Effectiveness of Using Black Track Detector Robot (BTDR) Probs to Improve Student Physics Learning Outcomes

Sudirman Sudirman[1(✉)]

[1]Department of Physics Education, UIN Alauddin Makassar, Samata-Gowa, Indonesia
sudirman.raja@uin-alauddin.ac.id

Abstract. The low value of student physics learning outcomes is influenced by students' attention and interest in the learning process. Whereas the conventional learning process is monotonous, students feel saturated and lose enthusiasm for receiving learning materials. This study aims to improve the learning outcomes of physics students by using teaching aids as a learning media, called *black track detector robots.* The research method carried out is use *pre-experiments*. The research design used in this study is one group *pretest-posttest design*, which is a design in which there is one group selected randomly, then given a pretest to find out the initial state before being given *treatment and* after that *a posttest* is carried out. The results showed that the learning outcomes of fourth-semester students after being taught using the media of black track detector robot props were in high category with an average score of 62.83 so that learning using the media of *black track detector robot* props was effective in improving learning outcomes.

Keywords: Physics Learning Outcomes, Teaching Aids, Black Track Detector Robot (BTDR)

1 Introduction

Education is a place to educate and develop potential in a nation. Education currently still has several obstacles related to the quality of education, so continuous improvement is needed. Various efforts are made to improve the quality of national education, including updating the curriculum, improving the quality of educators, improving educational facilities and infrastructure, structuring education management and implementing information technology in education [1].

Physics learning is one of the lessons that studies phenomena related to these objects. So in physics learning must be supported by activities that can improve mastery of concepts and student learning outcomes. Learning outcomes are the ability of skills, attitudes and skills obtained by students after the receive treatment given by the teacher so that they can costruct that knowledge in everyday life [2].

Physics learning is one of the lessons that studies phenomena related to these objects. So in physics learning must be supported by activities that can improve mastery

J. Warmansyah et al. (eds.), *Proceedings of the International Conference on Social Science and Education (ICoeSSE 2023)*, Advances in Social Science, Education and Humanities Research 789,
https://doi.org/10.2991/978-2-38476-142-5_49

of concepts and student learning outcomes. Learning outcomes are the ability of skills, attitudes and skills obtained by students after the receive treatment given by the teacher so that they can costruct that knowledge in everyday life [3].

From the results of research also conducted by Dewi on the development of learning props based on cheap technology, heat radiation and hydrostatic pressure materials. The results of his research were the effectiveness of heat radiation and hydrostatic pressure props along with LKS development results showed the achievement of learning objectives that were declared very effective in cognitive, affective, and psychomotor aspects as alternative learning resources for field test groups in students at SMP Negeri 4 Metro, SMP Negeri 1 Trimurjo, and SMP Negeri 2 Kalianda, this was evidenced by 100% of students achieving KKM scores [4]. As well as what is in line by Rahmah about the use of environmental-based physics learning props to improve student learning outcomes on liquid pressure material in class VIII of SMP Negeri 1 Baitussalam Aceh Besar. His research results show that using environmental-based physics learning props can improve student learning outcomes, especially on liquid pressure material at SMP Negeri 1 Baitussalam Aceh Besar [5].

From the three research results, it proves that using teaching aids in the learning process can increase the effectiveness in the learning process. The use of teaching aids will help the effectiveness of the learning process as well as save the message of the content of the lesson [6]. Of the three studies, it has similarities in one of the variables assessed, namely learning outcomes and using learning media, namely teaching aids. But what is different from the three studies is in the props used. So from previous research, the author tried to research the same thing but used a different medium of props, namely a lat per a ga black track detector robot which is one of the props that can be used by the author as a tool in teaching the basics of electronics. By using black track detector robot props, the author can provide visualization of the functions of the basic components of electronics.

An experiment is a set of actions and observations, which are carried out to check or blame hypotheses or recognize causal relationships between symptoms. In this study, the cause of a symptom will be tested to find out if the free variable affects the bound variable [7].

