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The Impact of Problem Based Learning Model with Android Multimedia Integrated on Student Learning Outcomes and Interest on Acid-Base Titration

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Abstract: The implementation of a learning model and learning media in the classroom has a significant impact on learning outcomes. This research aims to assess the degree to which different educational media can influence academic outcomes and interest learn. The selected research design is the Pretest-Posttest Design. This study employs a quasi-experimental research design utilizing a nonequivalent control group. The study employs a research design that utilizes a 3x2 Factorial Design. Using SPSS 25.0 for statistical analysis, it was determined that the academic performance of students instructed through various learning models resulted in a statistically significant outcome of 0.003 α (0.05). The alternative hypothesis (Ha) was deemed acceptable, whereas the null hypothesis (H_0) was deemed unacceptable. The aforementioned suggests a significant disparity in the average academic performance outcome among XI students subjected to diverse educational materials about acid-base titration. The calculated average discrepancy in academic outcome among the two groups of students is 8.61. The first experimental group, which utilized Smart Apps Creator as a learning medium and catered to various learning styles, yielded an average student learning outcome of 88.61 ± 7.98. By comparison, the mean learning outcome score for students in the second experimental class (which utilized PowerPoint as a learning medium) is 80.00 ± 7.00.

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Introduction

National education, according to Republic of Indonesia Law No. 20 of 2003 on the National Education System, serves to create capacities and establish dignified national character and civilization within the context of teaching the nation's life. As a result, the goal of national education is to help students become human beings who believe in and fear God Almighty, have noble character, are healthy, informed, capable, creative, and self–sufficient, and become democratic and responsible citizens (Julaiha, 2014). Chemistry learning is uninteresting because of the absence of technology. Futhermore, because chemistry is often abstract (it cannot be communicated verbally), it necessitates the use of appropriate media (El Shaban & Egbert, 2018). The presence of media in the process learning has meaning important, because of the ambiguity and complexity material can be concretized so students easier to digest lessons with the help of the media (Sianturi et al., 2019). The learning style of the teacher should be able to create a comfortable learning environment in which students can

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easily accept the material provided (Simbolon & Dalimunthe, 2020). Innovative use of media and according to learning objectives, material and the condition of students and the facilities available can also support creation interesting learning (Gusbandono et al., 2013).

Android Studio IDE can be used as supporting software for developing multimedia on an Android basis in chemistry lessons on buffer solution material, where the results obtained show that the learning outcomes of students who are taught using interactive multimedia accompanied by Android–based development results are higher than those of students who are taught using multimedia sourced from the internet (Humairah et al., 2020). Benefits of teaching and learning on an Android platform can be used as a source of independent learning as well as a learning resource and a teaching and learning media that users can access at any time and from any location (Tamhane et al., 2015).

Learning cannot be done as an active learner because student learning is still centered on the teacher, and the teacher does not provide direct physical activity to students during the learning process. The teacher promotes only one type of learning in the classroom, such as visual, auditory, or kinesthetic (Sakti & Wahyudi, 2019). Visual, auditory, and kinesthetic are three of the learning paradigms that can be used in active learning (VAK). The VAK learning model is a learning paradigm that optimizes three types of learning: seeing, hearing, and moving. This learning paradigm seeks to help pupils feel at ease while learning. The VAK learning model emphasizes direct learning experiences through vision (visualization), hearing (auditory), and movement (kinesthetic) (Setiawan & Alimah, 2018). In the development of VAK methods, media is frequently required to deliver messages from teachers to students in which the media can identify people, objects, materials, or activities that can contribute to students' long–term learning success (Sakti et al., 2019). The factor of implementing the learning model in the classroom is strongly suspected of influencing learning outcomes. Thus, it is used as an in–depth study of the factors identified in this research that influence it (Yanuarti & Sobandi, 2016). The learning model can be interpreted as a conceptual framework that describes a systematic procedure for organizing experience to achieve specific learning goals, and serves as a guide for instructional designers and teachers to plan and carry out learning activities (Ibrahim, 2017). To determine learning outcomes, environmental determination, earnings measures, and interaction with the environment, a systematic procedure is used, whereas the function of learning models is to provide guidelines, curriculum development, setting teaching materials, and assisting in the improvement of teaching (Nasir, Wagino, & Pasaribu, 2017). Learn the various roles of adults through their involvement in real or simulated experiences and their learning to be autonomous and independent (Desriyanti & Lazulva, 2016). Learning that students need to solve problems can be accommodated with the Problem–Based Learning (PBL) model. PBL has a learning scheme that involves meeting the problem (finding the problem), problem analysis and learning issues (analysis and learning problems), discovery and reporting (discovery and reporting), solution presentation and reflection (presentation of solutions and reflections), overview, integration, and evaluation (conclude, integrate, and evaluate) (Pranoto & Santosa, 2014). PBL is also meant to develop the learning independence and social skills of students. independence in learning and social skills that can be formed when students collaborate to identify information, strategies, and learning resources relevant to solving problems (Farisi, 2017). Problem–based learning is learning that presents itself to students in real–world problem situations, that are open (Hikmayanti, Saehana, & Muslimin, 2016).Learning outcomes are things that can be viewed from two sides. In particular, the student and teacher sides. From the student side, learning outcomes are higher levels of

