The Effectiveness of the GeoGebra-Assisted Inquiry-Discovery Learning Strategy on Students' Mastery and Interest in Algebraic Expressions

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***Abstract*—This study aimed to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery and interest in algebraic expressions. The Malaysian Ministry of Education recommends investigation or experimentation activities and the use of dynamic software technologies in mathematics lessons because these activities can improve students' mastery and interest. Therefore, this study was conducted to overcome the problem of low concept mastery and lack of students' interest in Basic Arithmetic Operations involving Algebraic Expressions. This quantitative study was carried out with quasi-experimental design. A total of 60 form students from a secondary school in Johor, divided into two groups: experimental group of GeoGebra-assisted inquiry-discovery learning strategy consisting 30 students, and a control group of standard textbook-based learning consisting of 30 students. The study sample was selected by a simple random sampling technique. The instruments used in this study were a modified pre-mastery and post-mastery test and questionnaires. The quantitative data in this research was analyzed based on descriptive and inferential statistics using Statistical Packages for Social Science (SPSS) software Version 28.0. The Wilcoxon test results showed that there are significant differences between experimental group ($M = 50.20$, $SD = 18.63$) and control group ($M = 41.97$, $SD = 17.81$) on students' mastery and interest after using GeoGebra-assisted inquiry-discovery learning strategy. The findings also show that there was a fairly strong positive relationship between students' mastery and interest, which was statistically significant using Spearman's rho correlation analysis ($p = 0.001$). In conclusion, GeoGebra-assisted inquiry-discovery learning strategy can improve students' mastery and interest in Algebraic Expression.**

***Index Terms*—Algebra, algebraic expressions, GeoGebra, inquiry-discovery**

I. Introduction

The field of Relations and Algebra is one of the learning areas in Form One's KSSM (Standard Secondary School Curriculum) Mathematics. At the beginning of the Relations and Algebra field, students start learning and using letters, symbols, or signs as representations of numbers and quantities. The topic of Algebraic Expressions introduces students to the basic concepts of expressions that combine numbers, variables, or other mathematical symbols with operations.

At an early stage, students need to master the application of basic arithmetic operations such as addition, subtraction, multiplication, and division involving algebraic expressions. However, the current scenario indicates that students' mastery of applying basic arithmetic operations involving algebraic expressions is still at a low level. Students often express disinterest in learning subtopics related to basic arithmetic operations involving algebraic expressions.

Therefore, the mastery of concepts and students' interest in basic arithmetic operations involving algebraic expressions need to be emphasized and well-developed from the beginning so that students can apply these skills when dealing with topics related to geometry, statistics, and calculus. The ability to apply basic arithmetic operations involving algebraic expressions is highly crucial when students reach the upper middle stage, where they encounter more complex mathematical problem-solving.

II. Literature Review

A. Student Learning Mastery Problems in Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions

Although the secondary school education system in Malaysia has experienced a curriculum transformation starting in 2017, the Ministry of Education Malaysia [1] found that the level of mastery of Malaysian students is still low in relation to basic topics in algebra. Algebra domain items related to Basic Arithmetic Operations involving Algebraic Expressions in in Programme for International Student Assessment (PISA) 2018 and Trends in International Mathematics and Science Study (TIMSS) 2019 were found to be unable to be answered well and weak in conceptual mastery [1–3]. Past studies also prove that secondary students are still faced with the problem of conceptual mastery in the Basic Arithmetic Operations involving Algebraic Expressions [4–7]. This scenario is further strengthened by the study of Leong and Shah [8], which proves that algebraic expressions are a difficult topic among the topics in form one mathematics.

Lower secondary school students found it difficult to master the concept of Basic Arithmetic Operations involving Algebraic Expressions because there are still students at the transition stage from concrete to formal thinking [9]. Other than that, Saputro *et al.* [10] explained that the level of cognitive development of students aged 12 and above would experience a change in the formal operational stage. Students can reason using the relationship between objects in life to relate to mathematical problems [11]. However, lower secondary school students experience the transition process of cognitive abilities from the development of concrete operations to formal operations [5]. When these students are exposed to algebraic thinking, students will have difficulty

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understanding the concept of algebra because it involves abstract thinking [12].

Abstract thinking in algebra at the lower secondary level occurs when algebra becomes a general form of arithmetic [5]. Students learning algebra at the secondary school level are first exposed to letters and symbols that are used to form algebraic arithmetic [13]. This change makes the content of algebra abstract [12]. Therefore, algebra is considered a difficult topic in mathematics, causing the algebraic expressions topic to be difficult for students to master [8]. Likewise, Egodawatte [14] stated that the topic of algebraic expressions becomes difficult when students can not differentiate in determining the value of variables when it comes to basic arithmetic operations, namely the operations of addition, subtraction, multiplication and division.

Jubri *et al.* [15] also explained that students' low mastery of Basic Arithmetic Operations involving Algebraic Expressions could be seen when students often feel confused about carrying out addition and subtraction operations for expressions with negative signs. Furthermore, students are weak in the skills of multiplying and dividing between terms that have a power of more than one [12]. In addition, students have problems with remembering, recalling, procedural and conceptual knowledge [8]. Apart from that, Baco and Ishak [3] stated that the problem of student mastery stems from basic concepts that are not explained well at the initial stage, causing students to be unable to form a deep understanding of concepts.

B. The Problem of Students Lacking Interest in Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions

On the topic of algebraic expression, students need to learn many concepts involving abstract concepts, such as the subtopic of Basic Arithmetic Operations involving Algebraic Expressions [15]. When students are exposed to algebra at an early stage, students try to solve problems using arithmetic thinking because students are exposed to algebraic problems that are easy to solve at the primary school level [16, 17]. Nevertheless, in secondary school, problem-solving becomes deeper, and they have to solve by learning to think algebraically [18, 19]. Therefore, students feel that this subtopic is difficult and poorly understood, causing students to feel that they are less interested in topics related to algebra [15]. Less interesting and boring learning strategies reduce student interest [15, 20]. Students' involvement is not utilized to the maximum in conceptualizing subtopic of Basic Arithmetic Operations involving Algebraic Expressions [21]. Students also do not get exposure to fun learning activities in the early stages of the learning session to learn Basic Arithmetic Operations involving Algebraic Expressions. Hence, they view the topic of Algebraic Expressions as an uninteresting and boring topic [22].

Students are less interested when they fail to master the concept of algebraic expressions [23]. Gusniwati [24] stated that interest in learning algebraic expressions is an important factor influencing students to master the concept of algebraic expressions. Interest is the main motivator for students to stay active in learning activities and encourage students to explore [1]. Alternatively, Harackiewicz *et al.* [25] characterized the attitude of students who are interested in a topic, i.e., students will attend class, pay attention, engage in the learning process actively and be able to process information effectively.

C. Students Learning in Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions

Traditional teacher-centered learning strategies are seen as a common practice in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions [26]. However, teachers are only guided by textbooks as a source of reference, causing the learning process to be unenjoyable, meaningless, less challenging, and boring [27]. The passive involvement of students also occurs because students receive information passively through the teacher's one-way explanation without involving the students' existing experience, understanding the examples written in the textbook and trying the drills given [28].