In the world of education, especially in learning, the implementation of research is not always possible to conduct a random selection of subjects, because the subject has *naturally formed in an intact group*, such as groups of students in one class. These groups are often very limited in number. Under these circumstances, the rules in purely experimental research cannot be fully met, because the control of variables related to the research subject cannot be carried out completely, so the research must be carried out using an intact group. Such research is referred to as quasi-experimental research (pseudo-experiment). So quasi-experimental research uses all subjects in the study group (intact group) to be given treatment, not using subjects taken at random [8]. So, experimental research is a form of action to confirm hypotheses in certain studies by involving subjects in study groups to be given treatment and will get the results of the treatment.

The author tries to improve learning outcomes by using *black track detector robot* props media because student learning outcomes are still relatively low because some-

times students feel confused about something explained by the course lecturer, especially in introducing electronic components in physics courses making students fantasize about the shape and function of these components, thus making students tend to use the memorization method in knowing the form and function of the component.

The limitations of practicum tools and student boredom are also one of the problems of ineffectiveness in the teaching and learning process [9]. The Limitation spurred the author to try to use a media props *black track detector robot* to be able to improve the learning outcomes of fourth-semester students at the Departement Physics Education UIN Alaudin, Makassar.

The use of media in learning does not mean replacing a good theacing methods, but rather to complement and assist lecturers in delivering material to students. By using media, it is hoped that communicative communication will occur, students will easily understand the meaning of the material conveyed by the lecturer in class, and using teaching media or teaching aids in learning can increase new desires and interests, and can motivate and have psychological influences on students [10].

Based on these problems, the limitation of facilities that can support the improvement of learning outcomes as well as the saturation of students and the ineffectiveness of the learning process can be overcome in one way, namely by using the media of teaching aids [11]. The teaching aids media used in this case is the black track detector robot which is one of the many physics teaching aids that can support the improvement of student learning outcomes.

Based on the background, it is very necessary to conduct research using *black track detector robot* props on the physics material of the subject matter of the basics of electronics. The title of this research is the effectiveness of the use of *black track detector robot* to improve physics learning outcomes of students of the Physics Education Department of Alauddin State Islamic University, Makassar.

This study aims to determine student learning outcomes before being taught using the media of robot black track detector props in fourth-semester students of the Department of Physics Education of UIN Alauddin Makassar, as well as knowing student learning outcomes and the effectiveness of applying black track detector robot props media to fourth-semester students of Physics Education Departement of UIN Alauddin Makassar.

The hypothesis of this study is that there are differences in student learning outcomes before and after being taught using the *black track detector robot teaching aids* for students of the Physics Education Department of UIN Alauddin Makassar. The operational variables are intended to provide a clear description of the variables considered. The operational definition of variables in this study is broken down into two components, namely independent variables and dependent variables. The application of the *Black Track Detector Robot* Props is includes in the independent variables (free variables). *Black track detector Robot* is a tool composed of simple components that are able to move automatically using sensors that can read black lines. This *black track detector robot* is used to improve student learning outcomes related to the material to be taught. Meanwhile, what is included in the dependent variable (bound variable) is student learning outcomes. Learning outcomes are evidence of a person's

success achieved through his learning process or learning activities [12]. This learning outcomes is question are learning outcomes in the cognitive domain.

2 Research Method

The type of research used in this study is *Pre Experiment*. The research design used in this study is *one* group *Pretest-Posttest Design*, which is a design in which there is one group that is randomly selected, then given a pretest to find out the initial state before being given *treatment and* after that *a posttest* is carried out [13].

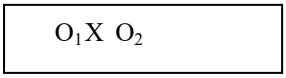


Fig. 1. one group Pretest-Posttest Design

Description:
X = Treatment using *black track detector robot* props
O_1 = Measurement of student learning outcomes before using learning media *(pretest)*
O_2 = Measurement of student learning outcomes after using learning media *(posttest)*

This research took place at Campus II UIN Alauddin Makassar in the fourth-semester students of the Physics Education Department, Faculty of Tarbiyah and Teacher Training UIN Alauddin Makassar.

