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Does the Use of Smart Board Increase Students' Higher Order Thinking Skills (HOTS)?

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ABSTRACT Results from international assessments focusing on the use of Higher Order Thinking Skills (HOTS) show that Malaysian students perform poorly in Data Handling. At the same time, the Malaysian education system is undergoing a dramatic change in which information and communications technology (ICT) is integrated into the education system in order to enhance the overall quality of education. Smart board has become one of the interactive technology tools that are widely used in schools to facilitate teaching and learning practices. Therefore, this study aims to design and develop an active learning instruction using smart board (ALuSB program) to enhance HOTS in Data Handling among students in Malaysian primary schools. The research was divided into two stages. In the first stage, the ALuSB program was developed by using the ADDIE model which integrated five phases, i.e., analysis, design, development, implement, and evaluate. Then, in the second stage, the quasi-experimental design, a non-equivalent control group design with a pre-test and a post-test, was used to evaluate the effectiveness of the ALuSB program on students' HOTS. The students were split into three groups equally, i.e., two experimental groups and one control group. Various instruments, including an ALuSB program evaluation form as well as pre-test and post-test rubrics, were used. The results of the analysis suggest that there is a statistically significant difference between the ALuSB program, an active learning instruction and a conventional learning method in enhancing each level of HOTS in Data Handling among students. Although all students from each group show improvements in enhancing HOTS in Data Handling, the ALuSB program is the most effective method compared to the active learning instruction and the conventional learning method. Therefore, the ALuSB program promotes students' active learning and ownership of learning, supports learning by doing, as well as encourages HOTS and peer sharing.

INDEX TERMS Active learning, higher order thinking skills, smart board.

I. INTRODUCTION

HOTS is the abbreviation for higher order thinking skills. The cognitive domains of HOTS in this study refer to applying, analyzing, evaluating and creating [1]. Lately, the concept of HOTS has been a major concern in the Malaysian mathematics education field. In Malaysian schools, 60% of the public examination questions test the analytical and creative thinking skills of the students. For the Primary School Achievement Test (UPSR), 40% of the questions focus on HOTS, whereas 50% of the questions for the Malaysian Certificate of Education (SPM) are related to HOTS [2]. This revolution in the mathematics assessments suggests that teachers in school will put less emphasis on guessing and drilling for content recall. Thus, students are taught to think critically and to use their knowledge in various environments. Likewise,

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school-based assessments will change their emphasis on HOTS. Within the Malaysian education system, the steady influence of HOTS is important in mathematics education. In the Malaysian education system, the term HOTS refers to the top four levels in the Revised Bloom Taxonomy which were used in this study [3], [4]. The levels are Applying, Analyzing, Evaluating and Creating. Applying focuses on the ability to use new concepts or knowledge, to solve problems in new circumstances, or to spontaneously use an idea by applying acquired facts, knowledge, skills and rules in a novel way. Analyzing emphasizes the process of examining and breaking information into parts by identifying purposes or causes to build an organizational structure that can be easily understood. Distinguishing facts from inferences is the main purpose of an analysis category. Learners need an understanding of the structural form and the content of a subject. Evaluating emphasizes the process of presenting and defending opinions by making judgement about information, the quality of work based on a set of criteria, or the validity of ideas. Basically, evaluating concerns with the learners' ability to judge the value of a subject for a given purpose. Creating involves collecting information from various elements by joining the elements into a new meaning or offering alternative solutions. Creating focuses on learners' creative behaviors and actions with a major emphasis on the formulation of new structures or patterns.

A. STUDENTS' MATHEMATICS PERFORMANCE ON APPLYING, ANALYZING, EVALUATING AND CREATING

Applying is the main domain assessed in the Trends in International Mathematics and Science Study (TIMSS) as 40% of the questions in the TIMSS 2011 eighth-grade mathematics assessment are about applying [5]. The result of applying on the 2011 TIMSS mathematics for Malaysia demonstrated the decrease of the average scale score from 477 in 2007 to 439 in 2011. In the analysis of the Malaysian students' performance on applying, several studies show that the students in Malaysia are lacking in mathematical problem-solving skills [6], [7], specifically in the definition and formulation of problems, the generation of alternative subscales, and the implementation and verification of solutions [8]. Reference [6] found that school students perform poorly in applying specific mathematical problem-solving strategies in which they are unable to perform the basic steps of mathematics procedures.

Analysis is one of the process categories in the Programme for International Student Assessment (PISA). In this assessment, students begin formulating situations mathematically to solve problems. They identify and recognize chances to use mathematics and then offer mathematical structures to a problem presented in some contextualized forms. Students can extract the needed mathematics to analyze, set up and solve the problems when they are in the process of formulating situations mathematically. Results for the cognitive domain of reasoning in the 2011 TIMSS mathematics for Malaysia show that the average scale score dropped from 466 in 2007 to 426 in 2011. Reasoning is the ability to make use of mathematical knowledge and it helps to make sense of mathematics [9]. Reasoning comprises the elements of analyzing as mathematical reasoning refers to the ability to analyze mathematical situations and construct logical arguments [10]. Problems may require reasoning in various ways as the complexity of the situation or the novelty of context must consist of numerous steps, possibly understanding different areas of mathematics and drawing on knowledge. Reasoning involves the ability to observe and make conjectures, making logical deductions based on particular rules and assumptions as well as justifying results [5]. People who reason and think analytically tend to note patterns, structures, or regularities in real-world situations as well as in symbolic objects; they ask if those patterns are accidental or if they occur for a reason, and they conjecture and prove [11]. Collectively, results show that the Malaysian students lack analyzing skills; they are unable to generally transfer the knowledge learnt to solve non-routine problems like those shown in the TIMSS assessment [12].

Evaluating is one of the process categories in PISA in which students need to reflect upon mathematical results, conclusions or solutions, and interpret them in the context of real-life problems. Evaluating consists of reasoning in the context of a problem, interpreting mathematical solutions, and determining whether or not the results are rational in the context of the problem. This mathematical process category encompasses the "evaluate" and "interpret" elements of the cognitive domain [13]. Students involved in this process may be called upon to communicate and construct arguments and explanations in the context of the problems, reflecting on both the result and its modelling process. In the analysis of the Malaysian students' performance in TIMSS over these several years, ref [14] discovered that only 2% to 10% of the students are able to draw generalizations and interpret the information in solving complex problems, while 60% of the Malaysian students achieve the average score set for an international benchmarking. The Malaysian students are also unable to comprehend the questions in the form of long texts that require them to interpret and reflect on real-life problems [2]. The students also fail to make judgements based on criteria and standards given in the mathematics assessment.

Creating places more emphasis on putting elements together into a new pattern or structure [15]. In this stage, students work on a model of the problem, identify the relations between mathematical entities, establish regularities and create mathematical arguments in PISA. This stage typically requires reasoning, manipulation, transformation, analysis, synthesis and computation [13]. Similar to the TIMSS results, the PISA's report for mathematics achievements reveals that only a small proportion (8%) of the Malaysian students have achieved the advanced level of thinking. Therefore, results from these international assessments (TIMSS and PISA) have provided the evidence of the Malaysian students' ongoing difficulties in solving mathematical tasks consisting of synthesis and interpretation, which are the key aspects of HOTS [16].

The students often fail in several aspects, such as coming up with alternative hypotheses based on criteria, devising a procedure for accomplishing some tasks, and constructing a new diagram based on the questions given in a mathematics assessment.

B. USE OF SMART BOARD IN THE MATHEMATICS CLASSROOM

At present, Malaysia is undergoing a dramatic transformation in the local educational system toward facilitating teaching and learning practices in the mathematics classroom. The UNESCO assessment notes that Malaysia is among the first few countries in the world that implement a strategic ICT plan for its education system that aims to explore the potential of ICT, to enhance the depth of knowledge, and to increase the overall quality of the education system in Malaysia [2]. The intention is more ambitious and goes beyond teaching students in using basic ICT functions such as the internet, email and word processors. ICT in mathematics education should also support students to nurture HOTS. Reference [17] states that parents are digital immigrants, whereas their children are digital natives who live in a technologically supercharged world. Technology in the mathematics classroom can be a powerful instructional tool to enhance HOTS at the primary school level. Reference [18] defines technology as a mind tool that functions as an intellectual partner with learners to facilitate and engage HOTS.

One of the educational technology programs that have caught the attention of teachers is the interactive board called smart board [19]. Smart board was introduced by the Ministry of Education (MOE) in Malaysia in 2004 [20]. It was one of the more widely used interactive technology tools in primary schools. Smart board can motivate students to become more involved in their learning and to enhance HOTS in mathematics. Student engagement has been potentially recognized as the most important aspect in a learning process [21]–[25]. Besides, smart board has been recommended by many researchers in addressing the learning requirements of the net generation. It has also been encouraged by the No Child Left Behind Act [26]. According to its proponents, smart board allows students and teachers to interact in various ways that enhance students' involvement in a classroom [27].