Based on the analysis of the presentation of content and examples in the form one mathematics textbook for the subtopic of Basic Arithmetic Operations involving Algebraic Expressions conducted by Khali and Rosli [26] found that the textbook on this subtopic focuses on formulas, examples, and exercises. The lack of exploration activities and the integration of mathematical tools such as dynamic software related to this subtopic causes students to not be well guided to understand the concept [29]. Other than that, students are not guided to compare the differences between four Basic Arithmetic Operations involving Algebraic Expressions [26].

In addition, the use of textbooks that contain static diagrams causes students' exploration activities to be limited [26, 30]. The first experience of form one student in the application process involving the basic arithmetic of expressions should be given in various assignments so that students can master algebra concepts well [8]. This is due to the variety of activities and tasks that can help improve students' mathematical literacy [26].

The Ministry of Education Malaysia [31] suggests that the classroom selection of materials, media and learning process activities should be appropriate and interest students to form deep abstract concepts. In constructing the concept of Basic Arithmetic Operations involving Algebraic Expressions, students should be guided by being allowed to explore basic arithmetic operations using concrete objects or real situations. This experience is brought to a representation using visuals or diagrams. Correspondingly, the new experience of students is built with representations in abstract form for describing the basic process of arithmetic involving algebraic expressions [26].

D. The Potential of Inquiry-Discovery Learning Strategy in Algebra

The Ministry of Education Malaysia [1] focuses on students mastering deep basic concepts. Note that mastery and understanding of mathematical concepts in algebra can be obtained as a result of the inquiry-discovery learning strategy [31]. Discovery is the main nature of inquiry [32]. Discovery learning happens when the main concepts and principles in algebra are studied and discovered by the students themselves [29]. The activities carried out by students will evaluate the pattern and then reach their conclusions. Subsequently, students will be guided by the teacher to discuss and understand algebraic concepts through the inquiry results. Students are also seen to tend to do hands-on activities when building new knowledge in learning sessions [31]. Inquiry is an approach through experience [31]. Hence, students will search for information, question and investigate a studied concept [33]. With that, students' intellectual development can be developed through experimental methods [34]. Students will be interested in finding answers starting from curiosity. Exploration activities like this allow students to have a meaningful and fun learning experience [35].

Therefore, the Ministry of Education Malaysia [1] suggests investigative or experimental activities be focused on because these activities can enhance students' interest and mastery of a learning topic. The learning process involving inquiry, exploration and investigation of mathematical concepts such as algebra needs to be carried out [31]. The design of learning sessions that give space and opportunities for students to make conjectures, reason, ask questions, make reflections and further form concepts and knowledge independently is seen to increase students' interest, especially in the field of algebra.

E. The Potential of Learning Strategy Using GeoGebra Software in Algebra

The use of technology tools such as dynamic software, graphing calculators, the internet and so on need to be integrated into algebra learning sessions [31]. The use of technology can help students form a deep understanding of a concept, especially involving abstract concepts in algebra [31]. Therefore, inculcating technology such as GeoGebra software is highly encouraged because the national mathematics textbook form one in the mathematics exploration slot on Algebraic Expressions provides a learning activity based on GeoGebra software [26]. Note that GeoGebra software is an open, dynamic software suitable for mathematics learning sessions [36]. This software facilitates learning related to geometry, algebra, and calculus [26, 37]. Students can explore these three areas and relate to each other through the GeoGebra software. GeoGebra software is free to be used by students and teachers [38].

GeoGebra software is very helpful for students in connecting mathematical concepts because this software provides dynamic worksheets [39]. Dynamic worksheets are interactive worksheets that can be accessed online [40]. Various elements can be combined, such as specific text, applets, videos or images, in a flexible worksheet design. Teachers and students can build dynamic worksheets through their accounts [38]. With the availability of dynamic worksheets, it will be easier for teachers to obtain material resources that can be used for activities in class with students and, simultaneously, save teachers time in preparing teaching aids [38]. In addition, students can also easily share work results in dynamic worksheets with teachers and peers through links provided in the GeoGebra software [38]. Students can communicate virtually with peers. Teachers can also hold classes online using GeoGebra software with students [41]. Other than that, interactive and interesting tasks can be given to students allowing teachers to assess the level of student progress in certain tasks either directly or as homework [38].

Therefore, GeoGebra software is very suitable to be used in the preparation of objects visually [42]. GeoGebra software also provides interactive exploration activities for students in algebra at the high school level [38]. In addition, Juwantara [43] recommends that mathematics learning needs to use concrete or visual objects for students to understand and complete learning tasks involving abstract concepts. When using visualization skills, students can improve their cognitive ability by mentally describing the process [44]. This mental process is assisted by using visual images that exist in the form of models, diagrams or any concrete form [15]. Next, students' ability can increase in solving problems related to mathematical questions using visualization methods [45].

F. The Potential of GeoGebra-Assisted Inquiry-Discovery Learning Strategy in Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions

Khali and Rosli [26] found that the GeoGebra technology application slot allows students to explore. Moreover, GeoGebra software provides the Computer Algebra Systems (CAS) Calculator, which can produce symbolic answers [46]. The CAS calculator can make calculations even if the value is given as a symbol. That is, it has a term consisting of variables and coefficients. CAS calculators can manipulate algebraic expressions in operations such as factoring, expanding and simplifying algebraic expressions [46]. This calculator can guide students to explore and find work solutions or check answers when assignments or activities are given at school or at home. With that, the skill of applying Basic Arithmetic Operations involving Algebraic Expressions can be improved.

In addition, the GeoGebra applet is easy to use in activities involving inquiry-discovery [26, 47]. Students' experience related to power to variables was first introduced in the concept of area, perimeter, and volume in primary school through units 2 and 3 [48]. Subsequently, students get further exposure to the topic of Squares [46], in which the concept of repeated multiplication is emphasized. Therefore, the student's existing knowledge needs to be used in inquiry-discovery activities with students using the GeoGebra applet. Students have the opportunity to investigate and compare different operations involved in the concepts of area, volume and perimeter through animating and visually manipulating two and three-dimensional shapes in the GeoGebra applet. Students can also connect with the value of increased power in the use of units, unit 2 and unit 3. With this, students go through the stages of observing, questioning, relating, experimenting, and linking the ability to think in a scientific approach [47].

GeoGebra-assisted inquiry-discovery provides activities that can improve student mastery of mathematical communication because this learning strategy affects students' ability to represent mathematics [26]. This learning strategy involves students actively learning by building their knowledge in Basic Arithmetic Operations involving Algebraic Expressions via making experiments and conclusions about rules or concepts from the results of their experiments [36]. This activity is also based on interest, which promotes integrating new knowledge into the student's existing knowledge [36].

Therefore, this study was conducted to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery and interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. This study is expected to provide ideas and benefits for a more effective learning process and help overcome student difficulties with the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

III. Problem Statement

The intention of the Malaysia Education Blueprint (PPPM) 2013–2025 is to improve the quality of the national education system. The quality of a good education system can guarantee the quality of students in the future. In order to ensure that the academic field of students produced through the national education system is at a high benchmark, students' mastery in knowledge, skills and values must always be identified. If the student's basic mastery is found to be still low, follow-up actions need to be implemented starting from the classroom by practicing various learning strategies so that the student's learning process can be mastered well and can increase student mastery and interest.

