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The Effectiveness of the Planetarium Android Learning Application Virtual Observatory on Solar System Material

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Abstract

The COVID-19 pandemic has affected education worldwide, and online learning is a solution to keep learning activities going. Learning in Indonesia also applies online learning by utilizing smartphones and the internet. The current education curriculum uses Education Technology (edutech), so innovation is needed in developing learning media, one of which is an Android learning application in the form of a Virtual Planetarium Observatory. The research objectives are (1) to analyze the validity of the Virtual Planetarium Observatory, (2) to analyze the feasibility of the Virtual Planetarium Observatory (3) to analyze the effectiveness of the Virtual Planetarium Observatory. This research is a research and development (R&D) research design pretest-posttest control group design with the research subjects of class VII students of MTs Al Hadi Girikusuma Mranggen Demak. The validation results of media experts and media validity experts are very valid, with 93%. The feasibility of the teacher's response and the student's response to the media is very feasible, with a percentage of 86%. The media's effectiveness is pretty effective in increasing student learning outcomes with a rate of 72%. Based on the N-Gain test, the experimental class was 0.72 in the high category, while the control class was in the middle category at 0.58. The significance of the effectiveness based on the t-test with a value of Sig 0.028 < 0.05 means a significant difference between before and after using the Virtual Planetarium Observatory on improving student learning outcomes. Based on the study results, it can be concluded that the Virtual Planetarium Observatory can improve student learning outcomes on solar system material.

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INTRODUCTION

The COVID-19 pandemic caused by the spread of the coronavirus has influenced education around the world (Mehall, 2020; Na Feature et al., 2020; Thongsri et al., 2020). Online learning is a solution to learn when the pandemic persists (Churiyah et al., 2020; Purwanto et al., 2020; Winaldi et al., 2020). The implementation of learning in Indonesia also applies to learn online; this is a form of government policy implementation to prevent the spread of the coronavirus (Ahied et al., 2020; Churiyah et al., 2020; Winaldi et al., 2020). Educational institutions adapt to the learning system (Gündüz, 2016). Although many educational institutions were previously reluctant to change traditional learning to online learning, there are no other options (Dhawan, 2020; Maskar & Wulantina, 2019; Widodo et al., 2020). Online learning is the only option that requires students to use technology in distance learning (Geng & Masanori, 2020; Kadeeva et al., 2020; Mon, 2020). Online learning is a revolution current educational technology (Maskar & Wulantina, 2019; Rusman & Rahmawati, 2020; Yustika et al., 2019). But online learning has been a long time developed (Nguyen, 2015; Teodorescu, 2015; Ventura, 2015). I am learning online as part of education technology (edutech) through computer media and Smartphones (Andyhapsari & Djukri, 2021; Kim et al., 2021; Lastariwati et al., 2021). The Industrial revolution 4.0 drives process changes education that applies technology in learning and is expected to get graduates competent in utilizing information technology and communication. So it is necessary to integrate technology into learning (Nofitasari et al., 2021; Oktafiani et al., 2021; Ridho et al., 2021). Distance learning Remote is a form of technology integration in science by utilizing smartphone technology and internet networks for learning (Ahied et al., 2020; Atmojo et al., 2020; Sukarno & Widdah, 2020). Online learning has been overgrown due to the covid-19 pandemic, so much research is being done to study its effectiveness (Martin et al., 2020; Miller et al., 2020; Yang et al., 2020). Some of these studies, for example, research by Martin et al. (2020), which developing student readiness for online learning (SROL) instruments for measuring student readiness in online learning, and by Yang et al. (2020), who evaluates online learning using the Self Directed tool Online Learning Scale (SDOLS). The role of technology in learning is a form of interactive implementation of distance education (Eryanto & Prestiliano, 2017; Sari et al., 2019; Wicaksono et al., 2020; Zikky et al., 2018). Mobile learning is used as an alternative to solving problems in education today (Widodo et al., 2020; Yustika et al. al., 2019).