Smart board combines all the functions of a computer, a whiteboard and a projector into a single system [28]. It is more than a computer, a projector or a screen [29] as it can be used to deliver an instruction in visual, auditory and tactile learning [22]. Smart board is an interactive whiteboard that can show images from the monitor with its surface being used as a huge touchscreen [30]. With smart board, educators can have the freedom to use any teaching tools that best suit their lessons [31]. This board is managed like a projection by touching a computer screen [32]. The use of smart board is monitored by special software installed in a computer. The computer is controlled either by electronic pens to write words, or by fingers to close or open programs and to move objects. Most of the smart board tools are equipped with an electronic blank page and other tools for academic purposes. It allows educators to prepare their topics easily and more efficiently for their students. The smart board software also includes many tools such as those for writing, underlining, and drawing. There are various colorful pencils for handwriting identification, hide and show tools, drag and drop tools, web browser tools, instant screen-capture tools, and interactive exercise tools. By touching the screen, colorful diagrams, charts, pictures and symbols can be presented to support virtually any concepts [33].

C. SMART BOARD FOR ACTIVE LEARNING IN THE DATA HANDLING TOPIC

Academicians found that integrating smart board into instruction sessions can facilitate active learning. This is an important component of contemporary instructions [34] as current students are primarily active learners. Traditional lectures may be increasingly out of touch with the way students engage with their world [35]. Active involvement in the learning process is vital for the mastery of critical thinking skills [36], [37]. Many researchers have demonstrated the advantages of active learning in terms of long-term cognitive retention and students' interest [38], [39]. Reference [40] defines active learning as anything related to courses in which all students are called upon to do many activities besides watching, listening and taking notes. Active learning concentrates on the teaching function and encourages the students to be responsible for their own learning. In particular, students must engage with HOTS such as analysis, synthesis and evaluation [41]. They must think about their completed works and the purpose behind them in order to enhance their HOTS. Students must also be more capable of implementing HOTS in various circumstances [42]. Active learning is an ideal environment to promote HOTS in mathematics.

One of the strategies for implementing effective forms of active learning into the mathematics classroom is to discover new ways to introduce students to ideas and information [43]. Smart board allows students to experience a range of new learning tools that encourage engagement with mathematics, thus serving as an alternative to passive learning such as lecturing or reading a text. Smart board using active learning could provide scaffolding for students to reveal and increase their development of HOTS. Given its large and interactive screen, smart board gives students the opportunity to solve problems and to be creative; they may explore a website, deliver presentations or take a virtual field trip in the mathematics classroom through the internet. Smart board also provides an effective way for users to interact with the multimedia and digital content in a multi-person learning environment. This situation leads to an active learning process in which teachers and students are involved. Smart board offers and enhances various options for the teaching process without requiring the teachers to force-fit their instructions into a restrictive style or method. It offers a method for the teachers to allow their students to actively participate in receiving and retaining information. Besides, smart board helps teachers to support students who need reinforcement or remediation and improves students' motivation and performance by turning an inquiry-based learning into a dynamic mathematics classroom experience. Smart board for active learning helps the teachers to select objectives at the correct level of difficulty to meet their students' needs. The teachers can enjoy a livelier classroom experience as students thoughtfully participate in mathematics classroom discussions, increasingly interact with the content, and ask better-focused questions. Post-class analytics offer teachers' immediate feedback on the impact of their teaching. Furthermore, smart board reduces teaching workload and enables an efficient use of time for classroom instructions.

According to [44], active learning activities motivate students to participate in a discussion, conduct a dramatic presentation, simulate real experiences and do real things. Firstly, in a mathematics classroom discussion, smart board supplementary software allows teachers and students to go beyond traditional instruction tools. Smart board attracts the interest and attention of participating students with various learning styles. Smart board supports active learning as it provides students with the opportunity to be self-directed learners who can work independently or cooperatively in small groups. Moreover, it allows them to use search engines in the internet for learning, to make decisions quickly, and to communicate with others across distances [45]. Secondly, the software in smart board, such as Microsoft files and various media, offer the opportunity for the students to deliver a talk or to conduct a dramatic presentation easily. Besides, the touch-screen technology of smart board also provides greater flexibility in the presentation of materials. Reference [46] states that, as students present their findings in front of the class using a high-tech device, their peers can recognize them as teachers. Furthermore, students' presentations can be recorded as videos or static documents and uploaded to various course sites. Such capabilities allow the creation of valuable resources that can later be used as references when working on related assignments. Smart board allows the use of dynamic and static documents [47]. Lastly, smart board allows students to simulate real-life experiences and conduct real activities. Teachers can use a video or a PowerPoint presentation that comprises screengrabs of numerous different webpages dealing with a particular subject matter related to daily life. It can gauge students' previous knowledge and act as a tool for immediate reflection. Smart board also promotes computer skills required by students to be successful in the 21st century as it provides a large work space for hands-on activities with various multimedia resources. Besides, having huge display surfaces encourages a high level of students' interaction.

In Malaysia, Data Handling is a significant part of the Mathematics Primary Curriculum. It is taught in a primary school during the first year of schooling. Data Handling consists of organizing and reducing, describing, analyzing and interpreting, as well as representing of a set of data. It is a very important subtopic of statistics that brings a learner out into the real world of seeing data, reflecting upon it socially or individually, and making decisions [48]. However, Malaysian students generally perform poorly in Data Handling in two international assessments, which are PISA and TIMSS. Both results are below the international average. For the PISA assessment, the trend items selected for PISA are spread across four domains. One domain is uncertainty and data; its percentage of score points is 25%. Students need to read, interpret, and use the data presented in a mathematical graphical form. The mathematical process category is interpreting, applying and evaluating mathematical outcomes. The item involves reasoning about the data presented, thinking mathematically about the relationship between their presentation and the data, and evaluating the result. According to the school location and the mathematics content in PISA 2012, Malaysian students in urban and rural areas perform moderately in uncertainty and data [13].

On the other hand, for the TIMSS assessment, the target percentage of the TIMSS mathematics assessment devoted to content domains, data and chance at eight grades is 20%. It stresses the fundamentals of probability and the interpretation of data. Students should be able to read different data displays, work with data that have been collected by others, or involve themselves in simple data gathering plans. They should be developing skills in identifying a range of forms of data display and representing data. From TIMSS 2003 to TIMSS 2011, the TIMSS content domains, data and chance results for Malaysia dropped the most compared to other TIMSS content domains. The average scale score fell from 505 in 2003 to 429 in 2011 [5].

It is crucial that any type of Data Handling is given a real-life context or a problem-solving approach to help build children's understanding of the purpose of Data Handling, and to help them recognize an appropriate time to use certain Data Handling approaches when dealing with problems. This must be a priority within Data Handling lessons, especially for the Year-Five primary school students, as the Malaysian integrated curriculum for the Year-Five primary school mathematics encompasses most of the important skills of Data Handling. At the end of the lesson, Year-Five primary school students should be able to understand and apply the knowledge of average, understand vocabulary related to data organization in graphs, as well as organize and interpret data from tables and charts [49]. The importance of Data Handling should therefore be followed by a great need to have it taught to learners with understanding. Graphical representation has always been part of the curriculum, but Data Handling is a separate strand. Interpreting or understanding visual representation is essential as a learner needs to be able to interpret data in an increasingly technological world. It is hoped that, where available, information technology such as smart board will be used by learners effectively in Data Handling exercises. Learners must understand how important it is to enter relevant data and ask clear questions if the information to be extracted from the database is to be of any use. The concept of chance is of great importance. It represents real-life mathematics and promotes thinking and discussions. Topics can be introduced through active learning, practical experiments and simulations that help develop learners' intuitive foundations for future work.

II. OBJECTIVES

This study aims to achieve two main objectives:

1. To design and develop an active learning instruction using smart board (ALuSB program) to enhance HOTS in Data Handling among students in Malaysian primary schools.
2. To evaluate the effectiveness of the ALuSB program in enhancing HOTS in Data Handling among students in Malaysian primary schools.

III. METHODOLOGY

The study was divided into two stages. In the first stage, the ALuSB program was developed by using the ADDIE model which integrated five phases, namely analysis, design, development, implementation, and evaluation. In the second phase, smart board as a teaching and learning interactive tool was integrated with a model of active learning which consisted of learning activities involving self-dialogues, dialogues with others, the experience of doing, and the experience of observing. Then, the effectiveness of the ALuSB program in enhancing HOTS in Data Handling among students in a Malaysian primary school was evaluated. The quasi-experimental design, a non-equivalent control group design with pre-tests and post-tests [50], was used in the second stage of the research. Based on a quasi-experimental research design, the participants from the same population were split into three groups equally, i.e., two experimental groups and one control group. Treatments were introduced in both experimental groups, i.e., the ALuSB program for one experimental group and an active learning instruction for the other experimental group. Meanwhile, the control group used the conventional learning methods.