In the implementation of curriculum transformation through Standard Based Curriculum for Secondary Schools (KSSM), the mathematics learning strategy emphasizes equal opportunities for students to be actively involved. When students are actively participating in learning activities, the learning process can provide fun, challenging, and useful experiences. Interaction between peers through hands-on activities and the use of appropriate technology makes the student-centered learning process more interesting for students to build their new knowledge and at the same time integrate existing knowledge, especially in forming abstract concepts in the subtopics of Basic Arithmetic Operations involving Algebraic Expressions.

However, traditional learning strategies are still practiced in algebra classes. As a result, students still face mastery problems to understand the main concepts in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. In addition, students' interest will decrease due to poor mastery in the subtopics of Basic Arithmetic Operations involving Algebraic Expressions and other topics which related to algebra.

Thus, the researcher introduced a learning strategy based on inquiry-discovery. This inquiry-discovery learning strategy involves investigative and exploratory activities assisted with open technology software such as GeoGebra software. GeoGebra-assisted inquiry-discovery learning strategies are capable to increase students' mastery and interest in understanding concepts in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Therefore, the researcher conducted this study to determine the effect of GeoGebra-assisted inquiry-discovery learning strategy on the mastery and interest of form one students in the subtopic of basic arithmetic operations involving algebraic expressions.

IV. Research Objectives

This study was conducted with the aim of:

1) Determining the effect of GeoGebra-assisted inquiry-discovery learning strategy on students' mastery in subtopic of Basic Arithmetic Operations involving Algebraic Expressions.
2) Determining the effect of GeoGebra-assisted inquiry-discovery learning strategy on students' interest in subtopic of Basic Arithmetic Operations involving Algebraic Expressions.
3) Identifying whether there is a relationship between students' mastery and interest, in subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

V. Research Methodology

This research used quantitative method with quasi-experimental design to achieve the objectives and answer the research questions. Based on the design of the quasi-experimental study, the researcher compared the scores between the pre-mastery and the post-mastery tests, as well as the pre-and post-questionnaire item scores for the study sample. A quasi-experimental design was chosen in this study because the researcher could not carry out a real experiment in a real situation at school [49]. The design of this study is also in line with the purpose of the study to determine the effect of a learning strategy [49].

In this study, there were 60 form one students from a secondary school in the Muar district, Johor. These students were divided into two groups. The first group, consisting of 30 students, utilized the GeoGebra-assisted inquiry-discovery learning strategy, while the second group, also comprising 30 students, followed the traditional textbook-based learning method. The study sample was selected by a simple random sampling technique. The ordinary mainstream secondary schools were chosen because the school was selected in the pilot program for the development of TIMSS and PISA at the Muar district level. The rationale for selecting form one student population is the possibility that the students involved will be selected for implementing either TIMSS or PISA assessments in the future. Therefore, the researcher hopes that a selected sample of students from the school can be helped in the application skills of Basic Arithmetic Operations involving Algebraic Expressions, and the effects of the GeoGebra-assisted inquiry-discovery learning strategy can be strengthened.

The researchers analysed the quantitative data in this study using both descriptive and inferential statistics through the utilization of Statistical Packages for Social Science (SPSS) software version 28.0. Descriptive analysis involving frequency, percentage and mean. Meanwhile, inferential analysis is Wilcoxon test and Spearman's rho correlation.

In addition, the selected school also needs to have good and comfortable computer lab facilities because this study requires a laptop and a stable internet connection. Hence, the supply of laptops was ensured to be sufficient for use by 30 experimental group samples. Based on Table I, there are 60 form one students selected as the study sample. A total of 33 male students (55%) and 27 female students (45%) were selected. The two classes involved were divided into two groups of 30 students in an experimental group and 30 in a control group.

TABLE I: DEMOGRAPHICS OF THE EXPERIMENT AND CONTROL GROUPS' SAMPLES

Gender	Experimental Group	Control Group
	Frequency (f)/ Percentage (%)	Frequency (f)/ Percentage (%)
Male	17 (56.7%)	16 (53.3%)
Female	13 (43.3%)	14 (46.7%)
Total	30 (100.0%)	30 (100.0%)

However, to ensure that the study sample meets the requirements of the study, the researcher did a preliminary study about the level of mastery of the entire sample of selected students by asking teachers of related mathematics subjects. The characteristics of the samples should consist of students who have studied chapter five of Algebraic Expressions. Nevertheless, these students have a low mastery level in the Algebraic Expressions subtopic involving basic arithmetic operations. At the same time, the student's mastery level is also identified and confirmed through a pre-mastery test.

There are two types of instruments used to measure the dependent variables, namely pre-and post-mastery tests and questionnaires for interest. The pre-mastery and post-mastery tests were modified from the study of Sagit [50]. The study of [50] involved the subtopic of Simplifying Algebraic Expressions with one and two unknowns but in this study involved the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Scores from the pre-mastery and post-mastery tests were used to compare students' mastery levels before and after using a GeoGebra-assisted inquiry-discovery learning strategy. The subtopic involved in this study is Basic Arithmetic Operations involving Algebraic Expressions. The interest-related questionnaire was modified from the study of [37]. The original questionnaire combines the construct of interest and perception. Therefore, the construct of perception was removed for this study. The questionnaire is suitable and makes it easy to get feedback from the study sample in a short time [49]. Apart from that, the questionnaire was distributed only to the experimental group to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. This questionnaire was also conducted before and after the sample through the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Based on the study, the effect of a learning strategy on interest can only be seen after the strategy is implemented [37]. The scale used in the questionnaire is a Likert scale of 1-5 to express the degree of agreement. In scoring, each item will be given a value. Score 1 for Strongly Disagree, 2 for Disagree, 3 for Not Sure, 4 for Agree, and 5 for Strongly Agree. A set of this questionnaire contains 16 items containing two parts, Part A and Part B. Part A contains 4 items and the respondent's background information. Meanwhile, Part B is related to the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in Basic Arithmetic Operations involving Algebraic Expressions.

A. Instrument Reliability

Reliability is the ability of a study to obtain similar values when the same measurement is repeated [3]. The reliability of the instrument was determined through the Cronbach's Alpha analysis using Statistic Packages Social Sciences (SPSS) software version 28.0 [49]. The reliability of the pre-mastery, post-mastery tests and questionnaires were conducted through a pilot study on 10 forms one students. The following are the results of the Cronbach's Alpha test in Table II below.

TABLE II: CRONBACH'S ALPHA TEST RESULTS FOR PRE- AND POST-MASTERY TESTS AND QUESTIONNAIRE ITEMS

Instrument	Cronbach's alpha coefficient	Number of items
Pre-mastery and Post-mastery test	0.93	20
Questionnaires	0.91	12

The Cronbach's alpha for the pre-and post-mastery test was 0.93. Meanwhile, the Cronbach's alpha for questionnaire was 0.91. Both results indicate a high level of internal consistency. Besides that, the post-mastery test and the questionnaire have a high-reliability value and can be used for actual research [51].

B. GeoGebra-Assisted Inquiry-Discovery Learning Strategy

In the context of this study, the GeoGebra-assisted inquiry-discovery learning strategy was built by referring to the [52], and the inquiry resource construction materials were modified from the [53]. The type of inquiry chosen in this study is guided inquiry [52]. Students do observations and discussions based on questions prepared by the teacher based on the worksheets given. This exploratory activity is carried out by an experimental group. A sample of students is divided into small groups. Each group consists of three members with learning sessions for inquiry-discovery given the help of GeoGebra applying the 5E Learning Model [52]. Alternatively, inquiry-discovery activities are divided into two learning sessions and two reinforcement sessions. In the first session, the exploration of student activities focused on the skill of simplifying Algebraic Expressions involving addition and multiplication operations. Students need to compare and contrast the skills of adding and multiplying Algebraic Expressions through exploratory activities based on activity worksheets, GeoGebra software, and reinforcement worksheets. Table AI (refer appendix) shows one of the Daily Lesson Plans (RPH) carried out in the first learning and reinforcement sessions.

