

# Effectiveness of Solar System Scope-Assisted PBL on Kepler Law Material Integrated with Al-Quran to Improve Student Learning Outcomes

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**Abstract:** This research is motivated by the low ability of students to understand physics subjects which are considered difficult, including the difficulties experienced namely visualizing subject matter which requires learning models and media as support to improve student learning outcomes. This research was conducted at MA Muallimin UNIVA Medan, by applying the Problem Based Learning (PBL) learning model assisted by Solar System Scope media on Kepler law material integrated with the Koran which is used in the learning process to improve student learning outcomes. The research method used is experimentation which is a type of quantitative research in class X MIA 1 as an experimental class with a Probe Based Learning (PBL) learning model. The sample was taken using a purposive sampling technique. The instrument used is a written test (essay) with 10 questions. It is known that the pretest and posttest data are normally distributed with a significance value of Experimental Pretest (0.078), Experimental Posttest (0.130), Control Pretest (0.200), Control Posttest (0.052) and are declared homogeneous with a significance value of Based on Mean (0.245) where the test value normality and homogeneity exceed ( $>$ ) the real level used in the measurement, namely  $\alpha = 0.05$  or 5%. With the help of SPSS it is known that the average learning outcomes of students in the experimental class (83.07) are higher than those in the control class (79.90) so it can be concluded that the hypothesis is accepted and the average of the experimental class is stated to be better than the average of the control class. As for the effectiveness of the experimental class with the PBL (Problem Based learning) model, it was 76.6% and the control class with the Direct Instruction learning model was 54.4%, where the experimental class was declared effective and the control class was declared less effective.

**Keywords:** Al-Quran; Kepler's Law; PBL; Solar System Scope; Learning Outcomes

## Introduction

Physics subjects are often considered difficult by students (Jamaludin & Batlolona, 2021). Apart from students, the general public also has the same view.

Results of initial interviews with students at MA. Muallimin UNIVA Medan pointed out that physics is a difficult subject to study. Physics subjects have characteristics in the form of products, processes and scientific attitudes (Capriconia & Mufit, 2022; Susilawati

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et al., 2023). Products in physics subjects are theories, concepts, laws and principles created by previous scientists (Coccia, 2020). The process in physics subjects includes skills to gain this knowledge. A scientific attitude is the attitude that underlies a person's ability to obtain this product, where Kepler's law is one of the materials in physics subjects which of course has the characteristics that have been mentioned (Orozco-Echeverri, 2020).

An inappropriate learning process tends to make it difficult for students to understand the material (Fathoni & Muhtadin, 2024; Sakliressy et al., 2021; Samsudin et al., 2023). The material studied in Kepler's laws includes the movement of celestial bodies, distance of planets from the sun, orbital periods of planets, space objects, exploration of stars and so on (Stember, 2024; Sucharitakul et al., 2022), where this material needs to be given to students with the help of appropriate learning models and media. Students have difficulty representing the movement of celestial bodies, planetary distances and planetary orbital periods and matters related to Kepler's law, therefore appropriate learning models and media are needed to help students learn Kepler's law so that it is easy to understand. So when students understand the concept of Kepler's laws well and can see visualizations of outer space and the solar system through the right media, of course it will make it easier for students to get the desired learning outcomes in accordance with the learning objectives.

The learning model used in this research so that it can realize appropriate learning is PBL (Problem Based Learning) (Amsal, 2021; Penprase & Penprase, 2020). PBL (Problem Based Learning) is able to grow students' learning skills (Hidaayatullaah et al., 2020; Masruro et al., 2021), because there are processes and stages in learning that students need to understand the material provided. It is hoped that choosing PBL (Problem Based Learning) as a learning model will really help improve students' abilities in analyzing problems related to Kepler's laws, so that students can understand the benefits of studying Kepler's laws. The PBL (Problem Based Learning) learning model encourages students to get used to collaborating in learning (Nurmahasih & Jumadi, 2023). In this way, students will be more enthusiastic and willing to play an active role in the learning process.