A. RESEARCH DESIGN (STAGE ONE)

In this research, the ALuSB program was built using the ADDIE model. The ADDIE model is also an instructional design model that is valid for any education. Although ADDIE comprises the components of all other design models, it is a relatively simple model [51], [52]. Besides, numerous professional instructional designers have employed the general ADDIE framework [53] as a standard model for technology-based education as it is an instructional system design model that presents a sequence of iterative steps for building effective training and education in five phases. The first phase was analysis, while the second phase was design in which smart board as a teaching and learning interactive tool was used to design the ALuSB program that was expected to enhance HOTS in Data Handling. The third phase was development, followed by implementation (the fourth phase), and evaluation (the fifth phase).

B. RESEARCH DESIGN (STAGE TWO)

The summative evaluation is an assessment of samples in which the emphasis is placed on the result of a program. It aims to summarize the overall learning at the completion of the program [54]. The research design used in the current study to evaluate the effectiveness of the ALuSB program in enhancing HOTS in Data Handling among students in a Malaysian primary school was based on the quasi-experimental design, a non-equivalent control group design with a pre-test and post-test design and with the combination of qualitative and quantitative approaches. It is one of the most generally used quasi-experimental designs in educational research [50] since students are considered to share similar characteristics and are naturally arranged in classes within schools [55]. In the quasi-experimental, non-equivalent control group design, there is a treatment group that is given a pre-test, receives a treatment, and then is given a post-test. At the same time, there is a nonequivalent control group that is given a pre-test, does not receive the treatment, and then is given a post-test. The question, then, is not simply whether participants who receive the treatment improve, but whether they improve more than the participants who do not receive the treatment.

In this study, the selection of the samples was based on purposive sampling. They were from medium performing groups with an average academic achievement in mathematics. In many cases, purposive sampling was used in order to access those who have in-depth knowledge about particular issues. Besides, the sample groups were non-equivalent, i.e., the assignment to control and experimental groups were not randomized [50]. The groups might be different prior to the study as the researcher did not control the assignment to groups through the mechanism of random assignment. Participant characteristics were not balanced equally among the control and experiment groups. Participants' experiences during the study were also different. A total of 90 students were involved in this study. They were split into three groups equally: 30 students for the experimental group using the ALuSB program, 30 students for the experimental group using an active learning instruction, and 30 students for the control group using a conventional learning method. Table 1 illustrates the design of this research. In the non-equivalent control group design with a pre-test and post-test design, O1 represents pre-tests, X and Y represent the treatment implemented, and O2 represents post-tests. After the control and experimental groups finish a pre-test, the experimental groups receive the treatment. Later, all control and experimental groups complete a post-test.

1) FEATURES OF SMART BOARD

In the ALuSB program, lesson plans with students' learning activities and exercise sheets were designed and developed. The ALuSB program integrated active learning activities with smart board. Students and teachers of the experimental groups were given a week to familiarize themselves with

TABLE 1. A quasi-experimental, non-equivalent control group design with a pre-test and post-test design.

Group	Pre-test	Method	Post-test
Experimental group, A	O1	X	O2
Experimental group, B	O1	Y	O2
Control group	O1	Z	O2

O = scores or measurements, X = the ALuSB program, Y = active learning instruction, Z= conventional learning method

TABLE 2. The basic operations of smart board.

Basic operations	Ways to Operate
Single-click	If you use a pen or a finger, press the surface with the pen or the fingertip using proper strength.
Double-click	If you use a pen or a finger, press the surface twice with the pen or the fingertip using proper strength. Please make sure you press at the same point.
Drag	If you use a pen or a finger, press an object with the pen or the fingertip and hold, then move the pen or the fingertip to drag the object to the desired position.
Write and Draw	If you use a pen or a finger, start the smart board software, select a drawing tool, and then you can write or draw by pressing the surface with the pen or the fingertip.

the use of smart board before the implementation of the ALuSB program. For smart board, the users could use the enclosed pen or their finger to write or perform the mouse function. Table 2 shows the tips for some basic operations of smart board.

The smart board came with a visualizer in which the students could use it to show their work or demonstrations. The visualizer had a zooming ability and could rotate images. The students could wheel right the middle wheel of the visualizer to zoom in, or wheel left the middle wheel of the visualizer to zoom out. In numeracy activities, the students could place a net of a shape on the visualizer and construct the 3D shape. The students could take a close look at the shape from different angles. The rest of the class could view the process of constructing the shape. If the students used the video function within some visualizers, they could also record their work through the problem and save it as evidence of their understanding.

Moreover, the smart board software, such as Flipbook, Sphere 2 and IQ Interactive Education Platform, was used to facilitate the student's learning activities in the ALuSB program. Flipbook contained all the subjects of the Standard Curriculum for Primary School (KSSR) textbooks and activity books. Sphere 2 connected the visualizer to the computer. The students could annotate, write and draw on the interactive screen using Sphere 2. Sphere 2 provided drawing tools such as a pencil and a brush pen. The students could customize each property, such as color and thickness, if necessary. Figure 1 shows the main page of Sphere 2 when the visualizer is not connected to the computer.

The IQ Interactive Education Platform began with the main page that contained the student login (see Figure 2). When

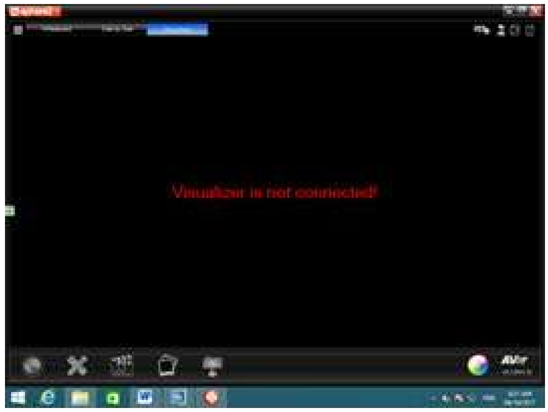


FIGURE 1. The main page of Sphere 2.

FIGURE 2. Main page of the IQ interactive education platform.

FIGURE 3. Home page of the IQ interactive education platform.

the students logged in successfully with their user account and password, the software would display the home page as shown in Figure 3.

a: IMPLEMENTATION OF THE IQ INTERACTIVE EDUCATION PLATFORM IN THE ALuSB PROGRAM

The IQ Interactive Education Platform consisted of various functions which could facilitate students' learning in the ALuSB program. The home page consisted of a Floating Tools toolbar. The Floating Tools toolbar enabled the students to access frequently-used tools and features quickly. The Floating Tools toolbar was capable of being anywhere on the screen and being moved. Wherever the Floating Tools toolbar was, there was a position-switching arrow on the opposite

FIGURE 4. Dual-user mode (split screen).

FIGURE 5. Multiple tabs.

side. The students could click the arrow to move the Floating Tools toolbar from one side to the other. This function allowed the students to access the Floating Tools toolbar conveniently on a large screen. If the students moved the Floating Tools toolbar to any edge of the screen, the toolbar would automatically hide. To show the toolbar, the students could move the cursor to the edge to which the toolbar was docked, or they could click on the button.

The IQ Interactive Education Platform enabled the dual-user mode (see Figure 4). Two users could use their own pen to write on the board simultaneously. However, Teacher Pen and Student Pen could only control its own Floating Tools toolbars respectively. Handwriting would be recognized automatically when the Student Pen used ''Handwriting recognition''.

The IQ Interactive Education Platform also could facilitate the students to organize their files and create objects in the class.

b: FILE MANAGEMENT

The IQ Interactive Education Platform also enabled the students to create and save their files in various forms while learning in a class. The students could create or open several files at the same time, and click tabs to switch among them, as shown in Figure 5.

c: CREATING OBJECTS

The students could use the Freehand Drawing Tools to annotate, write and draw on the interactive screen in a class. The

FIGURE 6. Show length.

Freehand Drawing Tools were the most frequently used tools when the students learned using the smart board. Seven Freehand Drawing Tools were provided including Pencil, Brush Pen, Pen, Washing Pen, Broad Pen, Creative Pen and Magic Pen. The students could adjust each property if necessary. The Objects drawn by the Magic Pen would fade out in eight seconds. The Magic Pen also had tool recognition to open reveal screen, spotlight, magnifier and even to delete an object by drawing given shapes. The students could also customize the properties of Freehand Drawing Tools such as color, thickness and transparency.

Several arrow and line effects were provided for the Pencil tool, the Creative Pen tool and the Magic Pen tool. The students could click on the menu arrow of the arrow section or the line section and then select the arrow or line effect from the list. The students could also click to customize their arrow or line styles. When the students added a line to the whiteboard page, they could display the line length by clicking on the properties toolbar and then select ''Show Length''. The students could also set the unit and decimal digits of length from ''Length Settings'', as shown in Figure 6

Various kinds of two-dimensional and three-dimensional shapes were provided in the IQ Interactive Education Platform. The students could customize the color, thickness and transparency of the shapes tool. The students could also enable the Shape Recognition function by using the Pencil tool. The stroke drawn by the Pencil would be revised automatically to Solid Line, Arc, Circle, Rectangle, Triangle or Polygon, and adjacent Solid Lines would be automatically combined to polygons. The students could fill different colors, gradients, patterns or images to any closed geometry.

