The effects of interactive whiteboard with activity theory towards year five students' motivation and performance in learning science

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ABSTRACT

The purpose of this study is to investigate the effects of interactive whiteboard (IWB) with activity theory (AT) towards year five students' motivation and performance in learning Science. This study explores the use and the effects of IWB in learning Science among Year 5 students. Learning activities that are based on Activity Theory approach have been designed to increase students' motivation and performance in learning Science. Students' learning process and perceptions was analayse too. This study uses a quasi-experimental research design. The data collection process took about 4 weeks where a total of 40 students were selected as the sample of this research. The sample of this study consisted of Year 5 students of primary schools in Segamat District, Johor. Data were obtained through several instruments such as questionnaires and pre-test and post-test. Teaching and learning activities by using interactive whiteboard (IWB) with activity theory (AT) were designed and carry out during the research. The findings of this study will provide a vital contribution to the education field by giving a new option of choosing IWB to enhance teaching and learning process. Overall, The use of IWB integrated with Activity Theory in learning Science is able to increase students' learning motivation. Students do better in class when they are motivated and have a positive attitude.

1. Introduction

Times are changing. Technology is also changing with each passing day, and the development of technology is booming. The ability to extract and absorb information from technology has become the key to determining people's success or failure in the future. School education is the best way to develop these capabilities [1]. Therefore, information technology must be implemented in the teaching environment to allow students to acquire more immediate and broader knowledge in the information environment [2]. Educational reforms that put information and communication in the teaching environment can help students adapt to the strong trend of information and communication technology. The teaching process in school education increases the students' interest and motivation in learning, activates the learning process, and enhances the learning results through the characteristics of the hardware and software equipment of information technology. These characteristics, such as timeliness, convenience, interactivity [3], and so on, can increase students' interest in learning, activate the teaching process, and improve teaching outcomes. At present, advanced countries and developing countries in the world are vigorously promoting and developing information and communication technologies (ICT). The products or tools related to ICT are also important in the educational field. Among these products and tools, the Interactive Whiteboard is one of the significant inventions that are helpful for the teaching and learning process. Moving Interactive Whiteboard (IWB) into classrooms is currently the most important trend in the world's education community. IWB can make

students' learning channels and methods more diversified [4]. Other than impacting the presentation of teaching materials, IWB also impacts teachers' teaching and students' learning methods. IWB is still an emerging teaching aid in Malaysia. After all, there are still many schools in the country that still use the traditional blackboard as a teaching mode. This research focuses on the effects of interactive whiteboard integrated with Activity Theory towards Year Five students' motivation and performance in learning science.

This research will be study the performance of Year Five students in Science, Unit 9 - Phases of the Moon and Constellations. The acquisition of knowledge in this research will be measured by using the Bloom level of knowledge, which consists of remember, understand, apply, analyze, evaluate and create. It is revised Bloom's Taxonomy by Anderson and Krathwohl [5]. This is the new version of Bloom's Taxonomy. The older version of Bloom's Taxonomy consists of knowledge, comprehension, application, analysis, synthesis, and evaluation. The Intrinsic Motivation Inventory (IMI) Survey aims to evaluate the motivational characteristics of instructional materials for learning and teaching courses using the Self-Determination Theory [6], which focuses on the Competence, Interest, Effort aspects. The Motivation Survey for this research is based on IMI using Self-Determination Theory developed by Richard M. Ryan and Edward L. Deci [7]. The interactive approach in this research is based on the principles of Activity Theory. The objective of activity theory is to acknowledge the mental capabilities of a sole individual. However, it declines the isolated individuals as inadequate units of analysis, analysing the technical and cultural aspects of human actions. The hierarchical structure of activity, object-orientedness [8], [9], internalization/ externalization, mediation and development are the principles of Activity Theory. The perceptions of user acceptance are measured by using the Technology Acceptance Model (TAM). This model is adapted from the Theory of Reasoned Action [10], and was originally proposed by Davis [11]. Fig 1 shows the Theoretical Framework of this research.