Apart from learning models that are tailored to students' needs, it turns out that the presence of learning media is also a supporting factor so that educational goals can be achieved well. The media chosen must be adapted to the subject matter, so that students' perceptions about the difficulty of physics lessons can be resolved and get the right solution to improve the quality of students' education in physics lessons (Chusni

et al., 2021). Solar System Scope is presented as a fun medium for students to understand the concept of Kepler's laws (Fitriyani, 2020). Solar System Scope has various features that can help students visualize the solar system on their devices so that they can be accessed easily. Apart from making it easier for students, using the Solar System Scope is also a means of implementing the learning process in the 21st century where students are required to understand technology well as a form of preparation for facing increasingly rapid developments.

Results of observations and interviews conducted at MA. Muallimin UNIVA Medan where the school implements a learning system that is also oriented towards Al-Quran knowledge. Many students are interested in how concepts between the Al-Quran and physics subjects can be integrated (Chandra et al., 2021; Chandra & Lizelwati, 2022). Basically all knowledge comes from the Al-Quran, including physics (Chandra & Lizelwati, 2024; Wati et al., 2020), where the connection between the concept of the universe and the Al-Quran will increase students' knowledge in understanding physics lessons (Adelia & Seprianto, 2022). In this research, the material that will be discussed is Kepler's law, which discusses the solar system, planetary orbits, periods and distances of planets, where the Al-Quran explains the process of creating the universe perfectly, including the solar system in the Milky Way galaxy.

**Method**

The method used in this research is an experimental method where the experimental method is a type of quantitative research that is very strong in measuring cause and effect relationships (Kaeedi et al., 2023). The design used in this research is *Pretest - Posttest Control Group Design* (Tania & Jumadi, 2021). This research is intended to determine the effectiveness of PBL assisted by *Solar System Scope* on integrated Kepler law material in the Koran to improve student learning outcomes in the experimental group so that a control group is needed for comparison. In this design there are two groups, each selected by *purposive sampling*. The design pattern for this research is as follows:

**Table 1.** Research Design

Group	Pretest	Treatment	Posttest
Experimental Class	O <sub>1</sub>	X <sub>1</sub>	O <sub>3</sub>
Control Class	O <sub>2</sub>	X <sub>2</sub>	O <sub>4</sub>

Information :

X<sub>1</sub> = Treatment using the PBL learning model assisted by Solar System Scope

X<sub>2</sub> = Direct Instruction Treatment

- O<sub>1</sub> = Pretest experimental group
- O<sub>2</sub> = Pretest control group
- O<sub>3</sub> = Posttest experimental group
- O<sub>4</sub> = Posttest control group

The subjects in this research were students of class X MIA 1 and 2 MA. Muallimin UNIVA Medan. The object of this research is the PBL (Problem Based Learning) Learning Model assisted by Solar System Scope on integrated Kepler law material in the Koran to improve student learning outcomes. When the research was carried out in the even semester of the 2023/2024 academic year, it was carried out at MA. Muallimin UNIVA Medan whose address is at Jl. Sisingamaraja, km 5.5 Medan Amplas District, North Sumatra.

The instruments used in this research were tests and documentation. The test technique is carried out by providing a test instrument consisting of a set of questions/questions to measure student learning outcomes. Researchers used tests in the form of descriptions. Written tests in the form of descriptions or essays require students to be able to remember,

understand, organize, apply, analyze, synthesize, evaluate, and so on the material they have studied. Documentation is carried out to obtain data sourced from available records or documents. Such as the presence of students in taking part in class learning which can be seen in the student attendance list, as well as the MA profile. Muallimin UNIVA Medan.

The research procedure carried out went through three stages, namely the planning stage, implementation stage and completion stage. The data analysis technique used in this research is *the t-test* and *f-test* with the help of *IBM SPSS Statistics 20.0*.