Furthermore, the students could create a table, a pie chart and a bar chart using the IQ Interactive Education Platform. They could set the title, the three-dimensional effects, the background color, the style for a pie chart, the title, the category (x) axis, the value (y) axis, and the style for a bar chart. For the bar chart, the students could modify the magnitude of each bar directly, while for the pie chart, the students could modify the magnitude of each sector and separate one or more sectors from the pie chart. The students could also use the fill tool to change the color of each bar or sector, as shown in Figure 7.

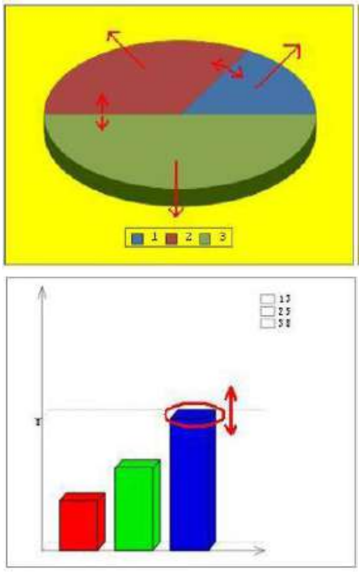


FIGURE 7. Pie chart and bar chart management.

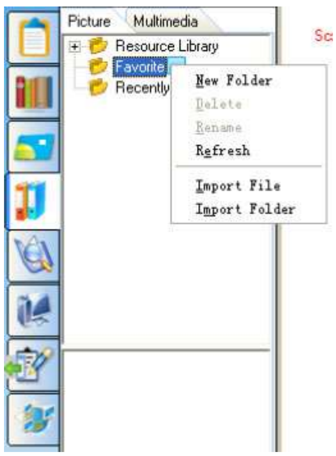


FIGURE 8. Resource library.

The IQ Interactive Education Platform consisted of a resource tab which could provide many pictures and multimedia resources for the students to use in presentations.

The students could set a video clip to play, or capture an image from the video and insert it into the page. By using the Search Tool, the students could also translate a word or a sentence into the target language, look it up in the dictionary, and search images for it. The students could save a created object into the Resource Library, as shown in Figure 8.

2) DESIGN AND DEVELOPMENT OF THE LESSON PLANS OF THE ALUSB PROGRAM AND AN ACTIVE LEARNING INSTRUCTION

The current study was based on a quasi-experimental research design. The participants were Year Five students. They were split into three groups equally, i.e., two experimental groups and one control group. The treatment was introduced to both experimental groups, i.e., the ALuSB program for one experimental group and an active learning instruction for the other experimental group. Meanwhile, the control group used the conventional learning methods. Therefore, two different sets of lesson plans for the ALuSB program and an active learning instruction were designed and developed by the researchers. The lesson plans for the conventional learning methods followed the yearly lesson plans designed and developed from the school teachers. The topic chosen by the researcher was Data Handling for Year Five primary school mathematics. The teaching and learning activities were developed based on the Malaysian integrated curriculum for Year Five primary school mathematics [49]. Upon completion of the ALuSB program, an active learning instruction, and a conventional learning method, students should be able to:

i. Describe the meaning of average.
ii. State the average of two or three quantities.
iii. Determine the formula for average.
iv. Calculate the average formula.
v. Solve the problem in a real-life situation.
vi. Recognize frequency, mode, range, the maximum and minimum value from bar graphs.
vii. Construct a bar graph from a given set of data.
viii. Determine the frequency, mode, range, average, the maximum and minimum value from a given graph.

Each lesson in the ALuSB program and an active learning instruction consisted of an induction, step one, step two, step three and closure. The content of teaching and learning activities designed in the active learning instruction and the ALuSB program was validated by five experts, as shown in Appendix K and Appendix L. With smart board as a teaching and learning interactive tool, the students learned through active learning activities which consisted of learning activities including self-dialogues, dialogues with others, the experience of doing, and the experience of observing. Firstly, for the experimental group, the ALuSB program consisted of 12 lesson plans with learning activities and exercise sheets. It incorporated active learning with smart board to enhance HOTS in Data Handling among Year Five students in a Malaysian primary school. Table 3 shows the mapping of the ALuSB program.

IV. DATA ANALYSIS

A. ANALYSIS OF THE MEAN OF EACH LEVEL OF THE COGNITIVE DOMAIN IN HOTS IN DATA HANDLING FOR EACH STUDENT GROUP

Pre-tests and post-tests were used to discuss the consequences of learning using the ALuSB program, the active learning instruction and the conventional learning method in enhancing each level of the cognitive domain in HOTS, i.e., applying, analyzing, evaluating, and creating in Data Handling among students. The mean score of each cognitive domain between the pre-test and post-test of each student group, i.e., the experimental group A, the experimental group B and the control group, was analyzed to show the improvement of the level of HOTS before and after implementing the ALuSB

TABLE 3. The mapping of the ALuSB program.

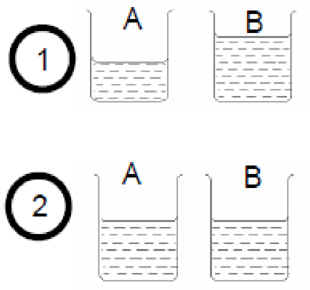
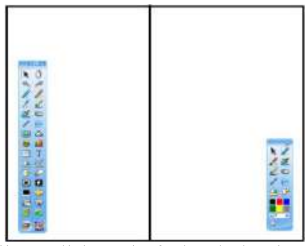
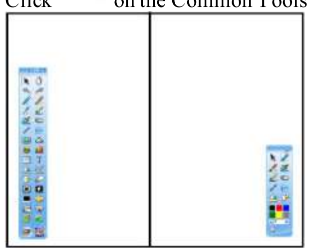
Steps	A Model of Active Learning (L. Dee, 2010)	Smart Board Activities	Examples of Smart Board Activities
Set Induction (≈5 minutes)	• Experience of observing	Using a visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform to demonstrate a different event or phenomenon by showing pictures or diagrams, a short practical activity, present a problem to be thought through, a video clip or a film show through internet and an experiment	1. The teacher shows two containers of the same size with different volumes of liquid under the visualizer. (Experience of observing)  2. The teacher asks the students to equalize the volumes of liquid in both containers under the visualizer. 3. Next, the teacher adds in more containers of the same size with different volumes of liquid and asks the students to equalize the volumes of liquid in the containers under the visualizer. (Experience of observing) 4. The teacher explains toward the students that the actions done by the students are to find the average of volumes of liquid in the containers.
Step 1 (≈10minutes)	• Self-dialogues • Dialogues with others • Experience of observing • Experience of doing	Using a visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform Discussion during the experiment, discourses in small groups, brainstorming, concept mapping, practical work, question-answer sessions, interviews of events, drawing pictures to illustrate science phenomena and presentations.	1. The teacher poses a short video through the smart board about the sum of questions a boy needs to solve in 3 days from https://www.youtube.com/watch?v=ZlwnrUSbvv0&t=52s (0:00time to 0:23time). (Experience of observing) 2. The teacher asks the students to try to calculate, reflect and discuss the question in the video. Example of discussion: How many questions that the boy needs to solve daily? (Experience of doing, self-dialogues, dialogues with others) 3. The teacher solves the question using drawing tools in the "IQ Interactive Education Platform" software. (Experience of observing)  4. The teacher shows the answer from https://www.youtube.com/watch?v=ZlwnrUSbvv0&t=52s (0:23time to 0:41time) and asks students to solve the question using drawing tools in the "IQ Interactive Education Platform" software again. (Experience of observing) 5. The teacher asks the students about the similarity between drawing and simple calculation methods (self-dialogues, dialogues with others) (Both methods provide the same answer for average.) 6. The teacher advises the students to spend their time wisely.
Step 2 (≈25minutes)	• Self-dialogues • Dialogues with others • Experience of observing	Using a visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during small group	**Group activity** 1. The teacher asks the students to form eight groups. 2. The teacher asks the students in the groups to gather all the money from the group members (RM10, RM5, RM1, 20 cents, 10 cents, and 5 cents). (Experience of