VI. RESEARCH FINDINGS

A. Is There a Significant Difference Between the Scores of The Pre-Mastery Test and The Post-Mastery Test on Students' Mastery?

In the first research question, this study was conducted to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. In this study, two groups are involved, namely the control and the experimental groups. The descriptive analysis of pre-mastery and post-mastery test scores for the experimental and the control groups was determined through the mean, standard deviation, frequency, and percentage. Descriptive analysis was conducted to determine the level of students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions before and after intervention for both groups. In addition, the researcher used the Wilcoxon's test analysis to determine whether the null hypothesis was accepted or rejected based on the first research question.

1) Descriptive analysis of pre-mastery test and post-mastery test for experimental and control groups

Table III shows the results of descriptive analysis of students' pre- and post-mastery test scores in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions for both groups. Descriptive analysis was used in this study to determine the level of students' mastery before and after intervention for both groups. The results show that the mean score of the pre-mastery test for the experimental group is 51.83 compared to the control group, which is 41.97. It found that there is a difference in the mean score of the pre-mastery test for both groups, which is 9.86. The standard deviation for the experimental group is 22.66, and the standard deviation for the control group is 17.81. The mean score of both groups was between 40 and 59 points. This shows that students from both groups have a moderate mastery level in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Both groups also had almost the same level of prior knowledge.

After exposure to different learning strategies, it was found that the mean score of the post-mastery test score for the experimental group was 65.13, and the mean score of the post-mastery test score for the control group was 50.20. The experimental group showed an increase in the mean score of student mastery with an average of 60 to 69 marks (good mastery level). Meanwhile, the mean score for students in the control group has not yet reached a good mastery level because there are still students who get around 40 to 59 marks (moderate mastery level).

Based on Table III, the findings show that there is an increase in mean score of mastery test for the experimental group, which is 13.3. Meanwhile, the mean score difference of mastery test for the control group is small, which is 8.23. This shows that the student's mastery in the experimental group is better than the students in the control group.

TABLE III: DESCRIPTIVE ANALYSIS OF PRE- AND POST-MASTERY TEST SCORES OF THE EXPERIMENTAL AND CONTROL GROUPS

Group	n	Test	Mean	Standard Deviation
Experiment	30	Pre-mastery test	51.83	22.66
		Post-mastery test	65.13	18.00
Control	30	Pre-mastery test	41.97	17.81
		Post-mastery test	50.20	18.63

Table IV shows the difference in the students' mastery levels of the experimental group and the control group before using GeoGebra-assisted inquiry-discovery learning strategy. The experimental group recorded that majority of students achieved a moderate mastery level, which is 11 (36.6%) students, followed by 10 (33.3%) students who achieved a weak mastery level. Meanwhile, a total of 6 (20.0%) students achieved an excellent mastery level and 3 (10.0%) students achieved a good mastery level. Meanwhile, the control group recorded that majority of students only achieved a weak mastery level which is 15 (50.0%) students, followed by 11 (36.6%) students who achieved a moderate mastery level. However, only 3 (10.0%) students achieved an excellent mastery level, and 1 (3.3%) student achieved a good mastery level. This finding shows that most students have a low level of mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions for both groups.

TABLE IV: FREQUENCY AND PERCENTAGE OF THE MASTERY LEVEL OF THE PRE-MASTERY TEST SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS

Pre-Mastery Test Grade		Experimental Group Frequency (*f*)/ Percent (%)	Control Group Frequency (*f*)/ Percent (%)
Excellent	70 to 100 scores	6 (20.0)	3 (10.0)
Good	60 to 69 scores	3 (10.0)	1 (3.3)
Moderate	40 to 59 scores	11 (36.6)	11 (36.6)
Weak	0 to 39 scores	10 (33.3)	15 (50.0)

Table V shows the difference in frequency and percentage for the students' mastery level in the experimental and control group after using the GeoGebra-assisted inquiry-discovery learning strategy. The results found that there is no student who achieved a weak mastery level in the experimental group. Most of the students in the experimental group achieved a moderate mastery level which is 17 (56.7%) students, followed by 9 (30%) students who achieved an excellent mastery level, and 4 (13.3%) students achieved a good mastery level. Meanwhile, most of the students in the control group only achieved a moderate mastery level which is 15 (50.0%) students, followed by 9 (30%) students who achieved a weak mastery level. However, only 5 (16.7%) students achieved an excellent mastery level, and 1 (3.3%) student achieved a good mastery level. This shows that students who use the GeoGebra-assisted inquiry-discovery learning strategy have a better mastery level in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions compared to students in the control group.

TABLE V: FREQUENCY AND PERCENTAGE OF THE MASTERY LEVEL OF THE POST-MASTERY TEST SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS

Post-Mastery Test Grade		Experimental Group Frequency (*f*)/ Percent (%)	Control Group Frequency (*f*)/ Percent (%)
Excellent	70 to 100 scores	9 (30.0)	5 (16.7)
Good	60 to 69 scores	4 (13.3)	1 (3.3)
Moderate	40 to 59 scores	17 (56.7)	15 (50.0)
Weak	0 to 39 scores	0 (0)	9 (30.0)

2) Inferential analysis of experimental group's pre- and post-mastery tests

In this study, statistical inference analysis was used to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. There are two hypotheses involved in performing this test. The hypotheses are:

H0= There is no significant difference between the scores of the pre- and post-mastery tests on students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions after using the GeoGebra-assisted inquiry-discovery learning strategy.

H1= There is a significant difference between the scores of the pre- and post-mastery tests on students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions after using the GeoGebra-assisted inquiry-discovery learning strategy.

Before determining the test for the appropriate inference analysis, the researcher conducted a normality test first on the pre- and post-mastery test scores data of the experimental group.

3) Analysis of normality test

Before the data was analyzed, a normality test was conducted to determine whether the score data of the pre- and post-mastery test scores of the experimental and the control groups were normally or not normally distributed [49]. Shapiro-Wilk normality test to determine the normality of experimental group study data. This Shapiro-wilk test was chosen because the number of respondents involved in the experimental and control groups was less than 50 [49]. Therefore, the Shapiro-Wilk test is an appropriate normality test. Table VI shows the results of the normality test using Shapiro-Wilk for both pre- and post-mastery test scores for the experimental and the control groups. The Shapiro-Wilk test results showed that the significant value for both the pre-mastery test (p = 0.012) and the post-mastery test (p = 0.001) in the experimental group which was $p < 0.05$. Similarly, in the control group, the pre-mastery test (p = 0.089) and post-mastery test (p = 0.028). This shows that the pre-mastery and the post-mastery test data of the experimental and the control groups are not normally distributed. Therefore, non-parametric statistical analysis is more accurate to use to answer this research question.