Population is a general ceverage area, including objects and subjects with certain characteristic qualities [14]. The population in this study is all fourth-semester students of the Physics Education Department of UIN Alauddin Makassar which consisting of 2 classes, based on the results of student data in the Physics Education Department, Faculty of Tarbiyah and Teacher Training UIN Alauddin Makassar. See Table 1.

Table 1. Research Population

No	Class	Number of Students
1	Physic 1,2	31
2	Physic 3,4	31
Total		62

The sample in this study was to take several students from the entire population who were used as experimental classes. The sampling technique used is a saturated sampling technique which is a nonprobability sampling technique [15]. The authors used all members of the population as a samples [13].

Before conducting research, the author must prepare several plans in conducting research and in collecting data the author takes 3 stages, namely the preparation stage, the implementation stage and the data collection stage / data analysis [16].

The research instruments in this study went through several stages, including initial knowledge tests, learning outcomes test, observation results, learning devices, and instrument validity. This test is used to find out the student's initial knowledge. This test is in the form of a 15-number multiple-choice question consisting of only 5 answers, 1 correct answer with point 1 and 4 incorrect answers with point 0 whose composition depends on the indicators used, namely mastery of the substance of the material, structure, concepts and scientific mindset of Physics.

The learning outcomes test is a test conducted by lecturers for students who's each question item is based on indicators of learning outcome indicators that have been previously determined. This test contains questions in the form of multiple-choice questions consisting of only 5 answers, 1 correct answer with point 1 and 4 wrong answers with point 0 whose composition depends on the indicators used, namely mastery of the substance of the material, structure, concepts and patterns of physics.

This observation sheet consists of two types, namely student observation sheets and lecturer observation sheets. This observation sheet consists of aspects of activities when applying black track detector robot props. This observation sheet is used to measure or assess the abilities of lecturers and students based on indicators of preliminary activities, core activities and indicators on the closing activities used [17]. activities and indicators on the closing activities used. Filling out this observation sheet is carried out by giving a check mark (√) in the answer column of the lecturer's observation sheet while for the student observation sheet by giving a score.

The learning tools used in this study are: 1) Semester Implementation Plan. Semester implementation plans used by educators as a reference in the learning process as a medium used in supporting implementation in research. The RPS will also discuss what material will be taught at each available meeting. 2) Textbook. Textbooks are used to find out the extent of student learning outcomes on the material. This textbook is in the form of a practicum guidance module along with teaching materials which contain questions in the form of descriptions and fillings. Next step is instrument validity. Before the research instrument is used, instrument validation is carried out which can be shown as in appendix E. Instruments used in this study will be validated by two experts (expert validation or expert validation). The instrument will be said to be valid if validators 1 and 2 give average values of 3 and 4. In addition to the relevance of validity, the reliability value of the instrument is also determined, the reliability value in question is a value that indicates the level of accuracy of the instrument and the determination of whether the instrument is suitable for use or not [18]. Reliability for learning outcome test instruments is determined by the Gregory test, while the observation sheet instrument is tested with a percent of agreement test. An explanation of instrument validation, can be further elaborated as follows. See table 2.