### Results and Discussion

This research uses the PBL (*Problem Based Learning*) learning model assisted by *the Solar System Scope* as a learning medium that makes it easier for students to visualize outer space related to integrated Kepler law material in the Koran so that it is hoped that it will be able to improve student learning outcomes. The *Solar System Scope* used in learning as shown in Figure 1.



**Figure 1.** Display of Solar System Scope media: (a) View of the Solar System; (b) menu; (c) Condition of the Sky Seen from an Observer; (d) Planets view; and (e) Star features

Results of prerequisite testing for research data analysis conducted at MA. Muallimin UNIVA Medan, Medan City, North Sumatra where the experimental class was given treatment using the Problem Based Learning learning model assisted by Solar System Scope on integrated Kepler law material in the Koran and the control class was given treatment using the Direct Instruction learning model. Before being given treatment, students are first given a pretest with a total of 10 essay questions, then after being given treatment they are tested with posttest essay questions. To determine the suitability of the questions and media used as research instruments, the validity of the questions and media is tested by a validator (Azriyanti & Syafriani, 2023). The Figure 2 is a validation diagram for material that has gone through validation tests by expert question and media validators.

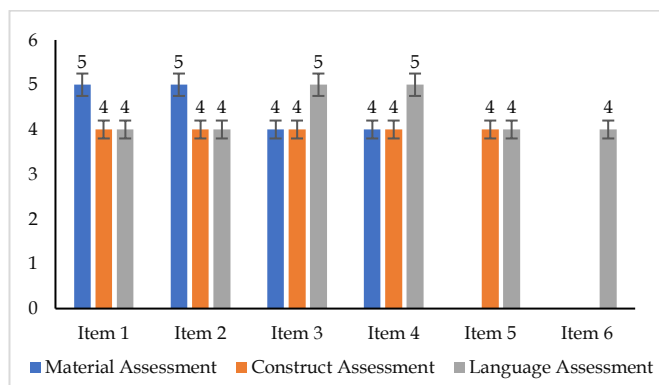


Figure 2. Material Expert Validation Diagram

Based on the diagram data above, it can be seen that the validity of the material in the form of questions is on a scale of 4 and 5 so that after going through the validity test it can be seen that the validity level is 85% and is stated to be at the "very valid" criteria.

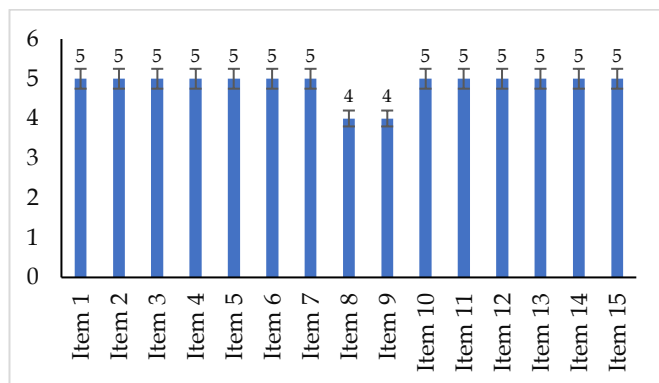


Figure 3. Media Expert Validation Diagram

Based on the diagram data in Figure 3, it can be seen that the validity of the media is on a scale of 4 and 5 so that after going through a validity test it can be seen that

the validity level is 85% and is stated to be at the "very valid" criteria (Dewi et al., 2022).

The data collected in this research consisted of pretest-posttest questions describing student learning outcomes during learning. The following is data obtained from research that has been carried out.

