baker et al. (2019).

The analyses involved an independent sample t-test (Pallant, 2020), with the intervention versus the control group as the independent variable and the conceptual understanding of student participation in the probe question as the dependent variable. The independent sample t-test was employed to assess the null hypothesis. The independent t-test for the quasi-experimental non-equivalent control group design and post-test can be conducted in this study while comparing interactive learning using GeoGebra software with conventional approaches to instructing quadratic functions and equations in one variable. In an independent t-test, the variances of the two groups being compared should be equally homogeneous and have a normal distribution. Commonly used significance levels are 0.05 (5%) values. These values can also be selected based on the unique study environment or hypothesis, marking the cutoff point beyond which the test statistic (t-value) would result in the rejection of the null hypothesis.

Moreover, Pearson correlation is the most widely used correlation analysis in educational studies. Pearson correlation analysis examines the association between two variables when the data are intermediate or ratio (Wilcox, 2009). Although Pearson correlation analysis is commonly employed for intermediate or ratio data, recent studies have found that it can also be used for ordinal-scale data. Pearson correlation analysis is used to determine the linear relationship between two pieces of data. It is a parametric analysis that assumes a probability distribution. The present study explores the relationship between student engagement and student conceptual understanding.

3. RESULT AND DISCUSSION

3.1. Results

The following is a descriptive analysis to answer the study question, 'What are the conceptual understanding level and engagement level for the topic of quadratic functions and equations in one variable among level four students?' The mean score and standard deviations are employed in the descriptive analysis of this study. Table 2 depicts the descriptive analysis of the conceptual understanding level for quadratic functions and equations in one variable among form four students.

Table 2. Descriptive analysis of the conceptual understanding

Group	Test	N	Mean	Standard Deviation	Level
Control	Post	30	73.467	5.532	High
Treatment	Post	30	82.267	7.529	Very High

Table 2 shows the mean score and standard deviation of the conceptual understanding test score for quadratic functions and equations in one variable, namely the control group and the treatment group. The post-test score for the control group experienced an increase in the mean (M = 73.47; SD = 5.53). Subsequently, the conceptual understanding test for the treatment group improved after the teaching and learning session using GeoGebra software with a Min at a very high level, which is (M = 82.27; SD = 7.53). It means that students who utilize GeoGebra software demonstrate superior conceptual understanding compared to those taught through traditional methods when studying quadratic functions and equations in one variable. Table 3 is an analysis and report designed to answer the study's question, "What is the level of engagement for the topic of functions and quadratic equations in a single variable among level four students?"

Table 3. Descriptive analysis of the engagement level

Sub-construct	Mean	Standard Deviation	Level
Interactive engagement	3.92	0.35	High
Problem-solving skills	3.77	0.28	High
Interests	3.86	0.36	High
Feedback	3.91	0.41	High
Overall	3.86	0.18	High

Table 3 displays the engagement sub-constructs' min-values and standard deviation. The highest min-value for the engagement sub-construct (M = 3.92; SD = 0.35), which is at the high level, is interactive engagement. Following that, problem-solving skills (M = 3.91; SD = 0.41) was the lowest. It means that students exhibit a high level of engagement across various sub-constructs, albeit at differing levels, ultimately falling under the category of active engagement. This finding highlights the diversity in students' levels of active engagement and underscores the importance of recognizing and addressing individual differences in engagement within classroom.

3.1.1. Independent t-test of conceptual understanding

The independent sample t-test in this study was used to determine the difference in the level of conceptual understanding between the control and treatment groups on the post-test of the topic of quadratic functions and equations in one variable among form four students. The Kolmogorov-Smirnov analysis for the conceptual understanding test is displayed in Table 4 to examine the normality of data.

Table 4. Kolmogorov-Smirnov test of conceptual understanding

Group	Kolmogorov-Smirnov			Skewness	Kurtosis
	Statistics	**Df**	**Sig**		
Control	0.129	30	0.200	0.231	0.481
Treatment	0.181	30	0.013	0.627	0.301

Table 4 shows that no significant values for the conceptual understanding test for the control group: sig. = 0.200 ($p>0.05$), which is normally distributed. For the treatment group conceptual understanding test as well, Kolmogorov-Smirnov shows sig. = 0.013 ($p<0.05$), which is not normally distributed. However, the skewness (0.231) and kurtosis (0.481) are between -2 and +2 (Mardia, 1970). It means that the distribution of students' conceptual understanding scores in the test for quadratic functions and equations in one variable among level four students remains normal. Consequently, the independent sample t-test remains applicable for comparing the conceptual understanding test results between the control and treatment groups. The results of the analyses are shown in Table 5.

Table 5. Level of conceptual understanding in the control and treatment groups

Group	N	Mean	Standard Deviation	t value	df	sig
Control	30	73.47	5.532	-5.159	58	0.001
Treatment	30	82.27	7.529			

Table 5 shows a significant difference in the level of conceptual understanding between the control and treatment groups on the post-test for the topic of quadratic functions and equations in one variable among level four students, with a t-value = -5.159 and sig. = 0.001 ($p<0.05$). The finding indicates that the null hypothesis (Ho) of a significant difference in conceptual understanding based on the group is rejected. The conceptual understanding of the treatment group and the control group is different. It means that students in the treatment group, utilizing GeoGebra software, exhibit a superior level of conceptual understanding compared to students in the control group, who follow a conventional teaching approach.