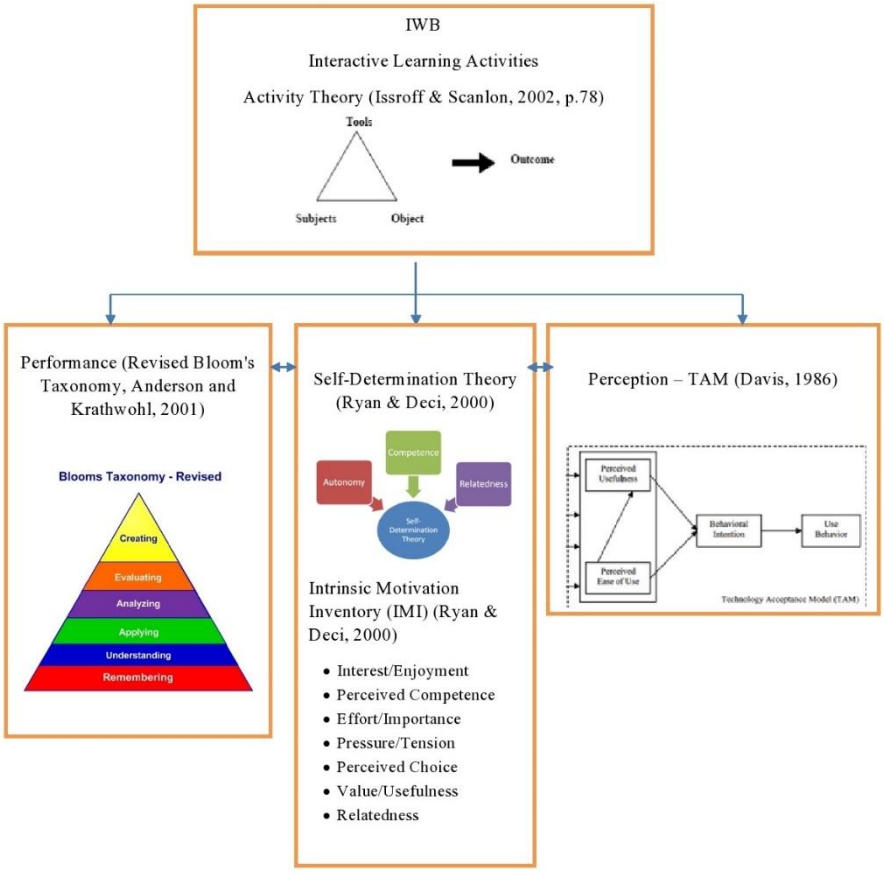

Fig. 1. Theoretical framework

2. Method

The main purpose of this research is to compare the impact of the learning environment created by the two different teaching methods, IWB-based on interactive learning and traditional teaching methods, on students. The purpose of this study is to investigate whether there will be a significant difference in learning interest and effectiveness between the experimental group and the control group. The researcher will collect relevant documents according to the research purpose, analyse and sort out relevant research results, sum up their theoretical basis, conduct this experimental research framework, design teaching activities that integrate IWB into teaching, and hope to increase students' motivation and the effectiveness of learning Science as a final target. The research design for this study is a quasi-experimental research design. A quasi-experiment is an empirical interventional study used to evaluate the causal impact of an intervention on a target population without stochastic distribution. Quasi-experimental research shares a resemblance with the conventional experimental design or randomised controlled trial, but it specifically lacks the component of stochastic assignment to treatment or control. On the contrary, quasi-experimental designs typically grant the researcher control of the assignment to the treatment condition, but using some standard other than stochastic assignment. In this study, the Year 5 students of a primary school in Segamat District, Johor will be used as the experimental objects. The two groups of students are the experimental group and the control group. Both the experimental group and the control group receive the pretest before starting teaching activities. The students in the experimental group will be under the conduction of experimental treatment and use the IWB with interactive teaching methods for teaching activities, while the control group does not perform any experimental treatment and adopts traditional teaching methods for teaching activities. After six weeks of research, the two groups of students will receive a post-test, while the experimental group will separately complete a questionnaire on teaching opinions. Next, the data on the school test of these two groups will be analysed to compare the retention and mastery of their teaching effectiveness. The experimental design of this study is as follows Table 1.

Table 1. Experimental design description

Group	Pre-test	Experimental treatment	Post-test	School-based assessment	Questionnaire on Motivation & Perception
Experimental group	O1	X	O2	O3	O4
Control group	O1		O2		

O1 is Pre-test, O2 is Post-test, O3 is Summative Assessment, O4 is Questionnaire for students in the experimental group on teaching surveys, and X is IWB and integrated with teaching activities.

- Independent variable; the self-variable item in this study is experimental treatment. The experimental group adopts electronic whiteboard teaching with interactive teaching methods, while the control group adopts traditional teaching methods.
- Dependent items; (1) Motivation in learning Science, based on the IMS questionnaire results of the experimental group before and after the study; (2) Performance in test, based on the pre-test and post-test scores of the experimental group and the control group before and after the study; (3) Students' learning process, based on summative assessment or School-based Assessment, which the teacher records on the learning progress sheet in every lesson; (4) Students' perceptions. Based on the TAM questionnaire results of the experimental group after the study.
- Control variables: (1) Teacher characteristics, the two teachers in the experimental group and the control group in this study have similar backgrounds. They both graduated from educational colleges. They have similar ages, similar teaching styles, and 8 years of teaching experience. In order to minimise this variable, the two teachers will have to teach according to the same syllabus with the same level of progress; (2) Learning content, the source of the learning content involved in the experimental courses of this study is mainly the Year 5 Science textbooks provided by the Curriculum Development Institute of the Ministry of Education of Malaysia. The learning content of the two groups of students is the same, but the teaching activities are different; (3) Teaching progress, the teaching progress of these two groups is controlled to be the same every week; (4) Number of lessons, the two groups of students have the same number of lessons. There are 4 periods of classes in a week, and the experiments are carried out in the formal courses; (5) Evaluation tool, the two groups of students did not arrange their classes

according to their abilities. In order to ensure that the starting point behavior was the same before the experimental treatment, a pre-test was conducted to analyze the differences between students.