TABLE VI: RESULTS OF NORMALITY TEST SCORES PRE-MASTERY AND POST-MASTERY TEST SCORES CONTROL AND EXPERIMENTAL GROUPS

Group	n	Test	Sig.
Experiment	30	Pre-mastery test	0.012
		Post-mastery test	0.001
Control	30	Pre-mastery test	0.089
		Post-mastery test	0.028

4) Wilcoxon's test

The researcher used the Wilcoxon test to see the difference between the scores of pre- and post-mastery tests of the experimental group and control group and the difference of the post-mastery test scores of both groups. This non-parametric test is suitable because the data is not normally distributed. Therefore, non-parametric tests are more appropriate to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Based on the Table VII, the Wilcoxon test results shows that there is significance difference between pre- and post-mastery test on students' mastery after using the GeoGebra-assisted inquiry-discovery learning strategy. The null hypothesis was rejected with a significant value of p = 0.001 for the experimental group and a significant value of p = 0.007 for the control group, which is $p < 0.05$. There were 23 students in the experimental group who obtained a post-mastery test score more than the pre-mastery test score, and seven students obtained approximately the same score between the post-mastery test and the pre-mastery test. While for the control group, three students scored less on the post-mastery test compared to the pre-mastery test score. Other than that, a total of 13 students obtained a score of the post-mastery test score more than the score of the post-mastery test, and 14 students obtained a score of less than the same between the post-mastery and the pre-mastery tests. Therefore, the findings show that the GeoGebra-assisted inquiry-discovery learning strategy is useful for improving students' mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

The researcher also used the Wilcoxon test to see the difference of the post-mastery test scores between the experimental group and control group. Based on Table VIII, the Wilcoxon's test result shows there is significant difference on the post-mastery test scores between the experimental and control groups in the post-mastery test scores. The null hypothesis was rejected with a significant value of p = 0.018 ($p < 0.05$).

TABLE VII: RESULT OF THE WILCOXON'S TEST OF THE PRE-MASTERY AND POST-MASTERY TEST SCORES FOR THE CONTROL AND THE EXPERIMENTAL GROUPS

Experimental Group				
Test	n	Mean	Standard Deviation	Sig. (2-tailed)
Pre-mastery test	30	51.83	22.66	0.001
Post-mastery test		65.13	18.00	
Control Group				
Test	n	Mean	Standard Deviation	Sig. (2-tailed)
Pre-mastery test	30	41.97	17.81	0.007
Post-mastery test		50.20	18.63	

TABLE VIII: RESULTS OF THE WILCOXON'S TEST OF THE POST-MASTERY TEST SCORES FOR THE CONTROL AND THE EXPERIMENTAL GROUPS

Test	n	Mean	Standard Deviation	Sig. (2-tailed)
Post-Mastery Test Scores for Experimental Group	30	65.13	18.00	0.018
Post-Mastery Test Scores for Control Group		50.20	18.63	

B. Is There a Significant Difference between the Pre- and Post-questionnaire Item Scores on Students' Interest?

This study was conducted to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. There were 30 respondents involved in answering the questionnaire before and after using the GeoGebra-assisted inquiry-discovery learning strategy. The researcher wants to see if the GeoGebra-assisted inquiry-discovery learning strategy can increase students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. The data in this study were analyzed using descriptive and inferential statistics.

1) Inferential analysis of interest questionnaire

The data obtained from the questionnaire were analyzed using a non-parametric test because the questionnaire items used a Likert scale which is ordinal scale data. Therefore, the appropriate inference analysis used for this data type is the Wilcoxon's test [49]. The Wilcoxon's test was used to determine the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. There are two hypotheses involved in performing this test. The hypotheses are:

H0= There is no significant difference between the scores of the questionnaire before and after using the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

H1= There is a significant difference between the scores of the questionnaire before and after using the GeoGebra-assisted inquiry-discovery learning strategy on students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

2) Wilcoxon's test

Based on Table IX, it was found that there was a significant difference in the mean score before and after the intervention ($p < 0.05$). The null hypothesis was rejected. The mean score for the pre-questionnaire is 2.51 (SD = 0.51), and the post-questionnaire score is 4.35 (SD = 0.049). Both the pre-and post-questionnaires score data were obtained from the experimental group. This shows that there is a significant improvement between the mean scores before and after the intervention. Therefore, the results found that the learning strategy using the GeoGebra-assisted inquiry-discovery learning strategy was effective in increasing students' interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions for the experimental group.

TABLE IX: WILCOXON'S TEST RESULTS OF PRE- AND POST-QUESTIONNAIRE TEST SCORES FOR THE EXPERIMENTAL GROUP

Questionnaire	n	Mean	Standard Deviation	Sig. (2-tailed)
Pre	30	2.51	0.51	0.002
Post		4.35	0.049	

C. Is There a Significant Difference between Students' Mastery and Interest?

This study was conducted to determine the relationship between students' mastery and interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions after using the GeoGebra-assisted inquiry-discovery learning strategy. The data from the post-mastery test scores and the post-questionnaires form in this study were analyzed using Spearman's rho correlation analysis. Spearman's rho correlation analysis is appropriate suitable to test the relationship between dependent variables for non-parametric statistical data, used to see whether the relationship between the two dependent variables is significant or not, and to see the level of strength of the relationship between two dependent variables [49].

There are two hypotheses involved in performing this test. The hypotheses are:

H0= There is no relationship between the students' mastery and interest after using the GeoGebra-assisted inquiry-discovery learning strategy in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

H1= There is a relationship between the students' mastery and interest after using the GeoGebra-assisted inquiry-discovery learning strategy in the Basic Arithmetic Operations involving Algebraic Expressions.

Based on Table X, the results of the Spearman's rho test show that the relationship between students' mastery and interest after using the GeoGebra-assisted inquiry-discovery learning strategy is significant ($r = 0.83$, $p < 0.05$). The null hypothesis was rejected. The correlation coefficient value shows a strong positive relationship between the two dependent variables. Hence, there is a significant relationship between students' mastery and interest after using the GeoGebra-assisted inquiry-discovery learning strategy. Based on the analysis findings, it was found that students' interest influences their mastery in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions after using GeoGebra-assisted inquiry-discovery learning strategy.

TABLE X: SPEARMAN'S RHO CORRELATION ANALYSIS OF POST-MASTERY TEST SCORES AND POST-QUESTIONNAIRE SCORES FOR THE EXPERIMENTAL GROUP

Score	n	Correlation Coefficient	Sig. (2-tailed)
Post-Mastery Test	30	0.833	0.002
Post-Questionnaire			

VII. DISCUSSION

This section discusses the results of the study based on three research questions. The discussion of the findings of this study determines the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery and interest in the Basic Arithmetic Operations involving Algebraic Expressions.

A. Students' Mastery of the Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions after Using GeoGebra-Assisted Inquiry Discovery Learning Strategy

Both the experimental and the control groups showed mean scores of 51.83 and 41.97, respectively. The mean score of this score indicates moderate mastery in the pre-mastery test for the Basic Arithmetic Operations involving Algebraic Expressions. The moderate mastery of students in these two groups can be attributed to the type of learning they may have experienced before [35]. Students go through a learning process that does not allow them to use existing knowledge to build their conceptual understanding [27]. Instead, students go through a one-way learning session [29]. The learning content is organized by only referring to examples given by the teacher and memorizing without understanding the concepts learned [54]. This strategy is seen as not helping students to build new knowledge well. Meanwhile, the mean score of the experimental group increased to 65.13, which is at a good mastery level in the post-mastery test after the students went through the GeoGebra-assisted inquiry-discovery learning strategy. At the same time, the mean score of the control group remains at medium dominance despite an increase in the mean score to 50.20. This shows that the GeoGebra-assisted inquiry-discovery learning strategy can change students' behavior and skills regarding understanding and mastery when the learning session is conducted practically [55].