Table 2. Instrument validity

Relevance	**Scoring**	
	Validator I	Validator II
Weak – Weak	1 or 2	1 or 2

Strong – Weak	3 or 4	1 or 2
Weak – Strong	1 or 2	3 or 4
Strong – Strong	3 or 4	3 or 4

Furthermore, for the calculation of question validity, the Gregory's formula is used, as follows:

$$v = \frac{D}{A+B+C+D} \quad (3.1)$$

Description:
v = Validity coefficient value
A = Weak-Weak relevance
B = Strong-Weak relevance
C = Weak-Strong relevance
D = Strong-Strong relevance

The non-test instruments and learning tools used in this study consist of a Semester Learning Plan (RPS), and observation shee. Theinstrument will be validated by 2 experts and analyzed using the Aiken V index.

$$V = \frac{\sum s}{n(c-1)} \quad (3.2)$$

Description:
V = Index of rater agreement on item validity
s = (r–lo), where r=rate's preferred category score and lo lowest score in the scoring category.
n = Number of raters
c = The number of categories that the raters can choose from

With the criteria for validity level as follows:

Table 3. Criteria for level of validity

Score range (V)	Level of validity
V ≤ 0,4	Weak validity
0,4 – 0,8	Medium validity
V ≥ 0,8	High validity

3 Results and Discussion

3.1 Results

Descriptive Analysis before Applying Black Track Detector Robot Props.
In the descriptive analysis of the processed data, namely pretest data (before) applied *r black track detector robot* props to fourth-semester students of the Physics Education Department of UIN Alauddin Makassar were analyzed to provide an overview of

student learning outcomes scores obtained in the form of the highest scores, lowest scores, average scores *(mean)*, standard deviations and variances as well as categorization of student learning outcomes. The results of the descriptive analysis are as follows:

Table 4. Descriptive statistics of learning outcomes before applying props

Descriptive Statistics	Pretest
Number of samples	30
Maximum score	46,67
Minimum score	13,33
Range	33,34
Average	26,67
Standard deviation	8,21
Variance	67,43
Coeffisient of Variance	2,53

Based on table 4. It can be shown, the maximum score before being given treatment (pretest) is 46.67, the drinking score is 13.33 with the score range is 33.34, the calculation of the average value is 26.67, the standard deviation is 8.21, the variance is 67.43 and the variance coefficient is 2.53. The data obtained in table 4. Becomes the basis for determining the categorization of learning outcomes where the categorization value interval is in the range (0-5). So that the score category before using the *black track detector robot* props on fourth semester student of the Physics Education Department of UIN Alauddin Makassar can be shown as follows:

Table 5. Distribution of *pr*etest categorization before applying props

No.	**Range Value**	**Pre test**		**Category**
		Frequency	Percentage (%)	
1	0 - 19	3	10	Very Low
2	20 - 39	24	80	Low
3	40 - 59	3	10	Medium
4	60 - 79	0	0	High
5	80 - 100	0	0	Very High
Total		30	100%	

Based on table 5. Above we can see that before being given *treatment (pretest)* there were no students who obtained very high and high learning outcomes, there were 3 students in the medium category with 10% presentations, 24 students in the low category with 80% presentations and 3 students in the very low category with a

presentation 10%. From the calculation, the average student has a learning outcome score of 26.67 so that the picture of learning outcomes before applying the *Black Track Detector Robot* props in the fourth-semester students of the Physics Education Department of UIN Alauddin Makassar is in the low category.

Descriptive Analysis after Applying Black Track Detector Robot Props.
In the descriptive analysis of the processed data, namely *posttest* data (after) applied *black track detector* props to fourth semester students of the Physics Education Demartment of UIN Alauddin Makassar were analyzed descriptively used to provide an overview of student learning outcome scores obtained in the form of the highest score, lowest score, average score *(mean)*, standard deviation and variance as well as categorization of student learning outcomes. See table 6.

Table 6. Descriptive statistics of learning outcomes after applying *black track detector robot props*

Descriptive Statistics	**Posttest**
Number of samples	30
Maximum score	86,67
Minimum score	40,00
Range	46,67
Average	62,78
Descriptive Statistics	**Posttest**
Standard deviation	9,35
Variance	87,42
Coeffisient Variance	1,39

Based on table 6. It can be shown, the maximum score after *treatment (posttest)* is 86.67, the drinking score is 40.00 with the score range is 46.67, the calculation of the average value is 62.78, the standard deviation is 9.35, the variance is 87.42 and the variance coefficient is 1.39. The data obtained in table 4.3 form the basis for determining the categorization of learning outcomes where the interval of categorization values is in the range (0-5). See Table 7.