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mental development in comparison to before studying. Types of cognitive, affective, and psychomotor domains reflect the level of mental development. In the meantime, on the side teacher defines the learning outcomes as the completion of the lesson material, which is defined as the learning outcomes by the teacher (Sumartono & Normalina, 2015).

According to Hidi, interest is a unique psychology that occurs between a person and the object they interested in (Akram et al., 2017). Individual students' interests are the main influence on their career goals (students) and the reasons for their choice of courses. Students are interested in learning something they like (Kahu et al., 2017).

Research Method

In this study using a quasi-experimental research type. The form of research design chosen is the Pretest-Posttest Design. Where this quasi-experimental research uses nonequivalent control group design. The research design uses a 3x2 Factorial Design. Both classes were then given a pretest to determine the initial abilities of each group or class. Then given treatment or treatment using the Problem Based Learning learning model. After being given the treatment, they were then given a post–test to find out the final state of each group or class.

Table 1. Research Design

Interest on Learning / Learning Media	High (X_1)	Medium (X_2)	Low (X_3)
Smart Apps Creator (Y_1)	X_1Y_1	X_2Y_1	X_3Y_1
PowerPoint (Y_2)	X_1Y_2	X_2Y_2	X_3Y_2

The population in this study were all students of class XI SMAN 2 Percut Sei Tuan for the 2022/2023 academic year. The number of class XI in SMAN 2 Percut Sei Tuan consisting of 6 classes. Samples were taken by purposive sampling. Of the 6 sample classes, two was selected. The first class was an experimental class taught with PBL using Android–based multimedia with the VAK learning style and the second class was a control class using direct instruction (PPT) with learning style and PBL.

The techniques used to collect data in this study are as follows: 1) The homogeneity test is given before the research is carried out. This test was carried out to see the similarities in basic abilities between the two classes, and the questions given were questions about prerequisite material, namely acid–base material. 2) The pretest is carried out before the research begins. The score from this test is used as the pretest value. The questions given are about acid–base titration material. 3) The post–test is given after the research is done to obtain student learning outcomes after being given treatment. The score from this test is used as the posttest score. The questions given are the same as the pretest questions, namely the matter of acid–base titration material. 4) Documentation is a data collection technique that originates from written objects. Researchers can directly take existing document materials and obtain the requires data, one of which is a list of student names. The instrument used in this study is an evaluation test. The use of this instrument is to determine student learning outcomes in Acid–Base Titration. The evaluation test consists of a pre–test and post–test, namely a written test in the form of multiple choices and essays.

Multiple choice is arranged based on indicators of subject matter and each question is A, B, C, D, and E. The cognitive field evaluation tests to be evaluated are knowledge (C1),

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understanding (C2), application (C3), and analysis (C4) . The instrument was tested for reliability, difficulty index and discrimination index. The questions given were 20 questions for the experimental class with the time allotted was 35 minutes. Evaluation test criteria.