Table 2. Descriptive Statistics

Parameters	Pretest Experiment	Posttest Experiment	Pretest Control	Posttest Control
N Valid	28	28	30	30
Missing	2	2	0	0
Mean	252.64	88.50	56.50	79.90
Std. Error of Mean	1.235	1.166	.857	1.190
Median	51.50	89.50	57.50	79.00
Mode	60	85	51	88
Std. Deviation	6.533	6.167	4.696	6.520
Variance	42.683	38.037	22.052	42.507
Range	21	22	17	19
Minimum	40	75	47	70
Maximum	61	97	64	89
Sum	1474	2478	1695	2397

Test Normality

Test normality done for know whether the data is normally distributed or not. For test normality researcher using IBM SPSS 20.0 with level significance 0.05 or 5%. Test This used for insufficient sample of 50 in order to produce accurate decisions (Oktaviani & Notobroto, 2014). As for results test normality on class experiment nor control can seen on Table 3.

Table 3. Test Normality Student Learning Outcomes

Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Exp	0.156	28	0.078	0.919	28	0.033
Post-Exp	0.146	28	0.130	0.939	28	0.102
Pre-Con	0.125	30	0.200	0.957	30	0.252
Post-Con	0.159	30	0.052	0.894	30	0.006

Based on Table 3, values on significance on Experimental Pretest (0.078), Experimental Posttest (0.130), Control Pretest (0.200), Control Posttest (0.052). In study This level actually used for measure its normality is  $\alpha = 0.05$  or 5%. If results obtained exceeds  $\alpha = 0.05$  or 5% then the data stated good normal distribution on class experiment nor class control .

Test Homogeneity

Test homogeneity This done for know variant between second group after given different treatment or done in frame test similarity variance every data group . Base taking decision in test homogeneity If mark significance (sig) on Based on Mean > 0.05 means the

data is homogeneous, however If mark significance (sig) on Based on Mean < 0.05 then the research data No homogeneous.

**Table 4.** Test Homogeneity Student Learning Outcomes

Parameters	Levene Statistic	df1	df2	Sig.
Mean	1.379	1	56	0.245
Median	1.026	1	56	0.315
Median and with adjusted df	1.026	1	52.891	0.316
Trimmed mean	1.469	1	56	0.231

Based on Table 4, values on significance on Based on Mean (0.245). In test homogeneity This level actually used for measure its homogeneity is  $\alpha = 5\%$  or 0.05. Based on results using IBM SPSS 20.0 results exceed of  $\alpha = 5\%$  or 0.05 so that can concluded the variant data second population stated homogeneous.

*Test Hypothesis*

Test hypothesis can done after obtained results test precondition data analysis viz test normality and test homogeneity that shows the data normally distributed and homogeneous. Test hypothesis done to know exists difference pretest and posttest results from research data. One of technique analysis statistics for testing the average is statistical t- test in matter. This on class experiment and control use independent sample t test served on Table 5.

**Table 5.** Test Independent Sample T Test Student Learning Outcomes

Class	N	Mean	Std. Deviation	Std. Error Mean
Experiment	28	88.50	6.167	1.166
Control	30	79.90	6.520	1.190

**Table 7.** Results Test Effectiveness

Class	Statistic	Std. Error	
Experiment	Mean	76.6612	
	95% Confidence Interval for Mean		
	Lower Bound	72.7189	
	Upper Bound	80.6035	
	5% Trimmed Mean	76.8587	
	Median	77.5255	
	Variance	103.365	
	Std. Deviation	10.16686	
	Minimum	56.90	
	Maximum	92.50	
	Range	35.60	
	Interquartile Range	13.48	
	Skewness	-0.384	0.441
	Kurtosis	-0.542	0.858
Control	Mean	54.4405	
		2.19643	

Based on Table 5 can seen that the average results Study students who are on class experiment (88.50) more tall from on class control (79.90) so can concluded that hypothesis accepted and class average experiment stated more good than the class average control.

*Test Effectiveness*

Test effectiveness This aim for see ability results Study student on material law Kepler integrated the Al-Quran with the PBL (Problem Based Learning) learning model in class experiment and the Direct Instruction learning model class control with give pretest and posttest. In study use group experiment and control, test effectiveness This use Percent N- Gain Test used for see is There is significant difference between the average posttest scores of the groups experiment and group posttest scores control through Independent Sample T Test.