Table 7. Categorization distribution *(posttest)* after applying *black track detector robot props*

No.	**Range Value**	**Pot test**		**Category**
		Frequency	Percentage (%)	
1	0 - 19	0	0	Very low
2	20 - 39	0	0	Low

3	40 - 59	8	26,66	Medium
4	60 - 79	20	66,67	High
5	80 - 100	2	6,67	Very High
Total		30	100%	

Based on table 7. Above we can see that after being given *treatment (posttest)* there were no students who obtained very low and low learning outcomes, there were 8 students in the medium category with a presentation of 26.66%, 20 students in the high category with a presentation of 66.67% and 2 students in the high category with presentation 6.67%. From the calculation, the average student has a learning outcome score of 62.83 so the picture of learning outcomes after applying *black track detector robot* props to fourth semester students of the Physics Education Department of UIN Alauddin Makassar is in the high category.

Inferential Analysis of Learning Outcomes before and After Implementing the Learning Process Using Black Track Detector Robot Props.

Normality Test.

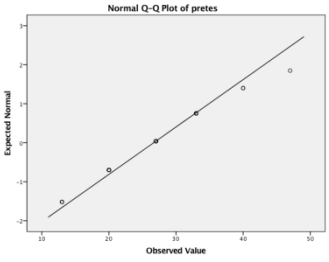
For normality testing in this study pretest and posttest were conducted using the SPSS *version 20* program whether the data obtained from respondents were normally distributed or not. By using the kolmogorov-smirnov method at a significance level of $\alpha = 0.05$ for the same data, namely 30 students.

Table 8. Test the normality of learning outcomes using spss *version 20 program* before treatment

Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Pretest	0.158	30	0.055	0.935	30	0.067

Based on table 8. For pretest data before applying learning using *black track detector robot* props in physics learning in fourth-semester students of the Physics Education Department of UIN Alauddin Makassar normally distributed. This can be seen from the significant value for pretest either by using the *Kolmogorov – Smirnov* method obtained a significant value of 0.055 greater than 0.05 (sig. > 0.05) so it can be concluded that the data is normally distributed. See Figure 2.



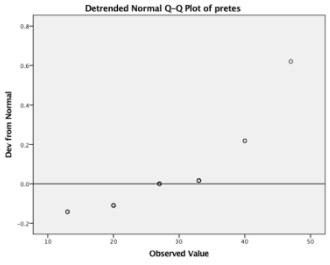


Fig. 2. Normal QQ Plot for pre-test

The QQ Plot digram shows that the plots are spread following the fit line. Similarly, the detrend QQ plot shows that the plots are evenly distributed both above and below the horizontal line, so it can be concluded that the data before applying learning using black track detector robot props in physics learning for fourth semester students of the Physics Education Department of UIN Alauddin Makassar are normally distributed. See Table 9.

Table 9. Normality test of learning outcomes using spss *version 20 program* after treatment

Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Posttest	0.152	30	0.075	0.956	30	0.242

Based on table 9. For posttest data after applying to learn using *black track detector robot* props in physics learning in fourth semester students of the Physics Education Departmen of UIN Alauddin Makassar are distributed normally. This can be seen from the significant value for Posttest either by using the *Kolmogorov – Smirnov* method obtained a significant value of 0.075 greater than 0.05 (sig. > 0.05), so it can be concluded that the data is normally distributed. See Figure 3.