2.1. Population

The object of this study is two groups of students in the Year 5 of a primary school in Segamat District, Johor. The primary school has been selected using a purposive sampling method. The school has been chosen because it has an IWB and is actively used by teachers in learning and teaching Science. The samples of 20 students that will be involved in this study will be selected using a simple random sampling method. The researcher divided the participating students into two groups, one group as the experimental group to implement the IWB integration with interactive teaching methods, and the other group as the control group to implement the traditional teaching method. The study conducted a 4 weeks experimental study of the Science class to explore the impact of different teaching methods on the learning motivation and learning effectiveness of the Year 5 primary school students. There are 10 students in both the experimental group and the control group. The Science teacher of the experimental group has a good ability to operate the IWB. The teacher can use the IWB software to design teaching activities and prepare teaching materials. In addition, after the experimental teaching, this research will conduct a teaching opinion questionnaire for the experimental group. The sample of this research object is shown in the Table 2.

Table 2. Samples of research subjects

Group	Experimental treatment	Gender		Total
		Male	*Female*	
Experimental Group	IWB with Interactive teaching methods	10	10	20
Control Group	Traditional methods	10	10	20

2.2. Research Procedure

This research mainly discusses the use of electronic whiteboards to enhance the interest and effectiveness of Year 5 students in learning Science. The research tools used are mainly quantitative data from student ability tests. These data will be analysed to determine whether IWB can enhance the interest and learning effectiveness of students in learning Science. In addition, in order to understand the students' thoughts and gains on the experimental teaching, there will also be in-depth interviews with qualified data as assistance. The design of Science teaching activities is also an important tool for research. Research tools that will be used by researcher include pre-test papers, post-test papers, teaching activity designs, and teaching opinion survey papers. These research tools can assist researcher in collecting research data. Before conducting the research, the researcher conducts a pre-test in order to determine the original learning ability and learning situation of the research object. The post-test is conducted after the research activities in order to be able to collect data on whether the use of IWB is effective for students' learning abilities. In the design of teaching activities, the IWB is the learning medium. During the teaching activities, a highlight of the interaction between the research object and the IWB must be carried out. The researcher also makes observations in order to grasp the learning progress and interests of the research subjects.

After determining the research theme, the researcher collected a large amount of relevant information and made a collation. Next, formulate the research plan to be carried out, and then review the relevant literature. Immediately afterwards, the researcher must design relevant teaching activities and produce relevant teaching materials for the Year 5 Science subject. This research is based on the interests and achievements of Year 5 primary school students in learning Science, and it will be conducted by experimental research design. Two groups of research targets from the Year Five primary schools are divided into an experimental group and a control group according to the needs of this study. The students in the experimental group conduct experimental treatment and use the IWB to integrate into the teaching activities, while the control group does not apply any experimental treatment and adopts the traditional teaching method for teaching activities. A pre-test will be carried out before the teaching experiment, followed by a 4 weeks Science teaching activity, and a post-test will be conducted after the teaching activity ends. Finally, analyse the results and write a report. The structure of this research idea is as follows Fig 2.