Learning media is a physical means to convey material learning (Pangestu et al., 2020; Pratiwi et al., 2018; Sari et al., 2019; Zikky et al., al., 2018) serves to clarify the meaning of the message conveyed so that the learning can be achieved, this can be realized with technology. Media learning becomes one of the determining factors for the success of learning, so that becomes a challenge for educators to innovate in developing it (Alkurdi, 2020; El Mawas et al., 2020). Learning media experienced many revolutions from conventional times to modern times using android-based media (Zikky et al., 2018). Technology can visualize material from books so that students learn in a visual environment (Kapoor & Naik, 2020). Learning media acts as extrinsic motivation, which can increase students' interest in learning. More learning objectives that a press can help, the better (Anugrah, 2021; Dwijayani, 2017; Eliza et al., 2019). Learning effectiveness can be attempted by using android-based independent learning media (Badriyah, 2015; Nofitasari et al., 2021; Oktafiani et al., 2021). Some research for measuring student learning outcomes by using the learning media, for example, research by Eryanto & Prestiliano (2017), Zikky et al. (2018), Sari et al. (2019), Wicaksono et al. (2020). Android system technology is worthy of consideration for learning media development because it has an open-source platform that gives freedom to developers. That is also supported by the popularity of using smartphones in Indonesia among students (Billah & Yazid, 2020; Dwitiyanti et al., 2020; Mahfud & Billah, 2020; Sajidan et al., 2020).

The development of Android smartphones is very fast, equipped with a variety of helpful software (Alfian & Kustijono, 2015; Anggraeni & Kustijono, 2013; Hendri Adi et al., 2020). Even the users become familiar with the community (Haryanto & Billah, 2020; Johansson & Eliasson, 2020; Maryanto et al., 2020). Android is one of the Operating systems (OS) that makes smartphone

devices have benefits such as computers (Hendri Adi et al., 2020; Ismatullah & Fathoni, 2018; Pratama & Haryanto, 2017; Putra et al., 2017). Google develops screen mobile devices that touch like a smartphone (Schulte & Wibawa, 2015). Mobile learning is part of e-learning (Martono & Nurhayati, 2014; Maskar & Wulantina, 2019; Ngapornchai & Adams, 2016). The current trend in online learning is mobile learning (m-learning), namely the use of portable media devices such as smartphones as learning media (Dhawan, 2020; Martin et al., 2020; Martono & Nurhayati, 2014). Smartphone users experience rapid development among students, so it is appropriate to be used in learning (Billah & Yazid, 2020; Dwitiyanti et al., 2020; Mahfud & Billah, 2020; Sajidan et al., 2020). A smartphone can be used as a learning medium to help teachers and students (Sulistianingsih, 2017) in online learning. Its use also supports this as a means of daily communication (Churiyah et al., 2020; Purwanto et al., 2020; Winaldi et al., 2020). Online learning needs independent learning resources that can be used anywhere and anytime (Billah & Yazid, 2020; Mahfud & Billah, 2020; Sajidan et al., 2020) installed on a smartphone. Another contributing factor is the large selection of applications that can be developed as needed.