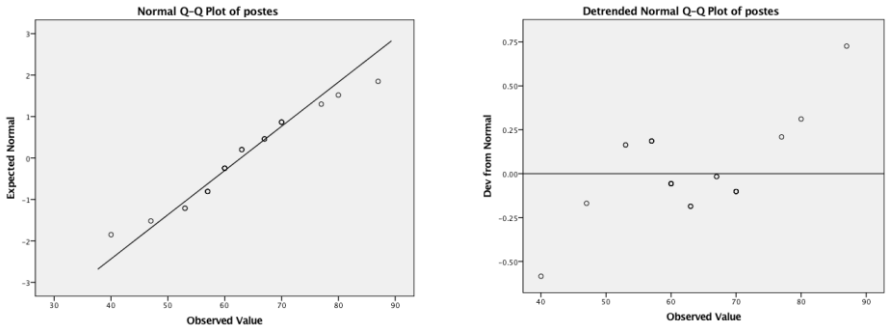


Fig. 3. Normal QQ Plot for post-test

The QQ Plot diagram shows that the plots are spread following the *fit line*. Similarly, in the *QQ* plot detrend which shows the plots evenly distributed both above and below the horizontal line, it can be concluded that the data after applying to learn using *black track detector Robot* props in physics learning in fourth semester students of the Physics Education Department of UIN Alauddin Makassar are normally distributed.

Homogeneity Test

Homogeneity testing aims to determine the object (2 or more samples) studied to have the same variant. If the object under study does not have the same variant, then the anova test cannot be applied. See Table 10.

Table 10. Homogeneity test of learning outcomes using spss version 20 program

Levene Statistic	df1	df2	Sig.
.453	1	58	.504

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	19560.787	1	19560.787	252.622	.000
Within Groups	4491.004	58	77.431		
Total	24051.791	59			

Based on the results of homogeneity testing using the one-way anova test, a significance value of 0.504>0.05 was obtained and calculated value F_{count} = 252.622 while the F_{table} = 4.006. Since the value F_{counts}> F_{Fable} then H_0 is rejected and H_1 is accepted. Thus, it can be concluded that the variance of data on the results of learning physics before and after learning using *black track detector robot* props at the Physics Education Department of UIN Alauddin Makassar is homogeneous.

Hypothesis Test.

This hypothesis testing aims to determine whether or not there are significant differences in influence on student learning outcomes before and after the learning model is applied using *black track detector robot* props. The prerequisite test results show that all distributed data is normal. So that the hypothesis test value using *compare means paired sample statistics* analysis can be seen in the table below:

Table 11. Calculation results of hypothesis test of physics learning outcomes

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	f	Sig. (2-tailed)
Pretes-Posttes	-36.17	13.38	2.44	-41.16	-31.17	-14.80	9	.000

Based on the results of hypothesis testing using the t-test, a negative value t_{count} was obtained, which was -14.80, this negative value t_{count} was due to the fact that the average value of pretest learning outcomes was lower than the average posttest learning outcomes. In the context of a case like this, a negative calculated t_{count} value

can have a positive meaning. So the calculated value t_{count}= 14.80 while the t_{table}= 1.71. Since the value of $t_{counts} > t_{table}$ then H_0 is rejected and H_a is accepted. Thus, it can be concluded that there are differences in learning outcomes before and after the implementation of the media-based learning model of teaching aids. Where there is an increase in learning outcomes after applying learning using *robotic black track detector* props.

Effectiveness Test.
To test the effectiveness of learning using *black track detector robot* props is to use the relative efficiency formula, with the following formula:

The relative efficiency of Ɵ2 to Ɵ1 is formulated:

$$R(Ɵ2,Ɵ1) = \frac{88,075}{67,816} = 1,30$$

Based on the formula above, it can be concluded that learning using *black track detector robot* props is effectively used to improve student physics learning outcomes because the relative efficiency is greater than 1 (R>1).