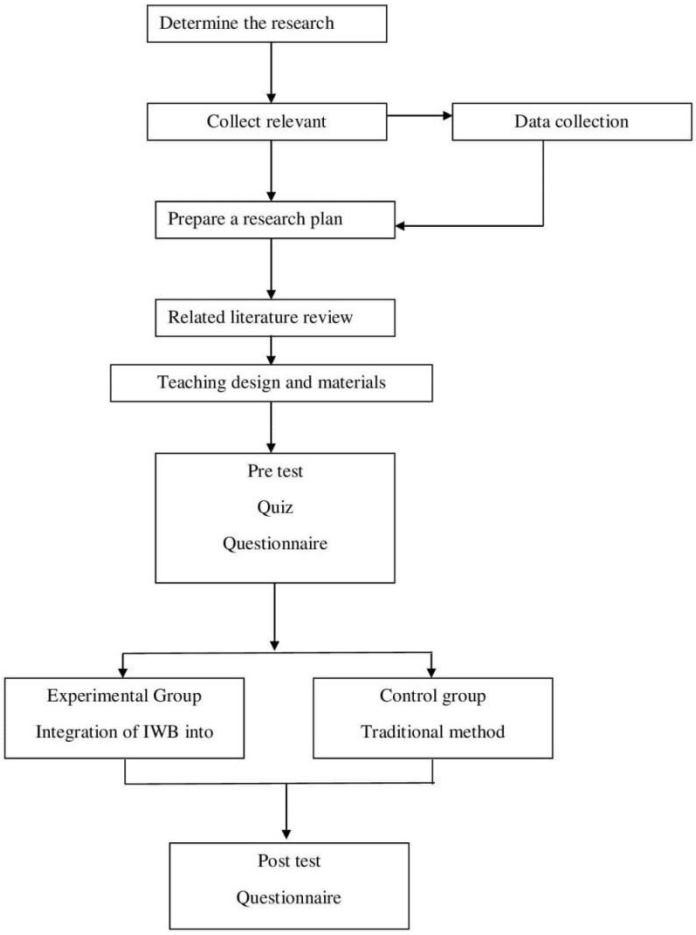

Fig. 2. The structure of this research idea

2.3. Instrument for Data Collection

In order to understand the student's learning situation before the experimental teaching, the researcher will prepare and revise the test questions to complete the pre-test papers for the experimental teaching by delving into the Year 5 Science textbooks, Year 5 Science Curriculum Standards, and multiple workbooks.

- Prepare test questions; based on the Year 5 Science textbooks and according to the standard content of the Year 5 Science, the topics are revised from textbooks, workbooks and other sources. Some test questions will be modified to facilitate students to read and meet the content of the class.
- Distribution of test questions; when preparing test questions, the sampling is average and the difficulty is moderate.
- Correction of test questions; the test questions will be revised by senior Science teachers from the Science Committee of our school in order to establish the effective test question content.

In order to understand the student's learning situation after the experimental teaching, the researcher will prepare and revise the test questions to complete the pre-test papers for the experimental teaching by delving into the Year 5 Science textbooks, Year 5 Science Curriculum Standards, and multiple workbooks.

2.4. Designing Teaching Activities

In this research, the Year 5 Science subject in the primary schools was selected for experimental teaching. The design of teaching materials is to consider the functions possessed by the IWB and to bring out many of the teaching functions of the IWB and use them in the classroom. The special functions of the IWB, such as moving, zooming, and marking, can attract students to focus on the content taught by the teacher. The colourful pictures can also catch students' eyes. The design of teaching activities is mainly student-oriented, encouraging students' willingness to operate the IWB,

express opinions, and answer questions in front of the class. The IWB with interactive teaching methods is suitable for use in a variety of teaching skills. Proper and effective teaching activity design can help to increase students' interest and effectiveness in learning Science.

- Questionnaire – IMI – motivation; the experimental subjects of this study are Year 5 primary school students. The questionnaire will be compiled as a questionnaire that is suitable for the students' level. This questionnaire will also be revised by senior teachers at our school first, and seek appropriate questionnaire content together, in order to get an accurate survey analysis. This questionnaire survey is to analyse students' motivation in learning with IWB.
- Questionnaire– TAM – perception; the experimental subjects of this study are Year 5 primary school students. The questionnaire will be compiled as a questionnaire that is suitable for the students' level. This questionnaire will also be revised by senior teachers at our school first, and seek appropriate questionnaire content together, in order to get an accurate survey analysis. This questionnaire survey is to analyse students' perceptions on teaching and learning with IWB.

2.5. Data collection

The duration of this research is 4 weeks. During this period, the researcher will collect and analyse the data about this research. The data collection method and process of this research are mainly through pre-testing and post-testing, observation in the classroom, opinion survey documents, and interviews. Through the pre-test and post-test papers, researcher can collect data on student learning effectiveness. The content of the pre-test and post-test must be consistent with the students' level and meet the syllabus. Researcher can distribute test papers in class and ask students to complete them. When conducting the test, the researcher must ensure that the research subject clearly understands the instructions and completes the test with their own abilities. Researcher can observe the teaching activities using IWB, and can explore students' interests in learning using IWB. The researcher can record the explicit behaviour and expression of the research object when the teacher uses the IWB. This is extremely useful data. Through opinion survey documents and interviews, researcher can understand students' opinions and feelings about using the IWB to learn. Researcher distributes survey papers after teaching activities to understand students' perceptions of the integration of IWB into teaching. Through personal interviews, researcher can grasp and understand the research object's feelings about the use of IWB. The above data is very important for this study, and researcher must analyse the data through these collection processes.