Kurikulum 2013 contains the implementation of learning at the junior high school level, an Integrated science that includes three fields of physics, chemistry, and biology (Billah & Yazid, 2020; Mahfud & Billah, 2020; Sajidan et al., 2020). Therefore, learning Science must be able to explain the concepts and theories of the three fields. The solar system material is one student must master in the 2013 curriculum (Eryanto & Prestiliano, 2017; Pratiwi et al., 2018; Zikky et al., 2018). The material studied the collection of celestial bodies, including stars, planets, satellites, comets, asteroids, and meteors (Muttaqin et al., 2016; Wicaksono et al., 2020). This learning has difficulty because not every object or phenomenon can be observed directly because of its location and size (Marwiyah et al., 2019; Muttaqin et al., 2016; Zahara et al., 2020). In addition, it is also due to a lack of learning media (Pratiwi et al., 2018; Zikky et al., 2018). Though it has been taught since elementary school, students have a level of understanding different. This problem was also experienced in other schools, including at MTs Al Hadi Girikusuma Mranggen Demak; it is necessary to innovate learning media to visualize it. The virtual planetarium is an Android-based media application to study the solar system (Muttaqin et al., 2016; Pangestu et al., 2020; Turangga et al., 2018). Research on the effectiveness of planetarium as a learning media is widely used (Marwiyah et al., 2019; Muttaqin et al., 2016; Zahara et al., 2020). For example, research by Eryanto & Prestiliano (2017), El Mawas et al. (2020), Zahara et al. (2020), development The application uses virtual reality, Raspberry Pi, and augmented reality. However, the drawback of this application is that it is expensive, requires programming skills, and must be connected to a device such as a PC or a laptop.

Based on these problems, the development of learning media for governance Sun is essential. This study aims to produce learning applications android in a Virtual Planetarium Observatory on a smartphone. One of the Android applications that support this are Smart Apps Creator (SAC), which is the latest digital interactive media that builds multimedia content for mobile devices that can be used to build android applications without coding, so it is easy for teachers to use because it does not require programming skills. Android learning application in the form of Planetarium Observatory Virtual is expected to be an independent and repetitive learning media that students can use anytime and anywhere. This application is used for knowing student learning outcomes and as an indicator for teachers to know student success in understanding solar system material in online learning.

METHODS

The research was carried out at MTs Al Hadi Girikusuma Mranggen Demak with the trial subject of class VII students in the even semester of the 2020/2021 school year. The Research and Development (R&D) research method was adapted from Sugiono (2017) Product development and testing its effectiveness (Sugiyono, 2017). Development research learning media using ADDIE development design. The stages of media development include the following stages: Analysis, Design, Develop, Implement, and Evaluate. The research procedure is presented in Figure 1.

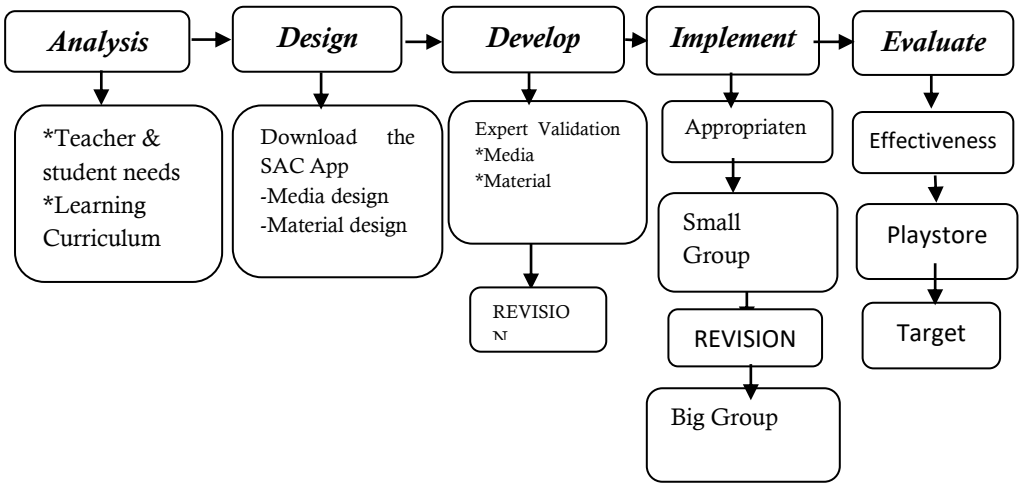

Figure 1. Research Design ADDIE

The research design used a pre-posttest control group design. The experimental design can be shown in Table 1 as follows:

Table 1. Research Design Pre-Posttest Control Group Design

Class	Pretest	Perlakuan	Posttest
Experimen	Q_1	X	Q_2
Control	Q_3	-	Q_4

Describtion:
Q_1 = Giving the experimental group pretest
Q_2 = Giving posttest to the experimental group
Q_3 = Giving pretest control group
Q_4 = Giving posttest control group
Q_5 = Treatment or treatment given

The data and data sources used in this study are presented in Table 2 Meanwhile, the research subjects in the usage trial were 32 students in class VII.a and the virtual Planetarium observatory application in class VII.a, VII.b and VII.c MTs Al Hadi Girikusuma Mranggen Demak academic year 2020/2021.