3.2 Discussion

Physics Learning Outcomes before Being Taught Using Black Track Detector Robot Props.
Analysis of test result data before being taught using *black track detector robot* props provides an overview in the form of a learning result score having an average score in the low category with a maximum score of 13.33 where the drinking score is 13.33 with a score range of 33.34, the calculation of the average score is 26.67. Student learning outcomes before learning using *black track detector robot* props are still very low, this is because previous students used conventional learning where students were lacking in seeing practicum tools that made students less in interpreting or interpreting the data obtained, so the value of student learning outcomes was relatively low. The low value of student physics learning outcomes before learning using *black track detector robot* props is also influenced by students' attention and interest in the learning process. Whereas the conventional learning process is monotonous so students feel saturated and lose enthusiasm for receiving learning materials.

Physics Learning Outcomes after Being Taught Using Black Track Detector Robot props.
Data analysis of the test results before being taught using a *black track detector robot* props provides an overview in the form of a learning result score having an average score in the high category with a maximum score of 86.67 where the drinking score value is 40 with a score range of 46.67, the calculation of the average score is 62.78.

There is an increase in learning outcomes in the electronic learning process, especially for logic gate courses using black track detector robot

props because students can directly see the functions of electronic components through a simple prop, and students can also directly know the principle of logic gates in simple props used in the learning process so that physics learning outcomes Students have increased from the previous relatively low to high. In addition, learning using black track detector robot props also makes students more excited in the learning process because the props used are made in the form of a robot which is something new to be used in the learning process for fourth semester students majoring in Physics Education UIN Alauddin Makassar so that students can receive the material taught well.

According to Anggereni, training learning outcomes is one of the important efforts to obtain optimal student learning success. The subject matter will be easier to learn, live and remember for a relatively long time if the student himself gains direct experience from the learning event through observation or experimentation [19].

Learning by using black track detector robot props is one of the many learning media and methods that can be used in the learning process. By using black track detector robot props in the learning process, it will provide a high attraction to learn the material that is the basis of the props theory, this is supported by Evi stated that using learning media is one of the most important topics in the learning process.

Because this media will create a learning community in the classroom. In addition, the use of learning media will have an impact on the motivation of students in teacher professionalism. Classes using diverse media will look livelier compared to classes that do not use any media [20].

Effectiveness of the Application of Black Track Detector Robot Props Media on Improving Physics Learning Outcomes.

From the results of data processing and hypothesis testing that has been carried out previously, it was obtained that the hypothesis (H1) was accepted, this indicates that the learning process using black track detector robot props has a significant influence on improving the learning outcomes of fourth-semester students of the Physics Education Department of UIN Alauddin Makassar.

Learning by black track detector robot props affects the improvement of learning outcomes. It is known from the difference in pretest and posttest results that have been carried out there are significant differences in learning outcomes. This was proven after a hypothesis test, where the results obtained were the value of tcount ≥ ttable with a value of t of 14.80 and a critical value of t table = 1.71 so that it can be concluded that H 0 is rejected and H1 is accepted, this indicates that the use of black track detector robot props in the learning process can improve the learning outcomes of fourth semester students of the Physics Education Department of UIN Alauddin Makassar.

From the discussion above, we can see that the application of learning to use black track detector robot props is more effectively used. This can be seen from the relative efficiency value obtained, where the estimator variance 1 has a value of 88.075 and the value of the estimator variance 2 is 67.82. From these two variances, a relative efficiency value of 1.30 was obtained.

The results of this analysis are supported by student responses during teaching and learning activities. The author observes that students during learning activities are very excited, so that the learning goals can be achieved well.

4 Conclusion

Based on the results of the analysis, the following conclusions were obtained; 1) The learning outcomes of fourth semester students of the Physics Education Department of UIN Alauddin Makassar before being taught using the media of *black track detector robot* props are in low categorization with an average score of 26.67. 2) Learning outcomes of fourth semester students of the Physics Education Department of UIN Alauddin Makassar after being taught using the media of *black track detector robot* props is in high categorization with an average score of 62.83. 3) The application of learning using the media of *black track detector robot* props is effective in improving learning outcomes in the fourth semester of the Physics Education Department of UIN Alauddin Makassar. It is said to be effective because the relative efficiency value is greater than one which is 1.30.