2.6. Data Analysis

The purpose of this study is to explore the use of IWB to enhance the interests of students and the effectiveness of learning Science. The quantitative aspects include the scores of pre-test and post-test and the scores of summative assesment. The researcher will analyse these scores in order to explore whether the experimental group using IWB integration in teaching has the function of enhancing learning interest and effectiveness in learning. In addition, the interests and views of students in the experimental group will be analysed by a questionnaire survey.

2.7. Descriptive statistics

This study uses averages and percentages to understand student responses to the teaching process. Researcher can obtain this data from the scores of the pre-test and post-test. In addition, the researcher also prepared questionnaires and surveys to explore students' opinions on the experimental teaching, which assisted the completeness of quantitative data. These two sets of questionnaires are related to students' motivation and perception.

3. Results and Discussion

3.1. Students' motivation

One of the objectives of this research is to analyse the effectiveness of an interactive whiteboard integrated with Activity Theory in learning Science between experimental vs control groups. The motivation questionnaire according to the Intrinsic Motivation Inventory (IMI) was distributed to experimental group students before the treatment and after the treatment. The questionnaire is divided into two sections: Part A, which contains demographic information; and Part B, which contains items that assess the student's motivation in learning Science subject.

3.2. Student's Motivation in Learning Science Subject. (IMI Pre-test & Post-test)

The purpose of these questionnaires is to determine the experimental group student's motivation in learning Science subject before and after the treatment. The teacher explains beforehand to ensure that students understand the questions in the questionnaire, and 12 bilingual items are used to investigate students' motivation. The questionnaire uses a three-point Likert scale. Students respond to this questionnaire by selecting "Disagree", "Neutral" or "Agree". According to Pimentel [12], the three-point Likert scale is considered an interval scale. The mean is very significant. From 1 to 1.66, it means disagree. From 1.67 to 2.32, it means neither agree nor disagree (neutral). From 2.33 to 3, it means agree.

3.3. Student's Motivation in Learning Science Subject. (IMI Pre-test vs Post-test)

The intrinsic motivation scales before the treatment and after the treatment are different. The mean for the competence scale before treatment is 1.72 with a standard deviation (SD) of 0.577, but after treatment it is 2.48 with a standard deviation (SD) of 0.535. The mean for interest scale increased from 1.78 (SD = 0.615) to 2.36 (SD = 0.529). For the effort scale, the mean before treatment is 1.68 (SD = 0.527) and increases to 2.27 (SD = 0.574). Overall, motivation has increased from 1.73 (SD = 0.573) to 2.37 (SD = 0.546). According to the paired sample t-test result, the *p* value for all the scales (competence, interest, and effort) is all 0.000. This indicates that there is a significant difference between the intrinsic motivation scales before and after the treatment. The overall means for these two test results show that there is a significant increase on the motivation scales among the experimental group. Table 3 is the data analysis of Intrinsic motivation scales (Pre-test vs Post-test).

Table 3. The data analysis of Intrinsic motivation scales (Pre-test vs Post-test)

	IMI-Pre		IMI-Post		Paired sample t-test
	Mean	***SD***	***Mean***	***SD***	***p***
Competence	1.72	0.577	2.48	0.535	.000
Interest	1.78	0.615	2.36	0.529	.000
Effort	1.68	0.527	2.27	0.574	.000
Overall motivation	1.73	0.573	2.37	0.546	.000

3.4. Pre-Test and Post-Test

This part is to compare the Pre-test and Post-Test scores for the experimental group and the control group. Students in the experimental group received treatment, and those in the control group received traditional teaching methods. Both Pre-test and Post-test consist of 40 questions. These tests were designed according to the Bloom's Taxonomy elements, which consist of evaluating, analyzing, applying, understanding, and remembering. These tests were designed based on the Standard Curriculum and Assessment Document (DSKP) Science Year 5 of the Science Standard-based Curriculum for Primary Schools (Revised 2017). The pre-test and post-test results are used to test and validate one of the objectives of this research, which is to analyse the effectiveness of interactive whiteboard integrated with Activity Theory in learning Science between experimental vs control groups on performance in the tests. The pre-test was conducted before the treatment of using IWB and the post-test was conducted after the 4 weeks of treatment of using IWB as a major teaching aid. According to the procedure of collecting data analysis for pre-test and post-test, the results of these tests were collected, and the inferential statistic which can be obtained from SPSS was used to investigate if there was any significant difference in students' achievement performance when using the IWB among primary students. Analysis on Pre-Test and Post-Test for Control Group and Experimental Group, can be seen in Table 4.

Table 4. Pre-Test Result Group Statistics

Group Statistics					
	Group	***N***	***Mean***	***Std. Deviation***	***Std. Error Mean***
Pre-Test Result	Control Group	20	47.500	16.4036	3.6680
	Experimental Group	20	41.500	7.0897	1.5853

From the pre-test result group statistics, the mean value for the control group is 47.500 and the mean value for the experimental group is 41.500. There are only 6 points separating the two groups. The means show that there is not much difference in the scores between the two groups on the pre-test.