Table 2. Instrument Criteria of Student Outcomes

No	Indicator	Cognitive Aspect				Total
		C1	C2	C3	C4	
1.	Estimating the concentration/level of acid or base based on data from acid–base titration results.	1,4,14,18	5,15,25	8	–	8
2.	Analyze the concentration/level of acid or base based on data from acid–base titration results.	20	19	–	2,3,7,21	6
3.	Calculates the concentration/level of acid or base based on the results of the acid–base titration.	–	–	9,10,24	6,12,16,23	7
4.	Find the concentration/level of acid or base based on the results of acid–base titration.	–	–	–	11,13,17,22	4
Total		5	4	4	12	25

The validity of the test used in this research is content validity. The content validity of a learning achievement test is the validity obtained after analyzing, tracing or testing the content contained in the learning achievement test. Therefore, to obtain valid test results, the test that the author used was consulted with the teacher in the chemistry department who taught class XI MIPA MAN 1 Medan.

$$r_{pbi} = \frac{Mp - Mt}{SDt}\sqrt{\frac{p}{q}} \qquad \text{(Triyono, 2013)}$$

The specification and type of tools and materials must be written in case the researches have been conducted by using them. The qualitative research, such as classroom action research, case studies, and so forth, need to mention the researcher attendance, research subject, and participated informants, as well as the methods used to explore the data, research location, research duration, and the description of research results validation.

$$rx_1x_2 = \frac{N(\Sigma X1X2) - ((\Sigma X1)(\Sigma X2))}{\sqrt{[N(\Sigma X1)^2 - ((\Sigma X1)^2][N(\Sigma X2)^2 - ((\Sigma X2)^2]}}$$

A good question is one that is neither too easy nor too difficult. To find out the level of difficulty of a problem.

$$IK = \frac{B}{JS}$$

The discriminating power of the item is a measure of whether the items are able to distinguish clever students (upper group) from students who are not proficient (lower group). Calculation of discriminating power in this study.

$$D = 1 + \frac{BA}{JA} - \frac{BB}{JB} = P_A - P_B$$

Distractors are all alternative answers (options) outside the key answer". The constructor can be taken three decisions; i.e. the constructor is "accepted", “rejected” or “revised”. An item is called eligible in terms of effectiveness constructor, if:

1. At least 5% of the test takers chose the constructor.

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2. Upper group voter ≤ lower group voter.
3. Not more than 5% of blank participants.

If the blank participants are more than 5% or the upper group voters are more than lower group selector, then there is a high probability that something "goes wrong" with the item. So it should be aborted or revised. The effectiveness of the constructor is determined by formula :

$$\text{Distractor X} = \frac{JPA + JPB}{JA + JB}$$

(Silitonga, 2014)

Homogeneity test is used to determine the level of scatter of quantitative data or the level of homogeneity of data in one population is homogeneous or not. The homogeneity test can be carried out using the Levene test with the help of SPSS 25.0 for Windows, provided that the significance value is α = 0.05. If sig > α (0.05) then the sample comes from a homogeneous population. If sig < α (0.05) then the sample comes from a non-homogeneous population. The normality test is used to determine if the data received from the study's findings are normally distributed posttest data or not. In this research, the Shapiro-Wilk test with SPSS 25.0 for Windows support and a significance level of 5% or 0.05 is employed as the normality test. If the price is sig > (0.05), the data is considered to be regularly distributed. If the price is sig (0.05), the data is not normally distributed.

In this research, using SPSS Version 25.0 for Windows. The test performed is a linear regression test. With the value of the linear regression test range 0 to 1. The closer to the value 1, the relationship between the dependent variable and the independent variable is getting stronger and more related. This calculation aims to determine the increase in pretest and posttest scores of both classes. The N–Gain formula according to Hake (in Sudjana, 2005) is: according to Hake (in Sudjana, 2005) is:

$$\text{N–Gain} = \frac{posttest\ scores - pretest\ scores}{maximum\ value - pretest\ value}$$

To test the hypothesis in this research, two ANOVAs were used path (two-way ANOVA) with univariate general linear model (GLM). using the SPSS software program version 22.0 for windows with a level significance (α) 0.05. If sig < α (0.05) then Ha is accepted whereas if sig > α (0.05) then H_0 is accepted.