Table 2. Research Data and Sources

NO	Data	Type of Data	Source of Data
1	Media Validity (Media Validity) Media and materials expert assessment	Quantitative	Media Expert Material Expert
2	Media Eligibility (Response users) Teacher and student responses	Qualitative	Teacher student
3	Media Effectiveness (Evaluation Question) Student cognitive learning outcomes	Quantitative	student

Data collection techniques and instruments in Table 3 are as follows:

Table 3. Data Techniques and Instruments

No	Data	Technical Data	Instrument Data	Description
1.	Needs Analysis (potential identification and problems)	Poling online	Guidelines interview and question	- Science teacher - Student

No	Data	Technical Data	Instrument Data	Description
2.	Media Validation (media expert and material)	- Validation Question Media - Validation Question Material	- Validation Sheet media - Validation Sheet material	- Media Expert - Material Expert
3.	Small-Scale Trial User Response Media eligibility (teacher and student)	- Questionary responses teacher - Questionary responses student	- Questionnaire sheet teacher's response - Questionnaire sheet student feedback	- Teacher - Student
4.	Large-Scale Test Media implementation Media Effectiveness (learning outcomes)	-Test	- Pretest questions & posttest (Evaluation)	- Student

Test the validity of the test questions carried out in this study using three instruments are interview guides, questionnaires, and tests. The test instrument is piloted first to analyze the validity, reliability, level of difficulty, and power differentiator.

A. Data Analysis Techniques

1. Media Validity Data

Media validators and material validators carry out media validity. Validation using a validated questionnaire. The data from the proof of the learning media were analyzed using the following percentage quantitative descriptive analysis:

$$P = \frac{f}{N} \times 100\ \%$$

Describtion:

P = Aspect percentage

f = Value obtained

N = Maximum Value

Table 4. Media Validation Criteria

Range%	Qualitative Criteria
$81 \leq \boldsymbol{score} \leq 100$	Very Valid
$62 \leq \boldsymbol{score} < 81$	Valid
$43 \leq \boldsymbol{score} < 62$	Enough Valid
$24 \leq \boldsymbol{score} < 43$	Less Valid

The Virtual Planetarium Observatory android learning application is valid if the percentage of assessment by media and material validators With criteria minimum enough valid.

2. Data of Small-Scale Trial Results

The Virtual Planetarium Observatory android learning application is valid if the percentage of assessment by media and material validators With criteria minimum reasonable trials to determine the feasibility of android learning applications in the form of Virtual Observatory Planetarium developed based on teacher feedback and students. Data on teacher and student responses to learning media were analyzed descriptively quantitatively with the formula:

$$\text{User feedback} = \frac{n}{N} \times 100\ \%$$

Describtion:

n = Score obtained

N = Maximum score

Based on the above calculation assumptions, it can be determined the criteria to be applied for teacher and student questionnaire responses can be seen in table 5 below:

Table 5. Criteria for Teacher and Student Response Questionnaires

Range%	Qualitative Criteria
$81 \leq \boldsymbol{score} \leq 100$	Very Good
$62 \leq \boldsymbol{score} < 81$	Good
$43 \leq \boldsymbol{score} < 62$	Pretty Good
$24 \leq \boldsymbol{score} < 43$	Not Good

Learning media android learning application Planetarium Observatory Virtual said to be feasible if the percentage of assessment $> 62\%$ on the minimum criteria is good.