Table 5. Independent Samples Test Levene's Test for Equality of Variances for Pre-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
									Lower	*Upper*
Pre-Test Result	Equal variances assumed	20.479	.000	1.502	38	.141	6.0000	3.9959	-2.0892	14.0892
	Equal variances not assumed			1.502	25.859	.145	6.0000	3.9959	-2.2158	14.2158

According to Table 5, the Independent Samples Test for Levene's Test for Equality of Variances and the t-test for Equality of Means for pre-test results, the p-value for equal variances assumed is 0.141 and the p-value for equal variances not assumed is 0.145. Both p-values are greater than 0.05. This shows that there is no significant difference between the mean scores of both groups. By this finding, it proves that there is not much difference in the performance of the students between the control group and the experimental group. They have a balanced ability and learning quality. From the post-test result group statistics, the mean value for the control group is 59.750 and the mean value for the experimental group is 67.000 (Table 6). There are 7.25 points between the two groups. The means show that the difference in the scores between the two groups on the post-test is higher than the difference in the scores between the two groups on the pre-test, which is 6 points away. The gap in their performance is higher compared to the pre-test.

Table 6. Post-Test Result Group Statistics

Group Statistics					
	Group	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
Post-Test Result	Control Group	20	59.750	11.4966	2.5707
	Experimental Group	20	67.000	10.0197	2.2405

According to Table 7, the Independent Samples Test for Levene's Test for Equality of Variances and the t-test for Equality of Means for post-test results, the p-value for equal variances assumed is 0.040 and the p-value for equal variances not assumed is 0.040. Both p-values are less than 0.05. This shows that there is a significant difference between the mean scores of both groups. By this finding, this proves that there is a significant difference in the performance of the students between the control group and the experimental group.

Table 7. Independent Samples Test Levene's Test for Equality of Variances for Post-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
									Lower	*Upper*
Post-Test Result	Equal variances assumed	.333	.567	-2.126	38	.040	-7.2500	3.4100	-14.1532	-.3468
	Equal variances not assumed			-2.126	37.304	.040	-7.2500	3.4100	-14.1575	-.3425

3.5. Analysis on Pre-Test and Post-Test for Control Group

From the pre-test and post-test results for control group statistics, the mean value for the pre-test result is 47.500 and the mean value for the post-test result is 59.750, Table 8. There are 12.25 points between the two test results. The means show that there is some positive progress in the control group's scores on the post-test. The result will be compared to the post-test result of the experimental group.

Table 8. Paired Samples for Pre-test and Post-test Result for Control Group.

Paired Samples Statistics					
		Mean	*N*	*Std. Deviation*	*Std. Error Mean*
Pair 1	Pre-Test Result	47.500	20	16.4036	3.6680
	Post-Test Result	59.750	20	11.4966	2.5707

From the Paired Samples Correlations for pre-test and post-test results for the control group, Table 9, it shows that the correlation for these two results is 0.0952. The p-value for these two results is 0.0000, which is less than 0.001. This means that there is a significant difference between the pre-test and post-test scores for the control group.

Table 9. Paired Samples Correlations for Pre-test and Post-test Result for Control Group.

Paired Samples Correlations				
		N	*Correlation*	*Sig.*
Pair 1	Pre-Test Result & Post-Test Result	20	.952	.000

From the paired differences for pre-test and post-test results for the control group, Table 10, it shows that the mean for these two results is -12.2500. The p-value for these two results is 0.000, which is less than 0.001. This means that there is a significant difference between the pre-test and post-test scores for the control group

Table 10. Paired Differences for Pre-test and Post-test Result for Control Group.

Paired Samples Test									
		Paired Differences					*t*	*df*	*Sig. (2-tailed)*
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				
					Lower	*Upper*			
Pair 1	Pre-Test Result - Post-Test Result	-12.2500	6.4838	1.4498	-15.2845	-9.2155	-8.449	19	.000

3.6. Analysis on Pre-Test and Post-Test for Experimental Groups

From the pre-test and post-test results for Experimental group statistics, Table 11, the mean value for the pre-test result is 41.500 and the mean value for the post-test result is 67.000. There are 25.50 points between the two test results. The means show that there is some positive progress in the scores of the experimental group on the post-test. This result compared to the result of the control group, which was 12.25 points away, is much higher. This means that there is a significant difference in performance between the control group and the experimental group. The experimental group students performed better than the control group, although both groups are progressing positively.

Table 11. Paired Samples for Pre-test and Post-test Result for Experimental Group.