TABLE 3. ***Continued.*** **The mapping of the ALuSB program.**

	• Experience of doing	discussions, projects, investigations, experimentation, demonstrations, practical work, simulations and presentations.	doing) 3. Each group is given 10 minutes to find the average of money among each group and write down the vocabulary related to average on a piece of paper. (Experience of doing, self-dialogues, dialogues with others) 4. The teacher randomly picks a few groups. The member in the group comes out and presents their works with the smart board by using the drawing tools in the "IQ Interactive Education Platform" software. (Experience of doing, experience of observing) Dual-user Mode: i. Select "Tools, then Dual-user" on the Menu Bar, or Click  on the Common Tools toolbar.  ii. Click on the freehand drawing tools. 5. The teacher discusses the correct answer with the students. (Dialogues with others) (Vocabulary related to average= Add, divide)
Step 3 (≈15minutes)	• Experience of doing	Using a visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform to solve problems in various but related circumstances, innovating, and worksheets.	**Worksheet (Group activity)** 1. The teacher gives a worksheet to each student. 2. The teacher gives 10 minutes to the students to solve the worksheet in groups. (Experience of doing) 3. After the students finish the worksheet, the teacher randomly picks a group. The member in the group comes out and presents their works with the smart board by using the drawing tools in the "IQ Interactive Education Platform" software. Dual-user Mode: i. Select "Tools, then Dual-user" on the Menu Bar, or Click  on the Common Tools toolbar.  ii. Click on the freehand drawing tools. 4. The teacher discusses the correct answer with the students.
Closure (≈5 minutes)	• Self-dialogues • Dialogues with others	Using a visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during group discussions.	1. The teacher asks the students to reflect and discuss the meaning of average. (Self-dialogues, dialogues with others) 2. The teacher explains that an average is a number expressing the central or typical value in a set of data.

program, the active learning instruction and the conventional learning method. Table 4 shows the results of the analysis.

The result from Table 4 is presented more clearly through the graph as shown in Figure 9.

Figure 9 shows the comparison of the mean score of each cognitive domain in HOTS between pre-tests and post-tests for each student group, i.e., the experimental group A, the experimental group B and the control group. The mean

TABLE 4. Comparison of the mean score of each cognitive domain in HOTS between pre-tests and post-tests for each student group.

Cognitive Domain	Applying		Analyzing		Evaluating		Creating	
Group	Pre-test	post-test	Pre-test	post-test	Pre-test	post-test	Pre-test	post-test
Experimental group A	4.43	7.57	3.43	7.23	2.23	6.70	1.20	6.73
Experimental group B	4.33	6.70	3.50	5.57	2.20	4.83	1.27	4.47
Control group	4.40	5.10	3.43	4.33	2.17	3.03	1.20	2.47

TABLE 5. Comparison of the mean score of each cognitive domain in HOTS between pre-tests and post-tests for each student group.

	Experimental group A			Experimental group B			Control Group		
	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)
Minimum	3	7	4	3	5	2	3	5	2
Maximum	6	8	2	6	8	2	4	6	2
Mean	4.43	7.57	3.14 (70.9)	4.33	6.70	2.37 (54.7)	4.40	5.10	0.7 (15.9)

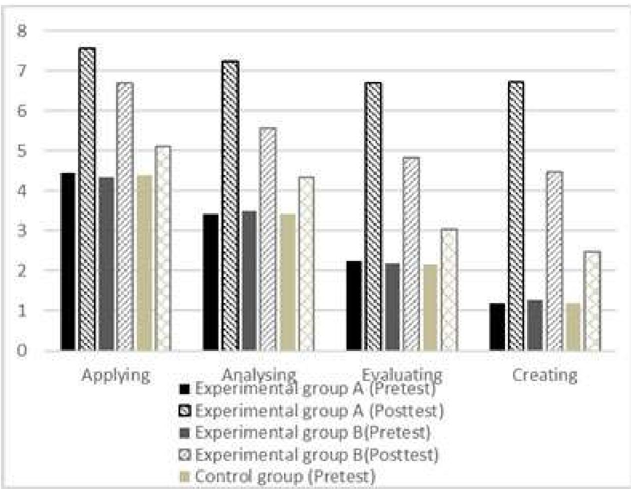


FIGURE 9. Comparison of the mean score of each cognitive domain in HOTS between pre-tests and post-tests for each student group.

score of each cognitive domain in HOTS for the post-test for each student group is significantly higher than the pre-test, indicating the improvement in HOTS in Data Handling among student groups. The experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement in HOTS in Data Handling as this group has the largest difference for each cognitive domain in HOTS between pre-tests and post-tests: Applying = 3.14; Analyzing = 3.8; Evaluating = 4.47; and Creating = 5.53. On the other hand, the control group who used the conventional learning method in learning Data Handling shows the smallest improvement in HOTS in Data Handling as this group has the smallest difference for each cognitive domain in HOTS between pre-tests and post-tests: Applying = 1.7; Analyzing = 0.9; Evaluating = 0.86; and Creating = 1.27. Besides, the highest mean score is Applying from the experimental group A for the pre-test (5.43) as well as the post-test (7.57). The lowest mean score is Creating from the experimental group A and the control group for the pre-test (1.20) and the control group for the post-test (2.47). The highest improvement between the pre-test and the post-test is Creating from the experimental group A (5.53). The lowest improvement is Applying from the control group (0.7).

B. ANALYSIS OF THE SCORE OF THE COGNITIVE DOMAIN (APPLYING)

The scores of the cognitive domain, applying, among the experimental group A, the experimental group B and the control group, were compared. Table 5 shows the change of the students' scores on the cognitive domain (applying) before and after learning using the ALuSB program, the active learning instruction and the conventional learning method.

As shown in Table 5, the experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement in the cognitive domain (applying) in Data Handling. The mean scores of the experimental group A increase 70.9%, followed by the mean scores of the experimental group B (an increase of 54.7%). The mean scores of the control group show the smallest improvement (15.9%). The minimum and maximum scores of the students in the experimental group A increase the most. The minimum and maximum scores of the students in the experimental group A are 3 and 6, respectively, before using the ALuSB program. After using the ALuSB program, the minimum and maximum scores increase to 7 and 8.

Next, the difference in mean values was explained by the ANOVA test. Prior to that, the normality tests and Levene tests were conducted. The distribution of the scores of post-tests of the experimental group A, the experimental group B and the control group fits the normal distribution well. The experimental group A shows skewness at −0.283

TABLE 6. Levene test of the cognitive domain (applying) in the post-test.

Test of Homogeneity of Variances
Applying

Levene Statistic	df1	df2	Sig.
1.025	2	87	.363

TABLE 7. One-way ANOVA for the mean scores of the cognitive domain (applying) in the post-test.

ANOVA
Applying

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	93.956	2	46.978	118.925	.000
Within Groups	34.367	87	.395		
Total	128.322	89			

TABLE 8. Post hoc tests of the cognitive domain (applying) in the post-test.

Multiple Comparisons
Dependent Variable: Applying
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
ALusB	Active learning	.867*	.162	.000	.48	1.25
	control	2.467*	.162	.000	2.08	2.85
Active learning	ALusB	-.867*	.162	.000	-1.25	-.48
	control	1.600*	.162	.000	1.21	1.99
Control	ALusB	-2.467*	.162	.000	-2.85	-2.08
	Active learning	-1.600*	.162	.000	-1.99	-1.21

*. The mean difference is significant at the 0.05 level.

and kurtosis −1.062. The experimental group B shows skewness at 0.33 and kurtosis at −0.461. The control group shows skewness at 0.567 and kurtosis at −1.778. In addition, the Levene's test results in Table 6 indicate that the critical significance level, 0.363 is higher than 0.05. The null hypothesis is retained for the assumption of homogeneity of variance and concludes that there is no significant difference between the three group's variances. The assumption of homogeneity of variance is met and hence the ANOVA test can be conducted.

Table 7 shows the analysis from the one-way ANOVA for the mean scores of the cognitive domain (applying) in the post-test. The results indicate that there are significant differences (sig. value = <0.000) between the mean scores of post-tests in the 95% confidence interval. The significance value is <0.000, which is below 0.05 and therefore, the null hypothesis is rejected and concludes that there is a statistically significant treatment effect.

To determine precisely whether the mean differences are significant, a post hoc test was conducted. Table 8 shows the analysis from the post hoc tests in the 95% confidence interval. The results indicate that there is a statistically significant difference between all the treatments as all the significance value is <0.000, which is below 0.05.

There is a statistically significant difference between groups as determined by one-way ANOVA ($F(2,87) = 118.925$, $p = <0.000$). The post hoc test reveals that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the applying domain in Data Handling among students in a Malaysian primary school ($p = <0.000$). In conclusion, the findings of the quantitative analysis discussed above indicate that the ALuSB program is the best method in enhancing the applying domain in Data Handling among students compared to the active learning instruction and the conventional learning method.

C. ANALYSIS OF THE SCORE OF THE COGNITIVE DOMAIN (ANALYZING)

The scores of the cognitive domain (analyzing) among the experimental group A, the experimental group B and the control group were compared. Table 9 shows the change of the students' scores on the cognitive domain (analyzing) before and after using the ALuSB program, the active learning instruction and the conventional learning method.