3. Data of Large-Scale Trial Results

Large-scale trials were carried out to obtain application effectiveness data-developed learning. Data is measured using outcome indicators Cognitive education of students with N-gain scores on the solar system material—processing quantitative data pretest-posttest with the test for normality, homogeneity, and T-test for the sample class. The normalized gain (N-Gain) test aims to determine the effectiveness of the android learning application in the form of a Virtual Planetarium Observatory on student learning outcomes as measured by pretest and posttest scores. Based on the acquisition of pretest and posttest scores, the N-Gain test was carried out to know the increase in student learning outcomes after using the application Virtual Observatory Planetarium. The N-Gain formula is as follows:

$$N - Gain = \frac{Skor\ postest - Skor\ Prettest}{Skor\ maksimal - Skor\ Prettest}$$

The N-Gain value category can be determined based on the N-Gain score or in percent (%). The N-Gain criteria can be seen in the following Table 6:

Table 6. Score Range and N-Gain Criteria

Interval	Criteria
$g > 0{,}70$	Height
$0{,}30 \leq g \leq 0{,}70$	Medium
$g < 0{,}30$	Low

The N-Gain criteria in the form of percent (%) can be seen in Table 7 below:

Table 7. Criteria for the effectiveness of N-Gain in percent (%)

Presentase (%)	Criteria
≥ 76	Effective
56 – 75	Quite Effective
40 - 55	Less Effective
< 40	Ineffective

The results of the N-Gain test are used to determine the increase in the result score of student learning between before and after learning by using. Virtual Observatory Planetarium. Based on the N-Gain criteria, the media is said to be influential on student learning outcomes if the N-Gain score is 0.70 with high standards or the percentage of N-Gain 76% with effective criteria. The Virtual Observatory Planetarium view is presented in Figure 2 below.

Figure 2. Appearance Planetarium Observatory Virtual

RESULTS AND DISCUSSION

Based on a preliminary study on the implementation of learning in the future, the covid-19 pandemic learning adapts to online learning. That is supported by research from Alzamil (2021), Rafique et al. (2021), Wang et al. (2021); due to the COVID-19 pandemic, face-to-face learning adapts to online learning in many parts of the world (Alzamil, 2021; Rafique et al., 2021; Wang et al., 2021). Smartphones as learning media 90.9%. That is supported by research from Andyhapsari&Djukri (2021), Kim et al. (2021), Lastariwati et al. (2021), Learning online as part of education technology (edutech) through computer media and Smartphones (Andyhapsari & Djukri, 2021; Kim et al., 2021; Lastariwati et al., 2021). supported by research by Nilamsari et al. (2016), Nofrida et al. (2020), Ramdhani et al. (2020); based on field observations and interviews, efforts need to be made media (Nilamsari et al., 2016; Nofrida et al., 2020; Ramdhani et al., 2020). Furthermore, 100% of students have smartphones. Based on these findings, it is a very appropriate Android learning application developed. According to research by Mattola et.al (2021), Nofrida et.al (2020), Subekti et.al (2021). The application runs on smartphones with the Android operating system (Mattola et al., 2021; Nofrida et al., 2020; Subekti et al., 2021).

a. Virtual Planetarium Observatory Media Validity

Validation on android learning application media in the form of Planetarium Observatory Virtual using media instruments. The instrument used is a sheet media validation which consists of four aspects, namely aspects of device engineering, software, audio-visual communication aspects, learning design aspects, and other aspects (Nofitasari et al., 2021). While validated by material experts of the solar system, The instrument used is a material validation sheet. There are four aspects, namely, Aspects of delivery, Aspects of language. Content elements, other elements. Validity analysis results in media and content validation of the Virtual Planetarium Observatory can be seen in Table 8 and 9 below

Table 8. Media Validity Analysis Results

No	Evaluation	Validation Result Score (%)	Criteria
1.	Validator 1	94.6	Very valid
2.	Validator 2	94.6	Very valid
3.	Validator 3	92.8	Very valid
Average		94	Very valid