**Table 6.** Categories Evaluation N-Gain Value Percent

Percentage (%)	Interpretation
< 40	Ineffective
40 - 50	Less Effective
56 - 75	Effective enough
> 75	Effective

After done test effectiveness based on results calculation N-Gain Percent test show that average N-Gain Score results for class experimental PBL (Problem Based Learning) model was 76.6612 or 76.6% stated effective and on class Direct Instruction model control is 54.4405 or 54.4% less effective so that percentage the show that class experiment more effective from class control. As for results from test effectiveness on study This there is on Table 7.

Class		Statistic	Std. Error
95% Confidence Interval for Mean	Lower Bound	49.9483	
	Upper Bound	58.9327	
	5% Trimmed Mean	54.5497	
	Median	51.7178	
	Variance	144.729	
	Std. Deviation	12.03035	
	Minimum	34.09	
	Maximum	72.09	
	Range	38.00	
	Interquartile Range	21.48	
	Skewness	0.075	0.427
	Kurtosis	-1.370	0.833

Before the t-test, a prerequisite test is first carried out. It is known that the pretest and posttest data are normally distributed with a significance value of Experimental Pretest (0.078), Experimental Posttest (0.130), Control Pretest (0.200), Control Posttest (0.052) and are declared homogeneous with a significance value of Based on Mean (0.245) where the test value normality and homogeneity exceed ( $>$ ) the real level used in the measurement, namely  $\alpha = 0.05$  or 5%. With the help of SPSS it is known that the average learning outcomes of students in the experimental class (88.50) are higher than those in the control class (79.90) so it can be concluded that the hypothesis is accepted and the average of the experimental class is stated to be better than the average of the control class.

From the research results it can be concluded that after applying this research to learning activities it can improve student learning outcomes. Applying the PBL (Problem Based Learning) learning model assisted by Solar System Scope to integrated Kepler law material in the Al-Quran has a greater influence on student learning outcomes (Ahmed, 2013; Haryadi et al., 2024) because the model is effective and accompanied by the use of learning media that makes it easier for students to understand Kepler law material that cannot be reached directly by the eye so there must be visualization so that the learning material and student learning outcomes improve (Apriliyanti et al., 2015; Rahayu et al., 2021). This is proven by the difference in the percentage of learning effectiveness in the experimental class and control class, where the effectiveness of the experimental class according to the data analysis that has been carried out is 76.6% which is declared effective and in the control class (Direct Instruction) it is 54.4% which is declared less effective.

## Conclusion

Based on the research results obtained from data analysis, hypothesis testing and effectiveness testing of data processing, the following conclusions can be

drawn: Applying the Problem Based Learning learning model assisted by Solar System Scope to integrated Kepler law material in the Koran has an influence on student learning outcomes; Applying the Problem Based Learning learning model assisted by Solar System Scope to integrated Kepler law material in the Koran has a rapid influence in stimulating students' ability to understand learning material so that student learning outcomes increase; After being given different treatment to the two samples, the comparison of the test results for the two samples looked different, namely in the experimental class (88.50) it was higher than in the control class (79.90). Applying the Problem Based Learning learning model assisted by Solar System Scope on integrated Kepler law material in the Koran will make it easier to deliver teaching material and learning activities will be maximized so that learning outcomes will increase; and The effectiveness of learning outcomes in the experimental class with the PBL (Problem Based Learning) model, namely 76.6%, was declared effective and the effectiveness in the control class with the Direct Instruction model, namely 54.4%, was declared less effective, so it can be concluded that the use of the PBL (Problem Based Learning) learning model assisted by Solar System Scope on Kepler law material integrated with the Al-Quran to improve student learning outcomes was declared effective.

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All authors contributed to writing this article

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