In relation to the results obtained in this study, the author proposes several suggestions, namely; 1) the time of application of learning using the media of *black track detector robot* props must be more controlled over students so that their learning outcomes are better trained and learning objectives can be achieved. 2) For the next author, the results of this study can be used as comparison and reference material, especially those who want to conduct research on learning outcomes using teaching aids.

References

1. S. Danim, *Media Komunikasi Pendidikan*. Jakarta: Bumi Aksara, 2008.
2. S. Wahyuni, "Model Pembelajaran Make a Match dan pengaruhnya Terhadap Hasil Belajar Ekonomi di SMAN 14 Padang," *Economica*, vol. 5, no. 1, pp. 39–45, Oct. 2016, doi: 10.22202/economica.2016.v5.i1.689.
3. A. Marsella, *Efektivitas Alat Peraga Dengan Media Audio Visual dan Alat Peraga Riil Terhadap Peningkatan Minat dan Hasil Beljar Peserta Didik SMAN 3 Klaten Materi Fluida*. Yogyakarta: UNY Press, 2017.
4. S. Dewi, *Pengembangan Alat Peraga Pembelajaran Berbasis Teknologi Murah Materi Radiasi Kalor dan Tekanan Hidrostatik*. Lampung: Lampung University Press, 2011.

5. S. Rahmah, *Penggunaan Alat Peraga Pembelajaran Fisika Berbasis Lingkungan Untuk Meningkatkan Hasil Belajar Siswa Pada Materi Tekanan Zat Cair di Kelas VIII SMP Negeri 1 Baitussalam Aceh Besar*. Banda Aceh: UIN Ar-Raniri Darussalam Press, 2017.
6. A. S. Sudirman, R. Rahardjo, and A. Haryono, *Media Pendidikan*. Jakarta: Raja Grafindo Persada, 2008.
7. Z. Aqib and A. Murtadlo, *Kumpulan Metode Pembelajaran Kreatif dan Inovatif*. Bandung: PT Sarana Tutorial Nurani Sejahtera, 2016.
8. S. Siyoto, *Dasar Metodologi Penelitian*. Yogyakarta: Literasi Media Publishing, 2015.
9. O. Hamalik, *Proses Belajar Mengajar*. Jakarta: Bumi Aksara, 2011.
10. W. Wibawanto, *Desain Dan Pemograman Multimedia Pembelajaran Interaktif*. Jember: Cerdas Ulet Kreatif, 2017.
11. W. Jatmiko *et al.*, *Robotika: Teori dan Aplikasi*. Jakarta: Universitas Indonesia, 2012.
12. I. Gunawan and A. R. Palupi, . "Taksonomi Bloom – Revisi Ranah Kognitif: Kerangka Landasan Untuk Pembelajaran, Pengajaran, Dan Penilaian," *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, vol. 2, no. 02, Nov. 2016, doi: 10.25273/pe.v2i02.50.
13. Sugiyono, *Statistik Untuk Pendidikan*. Bandung: Alfabeta, 2017.
14. Priyono, *Metode Penelitian Kuantitatif*. Surabaya: Zifatama Publishing, 2016.
15. Riduwan and Akdon, *Rumus dan Data dalam Aplikasi Statistika*. Bandung: Alfabeta, 2013.
16. Sudjana, *Metode Statistik*. Bandung: Tarsito, 2005.
17. Kadir, *Statistika Terapan*. Jakarta: PT Raja Grafindo Persada, 2015.
18. H. Retnawati, *Analisis Kuantitatif Instrumen Penelitian*. Yogyakarta: Parama Publishing, 2016.
19. S. Anggereni, *Mengembangkan Asesmen Kinerja Melalui Pembelajaran Berbasis Laboratorium*. Makassar: Alauddin University Press, 2014.
20. E. F. Rusydiyah, *Media Pembelajaran*. Surabaya: UIN Sunan Ampel Press, 2014