As shown in Table 9, the experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement in the cognitive domain (analyzing) in Data Handling. The mean scores of the experimental group A increase 110.8%, while the mean scores of the experimental group B increase 59.1%. Lastly, the mean scores of the control group show the smallest improvement (26.2%). The minimum and maximum scores of the students in the experimental group A increase the most. The minimum and maximum scores of the students in the experimental group A are 2 and 4, respectively, before using the ALuSB program. After using the ALuSB program, the minimum and maximum scores increase to 6 and 8, respectively.

Next, the difference in the mean value is further explained by the ANOVA test. Prior to that, the normality tests and Levene tests were conducted. The distribution of the scores of the post-test of the experimental group A, the experimental group B and the control group fits the normal distribution well. The experimental group A shows skewness at −0.201 and kurtosis −0.453. The experimental group B shows skewness at 0.551 and kurtosis −0.639. The control group shows skewness at 0.05 and kurtosis −0.699. Also, the Levene's test results in Table 10 indicate that the critical significance level 0.087 is higher than 0.05. The null hypothesis is retained for the assumption of homogeneity of variance and concludes that there is no significant difference between the three group's

TABLE 9. Score achievements on analyzing for each student group.

	Experimental group A			Experimental group B			Control Group		
	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)
Minimum	2	6	4	2	4	2	2	3	1
Maximum	4	8	4	4	7	3	5	5	0
Mean	3.43	7.23	3.8 (110.8)	3.50	5.57	2.07(59.1)	3.43	4.33	0.9(26.2)

TABLE 10. Levene test of the cognitive domain (analyzing) in the post-test.

Test of Homogeneity of Variances
Analyzing

Levene Statistic	dfl	df2	Sig.
2.514	2	87	.087

TABLE 11. One-way ANOVA for the mean scores of the cognitive domain (analyzing) in the post-test.

ANOVA
Analyzing

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	127.089	2	63.544	147.817	.000
Within Groups	37.400	87	.430		
Total	164.489	89			

TABLE 12. Post hoc tests of the cognitive domain (analyzing) in the post-test.

Multiple Comparisons
Dependent Variable: Analyzing
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
ALusB	Active learning	1.667*	.169	.000	1.26	2.07
	control	2.900*	.169	.000	2.50	3.30
Active learning	ALusB	-1.667*	.169	.000	-2.07	-1.26
	control	1.233*	.169	.000	.83	1.64
Control	ALusB	-2.900*	.169	.000	-3.30	-2.50
	Active learning	-1.233*	.169	.000	-1.64	-.83

*. The mean difference is significant at the 0.05 level.

variances. The assumption of homogeneity of variance is met, hence the ANOVA test can be conducted

Table 11 shows the analysis from the one-way ANOVA for the mean scores of the cognitive domain (analyzing) in the post-test. The results indicate that there are significant differences (sig. value = <0.000) between the mean scores of the post-test in the 95% confidence interval. The significance value is <0.000, which is below 0.05 and therefore, the null hypothesis is rejected and concludes that there is a statistically significant treatment effect.

To determine precisely whether or not the mean differences are significant, a post hoc test was conducted. Table 12 shows the analysis from the post hoc tests in the 95% confidence interval. The results indicate that there is a statistically significant difference between all the treatments as all the significance values are < 0.000, which is below 0.05.

There is a statistically significant difference between groups as determined by one-way ANOVA ($F(2,87) = 147.817$, $p = <0.000$). The post hoc test reveals that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the analyzing domain in Data Handling among students in a Malaysian primary school ($p = <0.000$). In conclusion, the findings of the quantitative analysis as discussed above indicate that the ALuSB program is the best method for enhancing the analyzing domain in Data Handling among students compared to the active learning instruction and the conventional learning method.

D. ANALYSIS OF THE SCORE OF THE COGNITIVE DOMAIN (EVALUATING)

The scores of the cognitive domain (evaluating) among the experimental group A, the experimental group B and the control group were compared. Table 13 shows the change of the students' scores on the cognitive domain (evaluating) before and after using the ALuSB program, the active learning instruction and the conventional learning method.

Table 15 shows the analysis from the one-way ANOVA for the mean scores of the cognitive domain (evaluating) in the post-test. The results indicate that there are significant differences (sig. value = <0.000) between the mean scores of the post-test in the 95% confidence interval. The significance value is <0.000, which is below 0.05 and therefore, the null hypothesis is rejected and concludes that there is a statistically significant treatment effect.

TABLE 13. Score achievements on evaluating for each student group.

	Experimental group A			Experimental group B			Control Group		
	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)
Minimum	1	5	4	1	4	3	1	2	1
Maximum	4	8	4	3	6	3	3	4	1
Mean	2.23	6.70	4.47(200.4)	2.20	4.83	2.63(119.5)	2.17	3.03	0.86(39.6)

TABLE 14. Levene test of the cognitive domain (evaluating) in the post-test.

Test of Homogeneity of Variances
Evaluating

Levene Statistic	df1	df2	Sig.
2.507	2	87	.087

TABLE 15. One-way ANOVA for the mean scores of the cognitive domain (evaluating) in the post-test.

ANOVA
Evaluating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	201.689	2	100.844	193.106	.000
Within Groups	45.433	87	.522		
Total	247.122	89			

TABLE 16. Post hoc tests of the cognitive domain (evaluating) in the post-test.

Multiple Comparisons
Dependent Variable: Evaluating
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
ALusB	Active learning	1.867*	.187	.000	1.42	2.31
	control	3.667*	.187	.000	3.22	4.11
Active learning	ALusB	-1.867*	.187	.000	-2.31	-1.42
	control	1.800*	.187	.000	1.36	2.24
Control	ALusB	-3.667*	.187	.000	-4.11	-3.22
	Active learning	-1.800*	.187	.000	-2.24	-1.36

*. The mean difference is significant at the 0.05 level.

To determine precisely whether or not the mean differences are significant, a post hoc test was conducted. Table 16 shows the analysis from the post hoc tests in the 95% confidence interval. The results indicate that there is a statistically significant difference between all the treatments as all the significance values are <0.000, which is below 0.05.

There is a statistically significant difference between groups as determined by one-way ANOVA ($F(2,87) = 193.106$, $p = <0.000$). The post hoc test reveals that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the evaluating domain in Data Handling among students in a Malaysian primary school ($p = <0.000$). In conclusion, the findings of the quantitative analysis as discussed above indicate that the ALuSB program is the best method for enhancing the evaluating domain in Data Handling among students compared to the active learning instruction and the conventional learning method.

E. ANALYSIS OF THE SCORE OF THE COGNITIVE DOMAIN (CREATING)

The scores of the cognitive domain (creating) among the experimental group A, the experimental group B and the control group were compared. Table 17 shows the change of the students' scores on the cognitive domain (creating) before and after using the ALuSB program, the active learning instruction and the conventional learning method.

As shown in Table 17, the experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement in the cognitive domain (creating) in Data Handling. The mean scores of the experimental group A increase 460.8%, while the mean scores of the experimental group B increase 252%. Lastly, the mean scores of the control group show the smallest improvement (105.8%). The minimum and maximum scores of the students in the experimental group A increase the most. The minimum and maximum scores of the students in the experimental group A are 0 and 2, respectively, before using the ALuSB program. After using the ALuSB program, the minimum and maximum scores increase to 5 and 8, respectively.

Next, the difference in mean value is explained by the ANOVA test. Prior to that, the normality tests and Levene tests were conducted. Referring to Appendix Q, the distribution of the scores of the post-test for the experimental group A, the experimental group B and the control group fits the normal distribution well. The experimental group A shows skewness at −0.918 and kurtosis −0.256. The experimental group B shows skewness at 1.039 and kurtosis 0.167. The control group shows skewness at 1.025 and kurtosis 0.113. Also, the Levene's test results in Table 18 indicate that

TABLE 17. Score achievements on creating for each student group.

	Experimental group A			Experimental group B			Control Group		
	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)	Pre-test	Post-test	Score Improvement (%)
Minimum	0	5	5	0	4	4	0	2	2
Maximum	2	8	6	2	6	4	2	4	2
Mean	1.20	6.73	5.53(460.8)	1.27	4.47	3.20(252.0)	1.20	2.47	1.27(105.8)

TABLE 18. Levene test of the cognitive domain (creating) in the post-test.

Test of Homogeneity of Variances
Evaluating

Levene Statistic	df1	df2	Sig.
5.984	2	87	.067

TABLE 19. One-way ANOVA for the mean scores of the cognitive domain (creating) in the post-test.

ANOVA
Creating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	273.422	2	136.711	234.131	.000
Within Groups	50.800	87	.584		
Total	324.222	89			

TABLE 20. Post hoc tests of the cognitive domain (creating) in the post-test.