There were 9 out of 30 students in the experimental group, and 4 out of 30 students in the control group obtained a score of more than 50% for the pre-mastery test. This number shows the passing percentage of pre-student mastery test scores found to be no more than half the number from both groups. Based on this percentage, students were not exposed to learning sessions through discussions with peers [27]. Students with good mastery cannot help their friends with moderate and weak mastery [56]. Apart from that, one-way explanatory learning does not encourage students to move actively, think critically and generate solutions through discussion with peers [27].

There are 30 students in the experimental group who have shown an impressive increase in mastery compared to the control group in the post-mastery test. The results of the study found that students in the experimental group could increase their mastery to moderate, good and excellent, which are mastery levels 2 and 3. While in the control group, there was still half the number of students with weak mastery. The other half of the control group's students were at moderate, good and excellent proficiency. This shows the effect of GeoGebra-assisted inquiry-discovery learning strategy can increase the mastery of experimental group students through activities carried out by students, and students have the opportunity to create relationships among peers when they engage in discussion activities [29]. The inference test results also show a significant relationship between the scores of the pre-mastery and the post-mastery tests on student mastery after using the GeoGebra-assisted inquiry-discovery learning strategy to increase students' mastery of the Basic Arithmetic Operations involving Algebraic Expressions. In this study, the effect of inquiry-discovery on mastery was found when students could be guided to understand new concepts of Basic Arithmetic Operations involving Algebraic Expressions through guided inquiry activities [57]. Exploration activities are organized based on real-life examples or real situations [52]. Students can investigate problems and make connections in symbolic form. Subsequently, students can also build knowledge of Basic Arithmetic Operations involving Algebraic Expressions by practicing conceptual knowledge in solving tasks procedurally through group discussions and presentations to classmates [32]. This active learning strategy encourages students to go through the learning exploration process by asking questions, making connections and being able to conclude the task [58].

Based on the research findings obtained, the effect of the inquiry-discovery learning strategy on increasing mastery is seen when students form mastery of basic concepts by integrating their existing experiences [59]. At the beginning of the activity, using the worksheet, students relate the existing experience in determining the value of the area, perimeter, volume, and the concept of repeated multiplication in the topic of Squares and Squares. Based on this existing experience, the teacher acts as a facilitator by asking several questions and problems by asking deeper high-level questions to encourage students to think [27]. This activity encourages students to think critically, with students giving opinions and making estimates and conclusions [57]. Students' involvement in critical discussions with critical arguments to explain the problems studied with logical reasoning can help improve their mastery [27].

The use of GeoGebra software also improves students' mastery through critical thinking and student problem-solving [60]. Students do not sit passively and just follow the instructions given by the teacher. Through GeoGebra activities, students can make their assumptions and conclusions [61]. In addition to understanding the Basic Arithmetic Operations involving Algebraic Expressions, students were also tasked to investigate by comparing the differences between four Basic Arithmetic Operations involving Algebraic Expressions in this study. Afterwards, students are asked to share their findings with their peers [60]. After that, they will share their findings with their classmates. If a question arises among friends, small groups of students do a discussion process to determine the conclusion from the question raised. The results of this discussion will be shared with teachers and classmates. The teacher will make a reinforcement explanation of the results of the discussion during the whole class discussion [54].

In this study, student mastery is seen to increase when students have the opportunity to explore the use of Computer Algebra Systems (CAS) calculators. The CAS calculator can be used to check each step in the process of completing a task and whether it has been done correctly or not in a GeoGebra-assisted inquiry-discovery learning strategy reinforcement session [62]. The CAS calculator facility in GeoGebra is still being explored by students [45]. Other than that, the CAS calculator allows students to improve their cognitive and interpersonal development by learning through their own experiences [63]. Students can enter values and observe the calculation path and the answer given because the CAS calculator is software that can manipulate algebraic expressions in symbolic form [63]. The CAS calculator is a tool that can be accessed for free on the GeoGebra software website to solve equations, expansion of expressions, find expansion factors, differentiation and integration [64].

The findings of the study show that the inquiry-discovery learning strategy with the help of GeoGebra can help students to master the subtopic of abstract Algebraic Expressions [55]. This can be seen at the beginning of the learning session when students are exposed to the use of concrete objects. Then students are given the opportunity to explore concrete objects by relating their existing knowledge. Next, students engage in explanatory activities by making representations of concrete objects using the visuals of GeoGebra software. Besides that, students investigate patterns in algorithms and formal rules of

Basic Arithmetic Operations involving Algebraic Expressions without the teacher showing them directly [41]. With that, a new experience about the abstract concept of Basic Arithmetic Operations involving Algebraic Expressions can be built. Through this activity, students can improve their conceptual and procedural understanding when the main concepts and principles are studied and discovered. Furthermore, activities through this approach allow students to evaluate patterns and reach their conclusions. Subsequently, the students are guided by the teacher to discuss and understand the Basic Arithmetic Operations involving Algebraic Expressions through the results of the GeoGebra-assisted inquiry-discovery learning strategy [52, 65]. This activity can reduce student misconceptions in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions [62].

In conclusion, this study's GeoGebra-assisted inquiry-discovery learning strategy conforms to the principles of constructivism theory and Piaget's theory of cognitive development. Constructivism theory emphasizes that activities planned in the classroom need to consider students' existing knowledge and previous learning experiences [66]. Piaget's theory of cognitive development suggests using materials that suit students' cognitive development because the use of teaching aids has been found to influence the effect of the learning session [43, 67]. Therefore, the effect of the GeoGebra-assisted inquiry-discovery learning strategy on students' mastery of subtopics of Basic Arithmetic Operations involving Algebraic Expressions can be improved.

B. Students' Interest in the Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions after Using GeoGebra-Assisted Inquiry Discovery Learning Strategy

The study's results found that the mean value showed a low level of interest in implementing the GeoGebra-assisted inquiry-discovery learning strategy in the pre-questionnaire. However, after going through the learning strategy of inquiry-discovery with the help of GeoGebra, the students' interest is at a high level. The increase in the mean level is further evidenced by the significant difference in pre-and post-questionnaires interest item scores after using the GeoGebra-assisted inquiry-discovery learning strategy. This is due to the students of the experimental group not having previous experience going through the learning strategy of GeoGebra-assisted inquiry-discovery learning strategy for the subtopic of Basic Arithmetic Operations involving Algebraic Expressions. Nevertheless, after they went through the inquiry-discovery learning strategy with the help of GeoGebra, the effect on their interest increased. Azmidar *et al*. [68] stated that interest does not appear spontaneously, but interest will arise when students participate in activities related to experiencing real experiences.

The level of students' interest increases because the GeoGebra software helps explain abstract concepts through a more concrete visual display [60]. In this study, students were given assignments in the form of worksheets. To complete the assignment, students need to use the applet in the GeoGebra software. This applet facility provides a more concrete visual display in two or three dimensions. This built-in applet makes it easy for students to quickly find perimeter, area and volume values. In addition, students only need to move the points provided in the applet [60]. The convenience of this applet allows students to engage with visual representation material and spark students' interest in the learning session.