Table 9. Material Validity Analysis Results

No	Evaluation	Validation Result Score (%)	Criteria
1.	Validator 1	87.5	Very valid
2.	Validator 2	92.8	Very valid
3.	Validator 3	94.6	Very valid
Average		91	Very valid

The results of the media validity assessment obtained a score of 94% with very valid criteria, and the material validity assessment received a score of 91% with excellent standards. Education technology learning (edutech) benefits the development of education relevant to global demands in the millennial era through the concept of electronic learning (Huang et al., 2021; Rosyadi et al., 2021). The Virtual Observatory Planetarium is very valid to be used in learning. This supports the research of Mattola et al. (2021) and Subekti et al. (2021). Learning applications are media used in learning on smartphone devices (Mattola et al., 2021; Subekti et al., 2021). Based on the assessment of media experts and material experts, the Virtual Planetarium Observatory is very valid and can be used in learning. This supports the research also by the statements of Huang et al. (2021), Isabel (2021), Rosyadi et al. (2021), that the effects of technological novelty and its interpretation are very helpful in learning with various applications

(Huang et al., 2021). ; Isabel, 2021; Rosyadi et al., 2021).

b. Eligibility of Virtual Planetarium Observatory Study Application

A android learning application in the form of a Virtual Planetarium Observatory has been revised and then tested on a small scale to determine the feasibility of the media based on teacher and student responses. The results of the analysis of teacher and student responses can be seen in Figure 3 below.

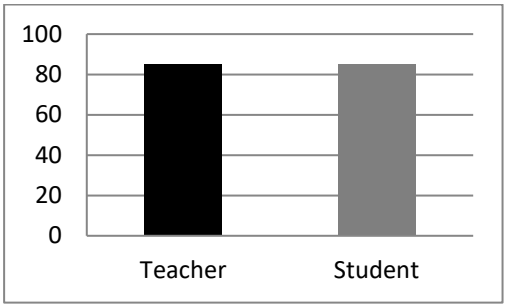

Figure 3. User Respon

Based on Figure 3, the feasibility of the Virtual Planetarium Observatory is based on 85.8% teacher responses and 85.9% student responses with very feasible criteria. Current technological developments can be used as creative and interactive learning media. This is supported by research conducted by Huang et al. (2021) and Rosyadi et al. (2021); technology is beneficial in learning with various applications (Huang et al., 2021; Rosyadi et al., 2021). The android application is effective in helping online learning because it is not limited by space and time used in learning on smartphone devices. Along with current technological developments, applications can be used as teaching media to make teaching and learning systems more creative and interactive as an effect of technical novelty and increase the usability of technology. Learning applications are media used in learning, including teaching aids and means of carrying messages from messengers to students (Mattola et al., 2021; Subekti et al., 2021). The teacher's role is no longer a source of information but a facilitator, motivator, and moderator in learning activities (Rosyadi et al., 2021). The advantages of using smartphones as learning media are many for both teachers and students. They are very supportive of online learning by Anugrah (2021) and Rosyadi et al. (2021), where the learning system is not limited by space and time because education is anywhere and anytime (Anugrah, 2021; Rosyadi et al., 2021).

c. Virtual Planetarium Observatory Media Effectiveness

The effectiveness of the Virtual Planetarium Observatory learning android application is measured based on improving cognitive learning outcomes. The evaluation tool used is the question multiple choice that has been tested for the validity of the questions. The results of the analysis of the truth of the questions include validity, reliability, level of difficulty, and distinguishing power with the program SPSS obtained a recap of the results of the item analysis, which can be seen in table 10.