Multiple Comparisons
Dependent Variable: Creating
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
ALusB	Active learning	2.267*	.197	.000	1.80	2.74
	control	4.267*	.197	.000	3.80	4.74
Active learning	ALusB	-2.267*	.197	.000	-2.74	-1.80
	control	2.000*	.197	.000	1.53	2.47
Control	ALusB	-4.267*	.197	.000	-4.74	-3.80
	Active learning	-2.000*	.197	.000	-2.47	-1.53

*. The mean difference is significant at the 0.05 level.

the critical significance level 0.067 is higher than 0.05. The null hypothesis is retained for the assumption of homogeneity of variance and concludes that there is no significant difference between the three group's variances. The assumption of homogeneity of variance is met, hence the ANOVA test can be conducted.

Table 19 shows the analysis from the one-way ANOVA for the mean scores of the cognitive domain (creating) in the post-test. The results indicate that there are significant differences (sig. value = <0.000) between the mean scores of the post-test in the 95% confidence interval. The significance value is <0.000, which is below 0.05 and therefore, the null hypothesis is rejected and concludes that there is a statistically significant treatment effect.

To determine precisely whether or not the mean differences are significant, a post hoc test was conducted. Table 20 shows the analysis from the post hoc tests in the 95% confidence interval. The results indicate that there is a statistically significant difference between all the treatments as all the significance values are <0.000, which is below 0.05.

There is a statistically significant difference between groups as determined by one-way ANOVA (F(2,87) = 234.131, p = <0.000). The post hoc test reveals that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the creating domain in Data Handling among the students in a Malaysian primary school (p = <0.000). In conclusion, the findings of the quantitative analysis as discussed above indicate that the ALuSB program is the best method for enhancing the creating domain in Data Handling among the students compared to the active learning instruction and the conventional learning method.

V. DISCUSSION

The effectiveness in this study refers to the impact of each type of learning, i.e., the ALuSB program, the active learning instruction and the conventional Learning method, on the students' HOTS in the Data Handling topic. HOTS in the context of this research refer to Applying, Analyzing, Evaluating and Creating.

A. EFFECTIVENESS OF THE ALUSB PROGRAM IN ENHANCING HOTS IN DATA HANDLING

From the mean scores of each cognitive domain in HOTS between pre-tests and post-tests among the student groups, there is an improvement of HOTS among the students. However, the experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement in HOTS in Data Handling. The control group who used the conventional learning method in learning Data Handling shows the smallest improvement in HOTS in Data Handling as it has the smallest difference in each cognitive domain in HOTS between pre-tests and post-tests. Also, the ANOVA tests and post hoc tests were conducted in this study. The results in the ANOVA test indicate that there are significant differences (sig. value $= <0.000$) between the mean scores of the post-test of each cognitive category in HOTS in the 95% confidence interval. Meanwhile, the results in the post hoc test indicate that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing each cognitive category in HOTS in Data Handling among the students in a Malaysian primary school ($p = <0.000$).

Most of the students were unable to answer the questions designed to evaluate their HOTS before the ALuSB program was introduced to them. However, after the students went through the learning of Data Handling with the ALuSB program, they were able to solve the HOTS questions correctly compared to the students who learned Data Handling using the active learning instruction and the conventional learning method. This is reflected in the improvement of the mean scores of each cognitive domain in HOTS in the post-tests. The smart board as an interactive technology tool facilitates the students' learning practice and enhances HOTS. A similar finding was reported by [56] in which the interactivity in the classroom by using the smart board is influenced by the students, especially when the students' engagement with the smart board changes from a viewer to an active user. The results from the current study are also consistent with those reported by other researchers who use smart board to promote HOTS such as [57]–[59]. These studies have shown that when smart board is used as an efficient tool for orchestrating the interaction and the lesson, the students' HOTS can be improved. The ALuSB program provides the students a collaborative and active learning environment. It provides the solutions of various questions clearly and encourages student thinking. The students can enhance their understanding of the Data Handling concepts throughout active learning activities in the ALuSB program. The use of active learning in learning Data Handling appears to be successful in increasing the students' level of satisfaction and in reducing their academic failure rates [60]. Besides, the data analysis indicates that active learning could promote students to engage in HOTS during the learning process. The findings of the current study are also consistent with the results reported by [61] and [62] in which students' achievement in HOTS was increased by using active learning in the classroom. Active learning helps students to ascend the Bloom's Taxonomy from remembering and understanding to analyzing and creating. Hence, it can be concluded that the ALuSB program designed and developed by integrating the smart board with active learning is capable of enhancing HOTS in Data Handling among students.

B. EFFECTIVENESS OF THE ALUSB PROGRAM IN APPLYING

Most of the primary school students fail to apply the mathematical knowledge and skills to Data Handling tasks as they are often confused by the question, uncertain to answer the question, have a problem understanding the needs of the question, spend much time to understand the problem, fail to collect and record data, and cannot construct graphs from the data given. This is consistent with the findings from [63] and [64] who assert that the students' inability to convert mathematics questions into mathematics operations and equations is due to their poor skills in basic mathematical concepts and knowledge. However, after the students learn Data Handling with the ALuSB program, they are able to solve the questions correctly compared to the students who learn Data Handling using the active learning instruction and the conventional learning method. This is reflected in the improvement of the mean scores of the cognitive domain (applying) in the post-test. From the scores on applying from each student group, there is an improvement among the students. The experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement. On the other hand, the control group who used the conventional learning method in learning Data Handling shows the smallest improvement. The minimum and maximum scores of the students in the experimental group A increase the most. In addition, the ANOVA results for the mean scores of the cognitive domain (applying) indicate that there are significance differences (sig. value $= <0.000$) between the mean scores of the post-test in the 95% confidence interval. Meanwhile, the results in the post hoc test indicate that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the applying domain in Data Handling among the students in a Malaysian primary school ($p = <0.000$). The students often learn Data Handling through memorizing the fact and formula in Data Handling. These findings accord well with [65] which claim that Data Handling is often taught by emphasizing algorithms and formulas with very few real applications.

The ALuSB program allows students to connect over the internet to learn and apply knowledge and skills to solve problems in new circumstances. As noted by [66], many libraries are located at the smart board manufacturer's website so that content can be added on a regular basis, thus giving teachers and students more options to learn in a classroom. The ALuSB program allows students to carry out or use a procedure to a familiar or an unfamiliar task. It provides various resources to suit students' requirements, enhances students' motivation to learn, and gives greater opportunities for student participation and collaboration, thereby developing students' knowledge and skills. The ALuSB program allows students to visualize more clearly all workflow data in real-time contexts through charts and graphs. Students could learn better and recall what they have learnt when their lessons are rich in graphic organizers and visual images. As one teacher notes, smart board helps students as they like its appearance. Visually, it is useful for students [67]. By touching the smart board screen, colorful diagrams, charts, pictures, and symbols can be shown to support virtually any concept. The ALuSB program and the active learning instruction, respectively, consist of a lot of group activities and tasks designed in problem-based learning. Students are exposed to various scenarios which can enhance their thinking skills. Students learn from various interactive activities actively, drill into any view or chart to see its details and then identify problems. In this way, students gain deeper conceptual understanding and knowledge to solve various questions or problems.

Referring to these findings, it is clear that learning through the ALuSB program is the best method for enhancing the applying domain in Data Handling among the students in a Malaysian primary school, followed by the active learning instruction and the conventional learning method. Students using the conventional learning method still face many difficulties in understanding the needs of the questions and are often confused by these questions.

C. EFFECTIVENESS OF THE ALUSB PROGRAM IN ANALYZING

Based on the previous studies, students always make mistakes in managing the facts in the questions; they are unsure on how to make connections and confused about the way to solve the problems. Students also face numerous difficulties to answer the questions of the cognitive domain (analyzing) in Data Handling. However, after they learn Data Handling with the ALuSB program, they are able to solve the questions correctly compared to the students who learn Data Handling using the active learning instruction and the conventional learning method. This is evident in the improvement of the mean scores of the cognitive domain (analyzing) in the post-test. From the scores of analyzing from each student group, there is an improvement among the students. The experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement. On the other hand, the control group who used the conventional learning method in learning Data Handling shows the smallest improvement. The minimum and maximum scores of the students in the experimental group A increase the most. The results of the ANOVA test for the mean scores of the cognitive domain (analyzing) indicate that there are significance differences (sig. value $= <0.000$) between the mean scores of the post-test in the 95% confidence interval. Meanwhile, the results in the post hoc test indicate that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the analyzing domain in Data Handling among students in a Malaysian primary school ($p = <0.000$).

The ALuSB program provides scaffolding and creates new pathways for students with varying learning styles. Lessons in the class are delivered in visual, auditory, and tactile learning. The ALuSB program provides various Data Handling questions, defines relationships between graphs, and pulls the data together in numerous meaningful ways. The relationships between data are shown clearly. A similar finding was reported by [68] in which the smart board has the advantage of adapting the manner in which the study material is conveyed according to students' learning style. With a touch of a finger, students can control applications, navigate the internet, write, change, move around, and save the content [69]. The smart board allows students to experience a range of new learning tools that encourage engagement with the course content. The smart board also supports students to distinguish between relevant and irrelevant parts, or between important and unimportant parts of materials. Besides, the smart board determines how the elements fit or function within a structure and identifies a point of view bias, values, or intent underlying the presented materials.