Result and Discussion

To determine the validity of each test item, the test instrument was tested on students who have studied the content covered in the question after being verified by a qualified validator. The trials were conducted on class XII MIPA 7 Madrasah Aliyah Negeri 1 Medan students, totaling 36 students. Point biserial correlation was used to assess the validity of the test. The test's conditions were $r_{pbis} > r_{table}$ for N = 32 and 0.05 as the significance level, r_{table} is found to be 0.349. If the questions satisfy these requirements, they are deemed valid. The items that have been determined to be valid based on the validity criteria are listed below.

Table 3. Validity of Question Items Result

No	Criteria	Question Item Number	Total
1	Valid	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,20,21,22,24,25.	21
2	Invalid	1,18,19,23.	4

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Based on calculation using the Alpha Cronbach formula, then the price is obtained r_{count} of 0.780 and r_{table} of 0.334. Because $r_{count} > r_{table}$ (0.780 > 0.334), then 20 questions that are valid, difficulty level meets the requirements, different power fulfills the conditions, and the constructors meet the conditions are declared reliablel.

The test's level of difficulty is examined in order to determine which items are acceptable or not. If the item falls into the moderate category, which is defined as having an index item difficulty between 0.20 and 0.80, it is said to meet the standards. Calculations show that of the 21 valid questions, 20 are in the "questions that requirements, feasible category." The answers to the item difficulty level test question are listed in the table below.

Table 4. Problem Difficulty Level

Nu	Criteria	Question Item Number	Total
1	Difficult	3,8,13,16,17,22	6
2	Medium	2,5,6,7,9,10,15,19,20,21,23,24,25	14
3	Easy	1,4,12,14,18	5

Based on the calculations that have been done, 20 questions that meet the requirements validity and level of difficulty, there are 20 questions that meet the criteria of enough and good. The following table summarizes the results of the different power test items.

Table 5. Discriminating Power of Question

Nu	Criteria	Question Item Number	Total
1	Very Bad	-	-
2	Bad	1,15,19,23	4
3	Enough	2,3,4,5,8,10,11,12,13,14,16 18,20,21,22,24,25.	17
4	Good	6,7,9,17	4
5	Very Good	-	-

Distractor analysis is used to determine whether alternative answers (choice) outside the answer key is eligible or not. The results of the constructor analysis shows that all alternative answers from 20 questions will be used as an instrument has fulfilled the requirements.

A homogeneity test was performed to determine whether the sample came from homogeneous data. 0.05-sig level homogeneity testing with SPSS 25.0 for Windows. Table 4.6 contains information on the outcomes of the homogeneity test.

Table 6. Homogeneity Test

		Sig.	Information
Learning Outcome	Mean	0.489	Homogeneous
	Median	0.572	Homogeneous

Data normality testing is performed on growing student learning results and student learning interest with SPSS 25.0 for Windows at sig-0.05 levels.

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Table 7. Normality Test

	Learning Media	*Shapiro-Wilk* Sig.	Information
Learning Outcome	Smart Apps Creator	0.056	Normal
	PowerPoint	0.067	Normal

Data in table 7 reveal that student learning outcomes utilizing Smart Apps Creator media and PowerPoint have sig values of 0.056 and 0.067, respectively, which are greater than the level significance of (0.05), indicating that both data are normally distributed.

c. Improved Learning Outcomes (R^2)

Table 8. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.458	.210	.186	7.319

a. Predictors: (Constant), Interest on Learning, Learning Media

Based on the output above, it is known that the R^2 value is 0.186, this means that the effect of learning media and interest in learning simultaneously on learning outcomes is 18.6%.

Table 9 N Gain

Nu	Class	N-Gain (%)	Summary
1	Experiment I	72	High
2	Experiment II	56	Moderate

Based on table 9, it can be seen that the increase in student learning outcomes after different treatment in the experimental class I and II. The increase in learning outcomes in the Experiment I class was in the high category with a score of 72%, while in the Experiment II class it was in the medium category with a value of 56%.