Table 10. The Result of the Test of Validity of the Questions

Validity	SPSS	Value	Description
Validitas	Pearson Correlation	0.004	Valid
Reliabilitas	Cronbach's Alpha	0.736	High
Difficulty	Mean	0.69	Medium
Distinguishing	Std. Deviation	0.463	Good

Based on table 10 shows that the questions as an evaluation tool have met the validity requirements with a score of 0.004 in the excellent category, reliability with a score of 0.736 in the high class, the difficulty level with a score of 0.690 in the medium category, and discriminatory power with a score of 0.463 in the excellent category. This means that the questions are worthy of being used as an evaluation tool. Evaluation is part of the teaching and learning process to monitor learning processes and outcomes (Fatimah & Alfath, 2019; Susanto et al., 2015). The N-gain test was conducted to determine the criteria for increasing pretest and post-test results before and after using the Virtual Planetarium Observatory. The results of the pretest-posttest analysis with the N-gain test between the experimental class and the control class can be seen in table 11 below.

Table 11. Results of Pretest-posttest and N-gain Analisis Analysis

Class	Average Score				N-Gain	Criteria
	Pretest	Posttest	Minimum	Maximum		
Experiment	59.27	89.28	43.33	100.00	89.28	High
Control	59.78	83.80	23.33	94.34	83.80	Medium

The analysis in the table above shows an increase in experimental class learning outcomes with a pretest value of 59.27 and a posttest value of 89.28 While the control class with a pretest value of 59.78 and a posttest value of 83.80. The N-gain score for the experimental course is 0.72 with a high category with a minimum score of 43.33 and a maximum score of 100. At the same time, the N-gain score for the control class is 58.32 with moderate criteria with a minimum score of 23.33 and a maximum score of 94,34. This shows that the virtual observatory Planetarium is effective in improving student learning outcomes. The next step is to determine whether the difference in effectiveness between before and after using the virtual Planetarium observatory is significant or not; it is necessary to carry out prerequisite tests including normality, homogeneity, and t-test tests for hypothesis testing with the IBM SPSS Statistics program. The results of the prerequisite test analysis are presented in table 12 as follows.

Table 12. Prerequisite Test Analysis Results

Test	SPSS	Sig	α	Describtion
Normality	Kolmogorov-Smirnov	0.272	0.05	Normal
Homogeneity	Levence	0.660	0.05	Homogen
T-test	T-test.	0.028	0.05	H_0 Rejected

Based on Table 12. above, the Sig value for the Kolmogorov-Smirnov normality test is Sig 0.27 >, then Ho is accepted, meaning that the data comes from a normally distributed population. Homogeneity test Levence Sig 0.66 > then Ho is born, meaning that the data comes from a homogeneous population. Furthermore, a t-test was conducted to determine the effect of the virtual planetarium observatory on student learning outcomes with the test criteria H_0 rejected if the value of Sig (2-tailed) < 0.05. The results of the t-test analysis obtained Sig 0.02 <0.05, meaning that H_0 is left. This indicates a significant difference in student learning outcomes between before and after using the virtual Planetarium observatory. This means a meaningful relationship between the Virtual Planetarium Observatory variable and the increase in the value of student learning outcomes. Effectiveness is the creation of learning objectives in the teaching and learning process which can be stated with certainty seen in learning outcomes where learning outcomes are changes in behavior due to learning activities (Latief et al. al., 2014; Manunggal & Fathurrahman, 2020; Situmorang et al., 2015). Learning outcomes consist of three aspects, namely cognitive, affective and psychomotor (Latief et al., 2014). It was concluded that the virtual planetarium observatory could improve student learning outcomes on solar system material and the use of the Virtual Planetarium Observatory application is quite effective in improving student learning outcomes on solar system material for class VII students of MTs Al Hadi Girikusuma Mranggen Demak

CONCLUSION

Based on the results of research, data analysis and discussion, it can be concluded that the validity of the Android learning application in the form of a Virtual Planetarium Observatory is very valid. The feasibility of an android learning application in the form of a Virtual Planetarium Observatory is very feasible. The effectiveness of the android learning application in the form of a Virtual Planetarium Observatory is quite effective in improving student learning outcomes for solar system material.

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