Moreover, the ALuSB program and the active learning instruction consist group activities which enable students to assist and support one another if group members encounter problems in understanding the concepts within Data Handling. As noted by [70], learners actively construct meaning in mathematics classrooms. Thus, teachers ought to provide learners with the opportunity to actively engage in problem-solving as a group. Many studies note that it is beneficial for learners to work in groups [71]–[73]. Students share their knowledge and skills during group activities and discussions. Students are able to gain deeper conceptual understanding when interacting in the classroom. This classroom interaction is facilitated positively and assists students' learning. In light of these findings, it appears that learning through the ALuSB program is the best method for enhancing the analyzing domain in Data Handling among students in a Malaysian primary school, followed by the active learning instruction and the conventional learning method. Students using the conventional learning method still face many difficulties when dealing with the facts in the questions and when relating the parts to one another.

D. EFFECTIVENESS OF THE ALUSB PROGRAM IN EVALUATING

Based on the previous studies, it was found that most of the students are unable to answer the questions of the cognitive domain (evaluating) in Data Handling. However, after the students learn Data Handling with the ALuSB program, they are able to solve the questions correctly compared to the students who learn Data Handling using the active learning instruction and the conventional learning method. This is evident in the improvement of the mean scores of the cognitive domain (evaluating) in the post-test. Based on the scores achieved for evaluating from each student group, there is an improvement in the cognitive domain (evaluating) in Data Handling among the students. The experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement. On the other hand, the control group who used the conventional learning method in learning

Data Handling shows the smallest improvement. Besides, the minimum and maximum scores of the students in the experimental group A increase the most. The results of the ANOVA test for the mean scores of the cognitive domain (evaluating) indicate that there are significant differences (sig. value = <0.000) between the mean scores of the post-test in the 95% confidence interval. Meanwhile, the results in the post hoc test indicate that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the evaluating domain in Data Handling among students in a Malaysian primary school (p = <0.000).

The ALuSB program and the active learning instruction facilitate active engagement, participation in groups, frequent interaction and feedback, and connection to real-world contexts. This environment supports students to solve a given problem on Data Handling as it provides a table or a graph for the data given in the questions. The results of the current study are consistent with the findings reported by [74] on the fundamental characteristics of effective learning. Besides, a number of studies have shown that when class-generated data are used, students report higher levels of enjoyment, an enhanced understanding of key concepts, and are likely to endorse the use of real data in future classes (see [75]–[79]). Using real-world situations in the classroom can help make mathematical concepts more relevant and meaningful to the students [80]. Students' interaction in the classroom is a useful tool in learning about real-world situations [81]. This is in line with [82] who propose that real-life examples should be used to teach Data Handling. Similarly, in a study focusing on the teaching of Data Handling, [83] point out that the goal of Data Handling is to solve real-world problems and that the content being taught must be made relevant to the learners within the educational milieu.

The ALuSB program supports students in exploring topics and in learning with more focus. It provides a framework to facilitate higher quality information which promotes students' thinking and helps them make better and faster decisions. Smart board consists of a well-designed database which can provide a systematic way for students to create, retrieve, update and manage data. In this way, students are able to manipulate information more easily, to list the main points, to see their relationships and accuracy, to plan the solutions of a problem, to analyze and evaluate the logic of solutions, and to support examples for the solutions. In light of these findings, it is clear that learning through the ALuSB program is the best method for enhancing the evaluating domain in Data Handling among students in a Malaysian primary school, followed by the active learning instruction and the conventional learning method. Students using the conventional learning method still face many difficulties when evaluating the logic of solutions and when making decisions on how to present their data.

E. EFFECTIVENESS OF THE ALUSB PROGRAM IN CREATING

Based on the previous studies, it was found that most of the students are unable to answer the questions of the cognitive domain (creating) in Data Handling. However, after the students learn Data Handling with the ALuSB program, they are able to solve the questions correctly compared to the students who learn Data Handling using the active learning instruction and the conventional learning method. This is shown in the improvement of the mean scores of the cognitive domain (creating) in the post-test. Based on the scores of creating from each student group, there is an improvement in the cognitive domain (creating) in Data Handling among the students. The experimental group A who used the ALuSB program in learning Data Handling shows the largest improvement. On the other hand, the control group who used the conventional learning method in learning Data Handling shows the smallest improvement. Besides, the minimum and maximum scores of the students in the experimental group A increase the most. The results of the ANOVA test for the mean scores of the cognitive domain (creating) indicate that there are significant differences (sig. value = <0.000) between the mean scores of the post-test in the 95% confidence interval. Meanwhile, the results in the post hoc test indicate that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing the creating domain in Data Handling among the students in a Malaysian primary school (p = <0.000). Creating mathematical word problems is a time-consuming task. Much time is wasted on the drawing of tables and graphs on a board in a classroom. As noted by [84], students' potential for learning mathematics can remain undiscovered if it is not supported at an appropriate time. By using the smart board, diagrams are drawn easily and time is utilized more effectively for students' learning. The ALuSB program can facilitate students' learning, attract their attention, and expand their ideas. This is consistent with the findings from [85]–[88] who assert that smart board can enhance students' attention, improve students' ability to learn the materials, and create students' interest in the lessons. Similarly, [89] compares learning in a traditional environment with the computer-aided learning and connects them to cognitive methods. His reports indicate that students with a verbal cognitive style have more positive attitudes toward the computer-aided learning and show better performances in this learning environment as compared to students with an analytical cognitive style who perform poorly at all learning levels.

The ALuSB program uses a visualization technique that identifies the behavior of one or several variables over time and examines their trends. It shows clear steps for students to create various tables and graphs. It helps students to actualize their learning and thinking. Moreover, the ALuSB program supports students to create various tables and graphs more easily as the smart board software includes many tools such as those for writing, underlining, and drawing. There are also various colorful pencils for handwriting identification such as the hide and show tool, the drag and drop tool, the web browser tool, and the instant screen-capture tool. These tools allow students to put elements together and form a new pattern or structure. Smart board creates dynamic and interactive presentations which allow students to be more creative in presenting their work in the classroom.

Based on these findings, it is clear that learning through the ALuSB program is the best method for enhancing the creating domain in Data Handling among the students in a Malaysian primary school, followed by the active learning instruction and the conventional learning method. Students using the conventional learning method still face many difficulties in creating a table or a graph. As creating graphs needs more time, students feel bored easily and are unable to concentrate on making a table or a graph. Sometimes, they make mistakes due to carelessness. They also lack the time to think of the solutions to create a table or a graph.

VI. CONCLUSION

In conclusion, most of the teaching and learning activities for mathematics in primary schools emphasize the development of knowledge, but not HOTS. The literature shows that HOTS is critical in educating people to cope with the rapidly changing world. Various researchers claim about the potential of technology in providing an innovative learning environment for students and in constructing their knowledge while mastering more advanced thinking skills [90]. Smart board is among the top technological tools that have been widely used by numerous school teachers in different countries. In Malaysia, the Ministry of Education introduced smart board in 2004 [20] and it has since been widely used in primary schools. The integration of smart board into lessons can facilitate active learning, which is fundamental to the mastery of skills that enhance HOTS and students' learning. Therefore, smart board as a teaching and learning interactive tool is integrated with a model of active learning in order to design and develop the ALuSB program that can enhance students' HOTS.

In this study, the data were analyzed based on the research questions using quantitative and qualitative methods. The quantitative data were obtained from the pretests, the posttests, and the ALuSB program evaluation forms. These data were then analyzed based on the descriptive and inferential statistics using SPSS 23. The quantitative data from the posttest of each group of students were analyzed through the use of mean, standard deviation, one-way ANOVA tests, post-hoc tests, and graphs. Before the ANOVA test, the normality of the posttest scores distribution was evaluated using the Rasch Model as well as the Levene's test to examine the assumption of homogeneity of variance. On the other hand, qualitative data were analysed by the transcription of the feedback and the identification of the themes. The findings from qualitative data were used to cross-check and to support the quantitative results. The results of the analysis suggest that there is a statistically significant difference between the ALuSB program, the active learning instruction and the conventional learning method in enhancing each level of HOTS in Data Handling among students. Although all students from each group showed improvements in enhancing HOTS in Data Handling, the ALuSB program appears to be the most effective method compared to the active learning instruction and the conventional learning methods. Moreover, based on the students' interviews, the ALuSB program is claimed to provide more benefits in students' learning compared to the active learning instruction and the conventional learning methods. The ALuSB program is highly motivating, promotes active learning and the ownership of learning, supports learning by doing, and encourages HOTS and peer sharing.

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