3.1.2. Independent t-test of engagement

In this study, the independent sample t-test is used to compare the level of engagement between the control and treatment groups for quadratic functions and equations in one variable among level four students. Table 6 displays the Kolmogorov-Smirnov analysis for student engagement in quadratic functions and equations in one variable among level four students.

Table 6. Kolmogorov-Smirnov of engagement

Kolmogorov-Smirnov				Skewness	Kurtosis
Group	**Statistics**	**Df**	**Sig**		
Control	0.135	30	0.173	0.168	-0.215
Treatment	0.151	30	0.081	0.151	0.482

Table 6 indicates that there was no statistically significant difference in the student engagement level between the control and treatment groups during the pre-test (p > 0.05). This suggests that student engagement in both groups followed a normal distribution. Additionally, the skewness values ranging from 0.151 to 0.168 and kurtosis values ranging from -0.215 to 0.482 fell within the range of -2 to +2, indicating a normal distribution of data. It means that the independent sample t-test can be performed to engage level four students in the topic of quadratic functions and equations in one variable between the control and treatment groups. Table 7 shows the findings of the analysis.

Table 7. Level of engagement levels of the control and treatment groups

Group	N	Mean	Standard deviation	t value	df	sig
Control	30	3.645	0.105	-2.268	58	0.027
Treatment	30	3.813	0.393			

Table 7 demonstrates a significant difference in the level of engagement between the control and treatment groups on the post-test of the topic of functions and quadratic equations in one variable among level four students, t = -2.268 and sig. = 0.027 (p<.05). According to the study findings, the post-test treatment group (M = 3.813 and SD = 0.105) was higher than the control group (M = 3.645 and SD = 0.393). A significant difference in the level of engagement between the control and treatment groups on the post-test of the topic of functions and quadratic equations demonstrates that the null hypothesis (Ho) that there is no significant difference in engagement level between control and treatment groups on the post-test of quadratic functions and equations in one variable among level four students is rejected. Student engagement for the treatment groups is different, which is teaching and learning based on GeoGebra software and teaching and learning based on conventional services.

3.1.3. Relationship between engagement and the conceptual understanding test

The study hypothesis used in this study was there is no significant relationship in the level of involvement between control and treatment groups on the post-test for the topic of functions and quadratic equations in one variable among level four students. The results of the analysis are shown in Table 8.

Table 8. Relationship between engagement and conceptual understanding test

Variable	Conceptual Understanding	
	Sig	***r***
Engagement	0.030	0.396

Table 8 demonstrates a significant correlation between engagement and the conceptual understanding test on quadratic functions and equations in one variable among form four students, with r = 0.396 and sig. = 0.030 ($p<0.05$). Data analysis demonstrated a low association between engagement and conceptual understanding achievement tests, with a positive correlation. Positive correlation does not support the null hypothesis (Ho) that no significant correlation exists between engagement and the conceptual understanding test of quadratic functions and equations in one variable among form four students. Student engagement significantly affects the conceptual understanding of quadratic functions and equations in one variable among form four students.

3.2. Discussion

Based on the findings of incorporating GeoGebra software into the treatment group, we found that the conceptual understanding test for the treatment group improved after the teaching and learning session using GeoGebra software with a very high level of student's ability to comprehend and portray problems in the form of quadratic equations. This aligns with previous research (Christmas et al., 2013), which indicated that students could perform the assignments independently after spending enough time understanding quadratic equation functions, communicating with competent others, and using GeoGebra software as a scaffolding tool. Students can demonstrate traits relating to mathematical understanding that are essential to the problem of quadratic functions and equations in one variable. Students can also solve quadratic function and equation operations such as effectively determining the values of a,b, and c for a quadratic expression, explicitly determining the graph form of the following quadratic function, whether there is a minimum or maximum, precisely calculating the value of c for a function of a quadratic equation, precisely determining whether the following value is a term for the given quadratic equation or not, and determining the term for the following quadratic equation by factoring method correctly. GeoGebra aids in the development of algebraic ideas. Sometimes using the correct concept in the wrong context can lead to frequent misconceptions. At the same time, the errors in the calculation that students make in the control group will reduce the mark of their achievement test compared to the treatment group. Therefore, this study supports the freelance study showing that GeoGebra significantly impacts the teaching and learning process regarding topic functions and quadratic equations in one variable among level four students.