Table 11. Hypothesis Test

Hypothesis	Source	Sig.	Inform
I	Learning Media	0.003	Ha Accepted

To respond to the first premise, "There is a difference in the average value learning outcomes of students who are given learning with learning media adapt to learning styles that vary in acid-base titration material." obtained sig 0.003 < 0.005 (α) which means that Ha is accepted and H_0 is rejected, so it can be concluded that there is a difference in the average value of student learning outcomes taught by media learning varies on acid-base titration material.

Discussion

After completing the educational procedures, each class cohort was instructed to use Smart Apps Creator and PowerPoint learning media for two in-person class sessions. Subsequently, a final evaluation (post-test) consisting of 20 multiple-choice questions was administered alongside the distribution of interest questionnaires containing 25 statements to gauge students' level of interest in the subject matter, categorized as high, moderate, or low. According to the post-test data, the mean score for student learning outcomes utilizing Smart Apps Creator learning media was 88.61 ± 7.98. In contrast, the mean score for student

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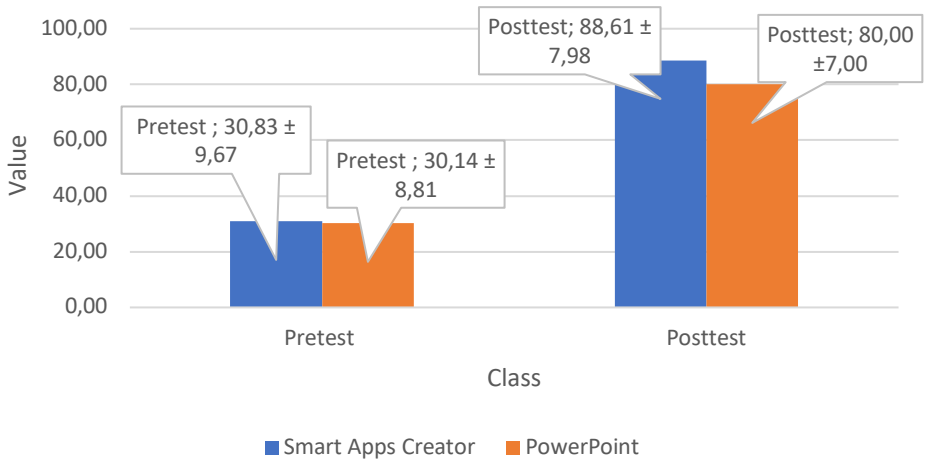
learning outcomes utilizing PowerPoint learning media was 80.00 ± 7.00. The difference in the average value of learning outcomes of the two models can be seen in Figure 1.

FIGURE 1. DIFFERENCES IN STUDENTS' PRETEST AND POSTTEST AVERAGE VALUE BASED ON LEARNING MEDIA



Upon conducting a statistical analysis using SPSS 25.0 for Windows, it was found that student learning outcomes, which were taught through diverse learning models, yielded a significant result of 0.003 < α (0.05). As a result, the alternative hypothesis (Ha) was accepted, while the null hypothesis (H_0) was rejected. This score indicates a significant difference in the mean value of class XI student learning outcomes who were exposed to various learning media on acid-base titration. The mean difference in student learning outcomes between the two classes is 8.61. Specifically, the average value of student learning outcomes achieved using Smart Apps Creator learning media is higher than that achieved through PowerPoint learning media.

Conclusion

There is a significant difference in the average grades of student learning outcomes XI-A and XI-B taught with different learning media, which varies on the acid-base titration material. The experimental class 1 (class with Smart Apps Creator learning media with learning styles) obtained an average result value of student learning is 88.61 ± 7.98. In contrast, the average value of learning outcomes for students in experimental class 2 (class with PowerPoint learning media) equals 80.00 ± 7.00.

Recommendation

In the context of teaching acid-base titration material, it is recommended that educators and aspiring educators utilize interactive learning media that fosters student engagement through problem-solving and discussion. This approach enables students to collaborate with their peers and practice their skills in a collaborative setting. Researchers have suggested the utilization of Smart Apps Creator learning media in conjunction with Problem-Based Learning models as a viable approach to learning.

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