GeoGebra software can provide materials that can support students' interest in learning algebra, and students can relate it to their daily lives [45]. In this study, students can easily understand the concept of basic arithmetic operations involving algebraic expressions when they can use animations and virtual displays in GeoGebra software. The use of animation features, and virtual displays allows students to get a real visual experience [63]. Furthermore, the results of two-dimensional and three-dimensional shapes commonly used by students, such as squares, rectangles, cubes and cuboids, can be used for students to give feedback on the characteristics, how to obtain perimeter, area and volume values and students can evaluate to ensure the accuracy of the values perimeter, area and volume obtained [68].

Other than that, the level of students' interest can be increased when students, through exploration activities, can obtain the truth of the answer through the explanation of the answer with more detailed exploration with the help of GeoGebra. Furthermore, the exploration of the truth of the answer and the explanation of this answer is obtained when the GeoGebra software facilitates students to explore diverse information sources online, such as using CAS calculators and applet facilities [69]. With that, students' interest in undertaking exploratory activities to find out the real answer can be increased [41].

In addition, the inquiry-discovery activity process in this study is investigation-oriented [52]. Students are driven by curiosity and the desire to understand something or even solve a problem. Therefore, as long as the GeoGebra-assisted inquiry-discovery learning strategy is carried out, students feel more enthusiastic to carry out investigative activities and have a high desire to find answers to what they are doing. At the same time, GeoGebra software is equipped with easy experimental material facilities [62]. In this study, the GeoGebra-assisted inquiry-discovery learning strategy encourages students to do their experiments by stimulating visual materials from the GeoGebra software and given worksheets. This activity increases student interest and makes it easier for students to master concepts for the subtopic of Basic Arithmetic Operations involving Algebraic Expressions.

Next, the inquiry-discovery learning strategy with the help of GeoGebra is seen to increase the fun in learning [52]. Hassan and Aziz [70] discussed that students' interest in mathematics could be increased when they feel that topics in mathematics are fun to learn. With this attitude, students will allow themselves to easily learn something new [64]. They tend to attend classes, and their interest in topics in mathematics will increase [62]. In this study, students could relate the concepts of basic repeated arithmetic operations to their existing experience in the concepts of perimeter, area and volume using the visuals of squares, rectangles, cuboids and cubes. After that, they began to get exposed to the use of CAS calculators for them to explore.

GeoGebra-assisted inquiry-discovery learning strategy helps in increasing students' interest because students enjoy being able to investigate and explore the concept of Basic Arithmetic Operations involving Algebraic Expressions in groups [61]. In this study, the GeoGebra-assisted inquiry-discovery learning strategy can involve the active participation of students from the beginning of learning and the distribution of tasks until the task can be completed well. Students can conclude assignments given by being monitored by the teacher, who acts as a facilitator. The participation of these students gives them satisfaction so they can better understand new concepts in the exploratory activities carried out [60].

In conclusion, Hidi and Renninger's learning theory, which is the foundation of this study, proves that interest plays an important role in the learning process [25]. Every student who is more confident and has a positive attitude towards the task will tend to be more interested in what they do and want to try other things in the future [71]. An example of the post questionnaire is the students' tendency to state that they agree that they are more confident, fun, excited and like learning mathematics with the GeoGebra-assisted inquiry-discovery learning strategy. Consequently, their interest increases in exploring topics in other areas of mathematics.

C. The Relationship between Students' Mastery and Interest in the Subtopic of Basic Arithmetic Operations Involving Algebraic Expressions after Using GeoGebra-Assisted Inquiry Discovery Learning Strategy

The study's findings show that the GeoGebra-assisted inquiry-discovery learning strategy has a significant relationship between students' mastery and interest in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions coincides with the findings of [72] and [73]. Students are more enthusiastic about doing mathematics exercises if they are highly interested in mathematics subjects. When students have good interest, the learning process becomes easier and the desire to master the learning task increases [69]. Next, students will try to improve their mastery to a better level [74].

The Curriculum Development Division [52] suggests that various learning strategies and techniques should be practiced to deliver learning content to students to receive it effectively. The cognitive and affective aspects of students need to be taken into account in determining appropriate learning tasks [75]. Based on the findings of this study, it is proven that the GeoGebra-assisted inquiry-discovery learning strategy is one of the effective strategies because this strategy includes cognitive and affective aspects in the characteristics of the tasks planned by the teacher. The characteristics of the assignment meet the needs of students with various abilities, tendencies and interests [75]. Among the characteristics of assignments that help connect the cognitive and affective aspects of students by integrating knowledge, skills, and values is when students can carry out communication activities through discussion in small groups with their peers. The use of inquiry-discovery worksheets integrated with GeoGebra software is seen to guide students to divide tasks equally among group members and maximize student involvement in helping them improve mastery and form an understanding of Basic Arithmetic Operations involving Algebraic Expressions.

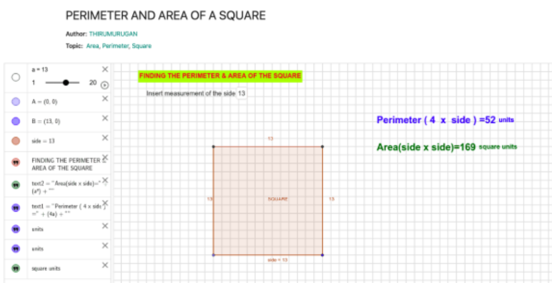
In addition, the GeoGebra-assisted inquiry-discovery learning strategy helps students change behavior and students' skills in practical understanding [76]. Apart from that, students can improve their mastery of problem-solving and help strengthen their knowledge of basic and procedural concepts because learning materials allow students to build new knowledge, such as the use of CAS applets and calculators. Students can apply higher-level thinking skills when carrying out GeoGebra-assisted inquiry-discovery activities for operational subtopics Basic Arithmetic Operations involving Algebraic Expressions [77]. Students can also increase interest as they feel excited and enjoy participating in group activities. They can explain the construction of this basic concept supported by logical reasoning. In conclusion, the effect of the GeoGebra-assisted inquiry-discovery learning strategy has a significant relationship between students' mastery and interest.