According to the study's findings, students in both the control and treatment groups actively participate in teaching and learning functions and quadratic equations in one variable if the teacher takes proactive steps to ensure each student is familiar with the fundamental ideas in every learning standard in the textbook. The fundamental idea is to ensure that students may fully engage in the instruction, which is a vital role performed by teachers. To attract students' interest in a lesson's subject, teachers should change their teaching strategies in the classroom. In order to visualize lessons that require drawing graph sketches and defining a coordinate point, teachers can also employ technology-based teaching tools like the GeoGebra software. Incorporating GeoGebra in classroom instruction can enable students to grasp mathematical concepts without the need for rote memorization. This discovery supports the idea prior research (Hidayat et al., 2023; Hiranyachattada & Kusirirat, 2020) that students can comprehend classroom teaching approaches; however, traditional teaching methods emphasize the importance of building foundational understanding before delving into new concepts introduced by the teacher. As a result, students' prior knowledge of the treatment group contributes more to topic achievement. Low-achieving students, particularly those in control groups, require more effective alternative teaching strategies to help them learn new information. Hence, students who possess a strong conceptual understanding benefit more from using GeoGebra software compared to those with misconceptions who do not utilize GeoGebra.

The results of our study indicate a significant effect of GeoGebra software on students' conceptual understanding. This current finding is consistent with previous research (Putra et al., 2021; Zulnaidi et al., 2020). Through active interaction with GeoGebra's interactive features and tools, students have had the opportunity to actively engage with and manipulate mathematical objects, graphs, and equations. This hands-on approach has facilitated a more profound grasp of abstract concepts by enabling students to visualize and interact with them in a dynamic and immersive manner. The visual representations offered by GeoGebra have played a vital role in improving students' understanding and intuition regarding mathematical relationships. Moreover, GeoGebra's collaborative features have enabled students to engage in peer-to-peer interactions and discussions, fostering a cooperative learning environment. Through collaboration, students can express and exchange ideas, receive valuable feedback from their peers, and participate in meaningful mathematical discourse. This collaborative learning approach has enhanced their conceptual understanding by exposing them to diverse perspectives and alternative problem-solving strategies. Hamzah and Hidayat (2022) indicated that using GeoGebra software had positively impacted various aspects of mathematics education. The review revealed that incorporating GeoGebra in instruction can improve academic performance, conceptual understanding, motivation, visualization skills, engagement levels, interest in mathematics, critical thinking abilities, mathematical reasoning, and problem-solving capabilities. This study showed that students were actively engaged in behavior by paying attention, listening, and asking questions to teachers and peers during teaching and learning sessions using GeoGebra software. Our results support the previous works (Groening & Binnewies, 2019; Zainuddin et al., 2020). Students actively participate in the classroom due to the GeoGebra software's ability to assist in increasing student engagement in learning, proficiency in use, and student self-awareness of interest in learning this topic. GeoGebra provides a dynamic and interactive learning environment where students can explore mathematical concepts through hands-on exploration. They can manipulate objects, graphs, and equations in real-time, allowing them to engage with the material and deepen their understanding actively. Moreover, GeoGebra supports inquiry-based learning, encouraging students to independently investigate and discover mathematical relationships. They can pose questions, formulate hypotheses, and test them using the software's tools. This empowers students to take ownership of their learning and fosters a sense of curiosity and engagement. The utilization of GeoGebra software during mathematics lessons not only enhances student engagement but also positively influences their motivation and attitudes toward learning.

Student engagement significantly affects the conceptual understanding of quadratic functions and equations in one variable among level four students. This finding is consistent with previous studies conducted by Al Mamun and Lawrie (2023), Bulatbaeva et al. (2023), Stephenson et al. (2020) and Sukor et al. (2021). The concept of interest in engagement pertains to students' concentration, concern, and active involvement in their educational encounters. Another possible justification for the impact of engagement is deeper comprehension. Another possible justification for the impact of engagement is deeper comprehension. When fully engaged, students have a higher probability of acquiring a comprehensive comprehension of concepts. Their active involvement enables them to establish connections, pose inquiries, and delve into ideas, leading to a deeper understanding of the subject matter. Engaging students is essential for maximizing the efficacy of learning activities, especially when they are aligned with established standards and tailored to optimize the overall learning experience. When these activities align with established standards and optimize the learning experience, student engagement through active participation, commitment, and attentiveness becomes a significant factor that positively correlates with academic success. Lastly, engagement fosters an environment that stimulates critical thinking and encourages students to actively participate in problem-solving. This involvement increases the likelihood of analyzing information, assessing evidence, and utilizing their knowledge to solve intricate problems, thereby promoting the development of higher-order thinking abilities.

4. CONCLUSION

Many students require assistance in grasping mathematical concepts thoroughly. When a student holds a misconception while articulating a mathematical idea, it typically stems from processes such as information processing, memorization, or interpretation, resulting in an inaccurate grasp of the concept. For instance, some students may struggle to differentiate between quadratic expressions and quadratic functions. This research delves into the effect of integrating GeoGebra software on both conceptual understanding and student engagement in secondary school. The results indicate a significant difference in conceptual understanding levels between the treatment and control groups among Level Four students concerning Quadratic Functions and Equations in one Variable. Furthermore, significant differences were observed in the levels of student engagement between the treatment and control groups. Importantly, a significant correlation was identified between the level of student engagement and students' conceptual understanding of Quadratic Functions and Equations in One Variable for both groups. In summary, this study emphasizes the potential of GeoGebra as a valuable tool in enhancing the effectiveness of mathematics education, leading to enhanced conceptual understanding and increased student engagement.

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