Paired Samples Statistics					
		Mean	*N*	*Std. Deviation*	*Std. Error Mean*
Pair 1	Pre-Test Result	41.500	20	7.0897	1.5853
	Post-Test Result	67.000	20	10.0197	2.2405

From the Paired Samples Correlations for pre-test and post-test results for the experimental group, Table 12, it shows that the correlation for these two results is 0.900. The p-value for these two results is 0.000 which is less than 0.001. This means that there is a significant difference between the pre-test and post-test scores for the experimental group.

Table 12. Paired Samples Correlations for Pre-test and Post-test Result for Experimental Group.

Paired Samples Correlations				
		N	*Correlation*	*Sig.*
Pair 1	Pre-Test Result & Post-Test Result	20	.900	.000

From the paired differences for pre-test and post-test results for the experimental group, Table 13, it shows that the mean for these two results is -25.500. The p-value for these two results is 0.000 which is less than 0.001. This means that there is a significant difference between the pre-test and post-test scores for the experimental group.

Table 13. Paired Differences for Pre-test and Post-test Result for Experimental Group.

Paired Samples Test									
		Paired Differences					*t*	*df*	*Sig. (2-tailed)*
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				
					Lower	*Upper*			
Pair 1	Pre-Test Result - Post-Test Result	-25.5000	4.7711	1.0668	-27.7329	-23.2671	-23.902	19	.000

3.7. Students' Learning Process through IWB Integrated with Activity Theory

The learning process through IWB integrated with Activity Theory was monitored by using the Standards-based Curriculum and Assessment Document (Dokumen Standard Kurikulum dan Pentaksiran - DSKP) Year 5 Science (Reviewed on 2019) as guidance. The curriculum standards are written in the form of Content Standard, Learning Standard, and Assessment Standard. In each lesson, the students' performances in class are recorded on the learning progress sheet. This is to ensure that the students' learning processes can be tracked and analyzed. The mastery rate of Experimental Group for lesson 1, lesson 2 and lesson 5 are 100%. For lesson 3, Experimental Group students obtained a 95% mastery rate. Meanwhile, for lesson 4, they got an 85% mastery rate. For lesson 6, Experimental Group students once again obtained an outstanding 100% mastery rate. The higher the mastery level, the better the mastery of the students. Table 14 is the table of mastery levels for Experimental Group students.

Table 14. Mastery Levels for Experimental Group

Mastery Level	Total Students
	Experimental Group
1	0
2	0
3	0
4	1
5	2
6	17
Overall	20

As we can see from the table above, the lowest mastery level achievement for the Experimental Group which is level 4. There is 1 student categorised as level 4. Then for level 5, there are 2 students in this level. The highest mastery level achievement for this group is level 6 with an outstanding 17 students.

3.8. Students' perception

One of the objectives of this research is To analyse students' perceptions towards learning Science through Interactive whiteboard integrated with Activity Theory. The perception questionnaire according to the Technology acceptance model (TAM) was distributed to experimental group students after the treatment. The questionnaire is divided into two sections: Part A, which contains demographic information, Part B, which contains items that assess student's perceptions in learning science subject. To investigate student's perception, the researcher had discussed the data gathered from Part B of the questionnaire in this section.

3.9. Student's Perception in Learning Science Subject Using Interactive Whiteboard. (TAM)

The purpose of this questionnaire is to determine experimental group students' perception in learning Science subject before treatment. The teacher explains beforehand to ensure that students understand the questions in the questionnaire, and 19 bilingual items are used to investigate students' perception. The questionnaire is using three-point Likert scale. Students respond to this questionnaire by selecting "Disagree", "Neutral" or "Agree". In summary, there is a significant positive trend in students' perceptions of learning Science subject using interactive whiteboard. The means of each question showed a clear positive trend, which indicates that participants have a positive perception of IWB.

3.10. Overall data analysis of Student's Perception in Learning Science Subject Using Interactive Whiteboard (TAM)

The overall motivation mean for the Technology Acceptance Model is 2.67 and the standard deviation is 0.462. According to the Table 15, the results for each motivation factor are between 2.33 and 3. This indicates that participants highly agree with the statements in the questionnaire, and they have high motivation.

Table 15. The overall data analysis of Student's Perception in Learning Science Subject Using Interactive Whiteboard. (TAM)

Technology Acceptance Model		
Factors	Mean	SD
Perceived Usefulness (PU)	2.69	0.456
Perceived Ease of Use (PEU)	2.69	0.463
Attitude (A)	2.72	0.439
Intention to Use (IU	2.58	0.490
Overall motivation	2.67	0.462

3.11. Student's Performance, Motivation, and Perception

From the nonparametric correlations test result for the experimental group, Table 16, it shows that the correlation coefficient (r) between post-test and IMI is r = 0.987, which range between 0.75 and 1. This means there is a very strong association between the post-test and IMI. Meanwhile, the correlation coefficient (r) between the post-test and TAM is r = 0.950 which range between 0.75 and 1 too. This means there is a very strong association between post-test and TAM too. The correlation coefficient (r) between IMI and TAM is r = 0.932 which also range between 0.75 and 1 too. This also means that there is a very strong association between IMI and TAM.