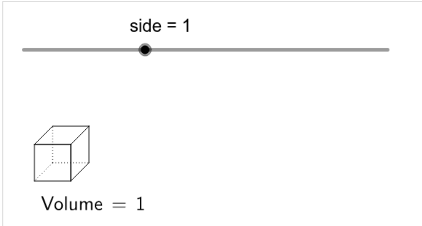
VIII. CONCLUSION

This study has some practical implications for the parties involved, such as students, teachers, schools and the Ministry of Education. Based on the findings of the study, students were given the opportunity to experience with their own experience the effects of the GeoGebra-assisted inquiry-discovery learning strategy. Alternatively, students can be well guided to understand conceptual knowledge and procedural knowledge. Students are also given the opportunity to compare the differences between four Basic Arithmetic Operations involving Algebraic Expressions. Students are also given the opportunity to use the Computer Algebra Systems (CAS) calculator. This CAS calculator needs to be widely used among secondary school students because the benefits obtained from the use of this CAS calculator are very useful, especially in the field of algebra. This CAS calculator can be used as a guide for students to explore solutions through inquiry-discovery or to check answers when assignments are given in the form of performing factoring operations, expansions and simplifying algebraic expressions, whether during discussions in class, with friends or at home. The CAS advantage of this calculator is also easily accessible for free and open to users through the GeoGebra website using a suitable device such as a laptop or smartphone. The application of the GeoGebra-assisted inquiry-discovery learning strategy needs to be practiced and become one of the teacher's learning activities in the mathematics class because this strategy increases students' mastery and interest. In implementing this strategy, the GeoGebra applet facilitates teachers in activities involving inquiry-discovery. The use of this existing applet is seen to be able to apply students' existing knowledge in inquiry-discovery activities. The teacher allows students to investigate and compare operational differences in the subtopic of Basic Arithmetic Operations involving Algebraic Expressions through visual animation of two- and three-dimensional shapes in the GeoGebra applet. Teachers can encourage students to observe, question, connect, experiment and relate thinking skills in a scientific approach. Other than that, activities involving learning inquiry-discovery strategies with the help of GeoGebra implemented in this study are expected to be considered by the Ministry of Education to be one of the exploration activities in the form one mathematics textbook for the introduction to the subtopic of Basic Arithmetic Operations involving Algebraic Expressions because form one students need to be assisted in developing mastery the concept of Algebraic Expressions well from the beginning of learning. Likewise, students' interest in this subtopic can be fostered from the very beginning. Besides that, these activities can also be used for the next batches of form one student. It is also recommended for mathematics teachers to develop and conduct this learning strategy for other mathematics topic especially in Geometry and Algebra as the use of GeoGebra is highly recommended by the Malaysian Ministry of Education.

APPENDIX

TABLE AI: LEARNING SESSION 1 OF GEOGEBRA-ASSISTED INQUIRY DISCOVER LEARNING STRATEGY

DATE:		DAY:	
TIME:	Two Period	FORM:	One
SUBJECT:	Mathematics		
TEACHING AND LEARNING ACTIVITIES:	GeoGebra-assisted Inquiry-Discovery		
FIELDS OF STUDY:	Relation and Algebra		
TITLE:	Chapter 5 Algebraic Expressions		
STANDARD CONTENT:	5.2 Algebraic Expressions involving Basic Arithmetic Operations		
LEARNING STANDARDS:	5.2.1 Adding Algebraic Expressions containing one or two terms. 5.2.3 Multiply Algebraic Expressions containing one or two terms.		
LEARNING OBJECTIVE:	At the end of learning, students will be able to distinguish the process of adding and multiplying Algebraic Expressions involving one or two terms.		
TEACHING AIDS:	Worksheets, scientific calculators, stationery, GeoGebra software		
EXISTING KNOWLEDGE:	Two-dimensional shapes-solving everyday problems involving perimeter and area. Three-dimensional shapes - solving everyday problems involving volume. Chapter 3: Squares, Square Roots, Cubes and Roots of Cubes 5.1 Variables and Algebraic Expressions		
LEARNING ACTIVITIES			
PHASE/ TIME OF ACTIVITY	TEACHER	STUDENTS	REMARKS
Engagement (5 minutes)	1. The teacher uses origami techniques to build four-sided polygons and cubes. 2. The teacher asks students to explain the concepts of perimeter, area and volume based on the given shape. 3. The teacher relates the answers given by the students to the topic and learning objectives of the day. Students need to compare and contrast the process of adding and multiplying algebraic expressions involving one or two terms through inquiry-discovery inquiry activities with the help of GeoGebra software.	1. Students analyze the 2D shape of the four-sided polygon and the 3D cube. 2. Students relate the shapes with the concept of perimeter and area of a four-sided polygon and the volume of a cube.	Student response allows teachers to identify students' existing knowledge. <u>Reference guide:</u> Perimeter is the length measurement around an object, area, or figure. The perimeter of a quadrilateral is obtained by adding all its four side lengths. This perimeter value can be labeled in units, cm and m. The area of a rectangle is when the length of the side $\times$ the width of the side. This area value can be labeled unit^2, cm^2 and m^2. The volume of a cube is when the long side $\times$ wide side $\times$ high side. This area value can be labeled unit^3, cm^3 and m^3.
Exploration (15 minutes)	1. The teacher divides the students into 4 people for each group. 2. The teacher distributes the worksheet to the students. 3. The teacher gives explanations to complete the given worksheet. 4. The teacher monitors the student's activities.	1. Each student is given a worksheet. 2. In order to understand the difference in arithmetic operations involving the addition and multiplication of algebraic expressions, students need to use GeoGebra software to complete the perimeter, area and volume values based on the side	Refer to the Worksheet. <u>Reference guide:</u> GeoGebra software link for perimeter and area https://www.geogebra.org/m/vfdqvtwd  GeoGebra software link for volume https://www.geogebra.org/m/Djft69NTt

		values given in the worksheet. Students observe the change of values in numbers and units in values of perimeter, area and volume. 3. Students discuss the results obtained with group mates.	
hisExplanation (15 minutes)	1. The teacher relates the concepts of perimeter, area, volume squared and squared in the student's explanation. 2. The teacher asks students to compare the difference between perimeter, area and volume, which number value is doubled, and which value is added? 3. The teacher also asks students to present between the concepts of perimeter, area and volume; which unit has the power of 1, power of 2 and power of 3?	1. Students present their findings and questions posed by the teacher.	Students respond that the result of the total perimeter is the result of adding the value of each side in a four-sided polygon. The number value will increase. The perimeter still retains units (no change to the power value to its units). While the area value is the product of two sides (long side × wide side), and the volume value is the product of three sides (long side × wide side × high side). The number value will be doubled, and the units used on each side will be increased to unit2 (square) or unit3 (cube).
xpansion (10 minutes)	1. The teacher asks the students to discuss the questions in the discussion section. 2. The teacher gives explanations to complete the questions in the discussion section. 3. The teacher monitors the student's activities.	1. Students discuss the values that should be obtained when the sides of each four-sided polygon and cube are converted to variable values. 2. Students relate the findings they obtained in the explanation phase. 3. Students present their findings. 4. Students draw conclusions on the sheet provided.	The concepts of like terms and unlike terms are used. When adding two or more algebraic expressions, group like terms first. Then add those similar expressions. To find the product of an algebraic expressions containing one term, regroup the same variable, then multiply the number by the number and the variable by the variable. The concept of exponential law is emphasized indirectly. The concept of the commutative law of arithmetic operations is emphasized. <u>Activity summary:</u> The process of adding algebraic expressions involves only adding coefficients, not powers of the variable (Numbers will be added to numbers of like terms). However, if the terms are not identical, the addition process cannot be carried out. The commutative law a+b=b+a is emphasized. The process of multiplying an algebraic expressions involves the coefficient being multiplied by its value (a number is multiplied by a number), and the value of the power of the variable will increase for like terms. But if it involves dissimilar terms, the coefficient can still be multiplied between two dissimilar terms, and the dissimilar terms will be combined like the commutative law a×b=b×a.
Evaluation (10 minutes)	1. The teacher conducts a 6-question pop quiz. 2. The teacher will discuss the students' answers in the next learning session.	1. Students answer the pop quiz questions given in the given time. 2. Students send their answers after the time is up.	
Closing (5 minutes)	The teacher responded to the student's reflection by summarizing the learning session today.	Students conclude today's learning session.	

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

ZM conducted the research and analyzed the data; AHA wrote the paper; SNSAR proofread and converted the paper into the template; all authors had approved the final version.

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