Table 16. Nonparametric Correlations Test Result for Experimental Group.

Correlations					
			PostTest	***IMI***	***TAM***
Spearman's rho	PostTest	Correlation Coefficient	1.000	.987**	.950**
		Sig. (2-tailed)	.	.000	.000
		N	20	20	20
	IMI	Correlation Coefficient	.987**	1.000	.932**
		Sig. (2-tailed)	.000	.	.000
		N	20	20	20
	TAM	Correlation Coefficient	.950**	.932**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

This result also shows that the significant value (p) for post-test and IMI, post-test and IMI, and also IMI and TAM are all 0.000. The significant value (p) is lower than 0.05. This means that there is a significant relationship between post-test and IMI, between post-test and IMI, and also between IMI and TAM. There are significant relationships between all three of these instruments. In summary, the relationship between students' performance, motivation, and perception after learning Science through Interactive whiteboard integrated with Activity Theory is strong and significant. Students are performing better in their lessons with positive motivation and positive perception. Radovan and Makovec [13] in their research found out that the association between intrinsic goal orientation, self-efficacy, and control beliefs was shown to be quite strong. The most critical aspects of the learning

environment that contribute to the development of intrinsic goal orientation and enjoyment of education are a positive attitude toward the studied topics, a sense of autonomy, and instructor support

4. Conclusion

The main purpose of this study is to explore the effects of interactive whiteboard (IWB) integrated with Activity Theory towards Year Five students' motivation and performance in learning science. Based on the research findings from the analysis of the IMI questionnaire, the use of IWB integrated with Activity Theory in learning Science is able to increase students' learning motivation. These students also perform well in tests. They showed significant improvements and advancements after they were assisted by IWB in the learning process. The students' learning process through IWB integrated with Activity Theory in learning Science is outstanding. In each lesson, teachers record their mastery level according to their ability. They are not only performing well in formative assessment, but they are also showing improvement in summative assessment during each lesson. According to the findings from the analysis of the TAM questionnaire, the students' perceptions towards learning Science through Interactive whiteboard integrated with Activity Theory is seen positively by students. They were able to quickly adapt to using the IWB in their Science lessons. There is a strong and significant relationship between student performance, motivation, and perception after learning Science using an Interactive Whiteboard linked with Activity Theory. Students do better in class when they are motivated and have a positive attitude.

Limitations and Future Studies

The number of respondents in the sample of this research is limited. Only 40 students from primary schools in northern Johor districts participated in this study. As a result, the findings cannot be applied to other groups of respondents. It is suggested that in future studies, researchers focus on a larger sample size. The main research method in this research is the experimental research method, to obtain quantitative data related to the research and support the research with pre-test and post-test to explain the effectiveness and specific differences. It is suggested that in-depth interviews with students and observations can be carried out as additional explanations in future research. This qualitative data can be used to analyse the real situation of the research. Researchers can use observation methods to directly observe the research objects according to the research purpose and research outline, and use their own senses and auxiliary tools to obtain information. This scientific observation is purposeful and planned, systematic and repeatable. Through observation, people can expand their perceptual knowledge and inspire their thinking. Researchers can also lead to new discoveries through observation. researcher observing and recording the research objects in the "Observation Record Table". The researchers can also seek other teachers to observe in the classroom to obtain more observation data.

In future research, researchers can conduct individual interviews with selected research subjects to further understand their views on the study. In addition to conducting interviews with the research subjects, the researcher can also conduct interviews with teachers who teach in the same class as the research subjects to understand their feelings and analyse the data to obtain the research results. This study uses the Year 5 Science subject of the Primary School as the content of information integration into teaching research. It is suggested that in future studies, researchers can carry out research to explore the use of IWB to enhance the interests of students and the effectiveness of learning other subjects than Science such as Language subjects and Mathematics. Future research on other classes at different levels, or even secondary school, can be carried out too. In recent years, the COVID-19 epidemic has altered educational practises at all educational stages. Students can only study in virtual classrooms during lockdown. The difficulty was how to convert the learning approaches utilised in the classroom to virtual environments as institutions and faculty members worked to ensure academic continuity. A digital IWB was integrated into synchronous class sessions to complement the educational experience. Thus, future research can be carried out to investigate the use of digital IWB in the virtual classroom to enhance the interests of students and the effectiveness of learning various subjects. This research was carried out after the COVID-19 lockdown. Online classes were cancelled and students were returning to school to continue their studies. Therefore, this research focuses on the real-life IWB and not the digital or virtual IWB.

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