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[Research Article]

STUDY OF THE ACHIEVEMENT OF PHYSICS LEARNING OUTCOMES OF STUDENTS IN HIGH SCHOOLS IN THE SOUTH TANGERANG REGION THROUGH THE TRIAL OF LKS BASED ON THE *SCIENTIFIC APPROACH*

Erina Hertanti[1], Risma Mega Silvia[2], and Jaenab Athial Al-Afifah[3]

[12]*Tadris Fisika, Fakultas Ilmu Tarbiyah dan Keguruan, UIN Syarif Hidayatullah Jakarta, Tangerang Selatan, Indonesia*
[3]*Bioresource Sciences, Faculty of Agriculture, Shizuoka Univercity, Japan*
E-mail: erina.hertanti@uinjkt.ac.id

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ABSTRACT

The research is purposed to study the physics result of learning achievement in the senior high school students in South Tangerang, through LKS trial-testing based on a scientific approach. The research was held in four senior high schools in South Tangerang. They are SMA Negeri 6 South Tangerang, SMA Al-Hasra Bojongsari Baru, SMA Negeri 1 South Tangerang, and SMA Dua Mei. It was conducted from May to August 2014. The research method used was pre-experimental, using a one-group pretest-posttest design. The sampling was done by purposive sampling technique. The hypothesis test used a statistical test of one-way analysis of variance. The result analysis or hypothesis test can gain a significance value <0.05, which means H_0 is denied, it can be concluded that the two N-Gain averages are different from the group data. This result has proven an influence of LKS based on a scientific approach to physics result learning on senior high school students in South Tangerang

Keywords: *LKS, physics student learning, scientific approach*

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1. INTRODUCTION

Learning tools are media, tools, or means used by students and teachers in the teaching and learning process (Hidayatni & Fathani, 2023). One of the learning tools that can support the teaching and learning process is LKS or Student Worksheets (Hamidah et al., 2023).

LKS are sheets of paper that contain material, summaries, questions, and guidelines for carrying out tasks that students must do according to the basic competencies to be achieved (Astari, 2023). However, in the 2013 curriculum, schools are no longer allowed to use LKS. There are several factors behind this policy. First, package books/student study guides containing teaching materials and assignments are provided by the government whose system is distributed to schools according to the applicable curriculum (Siregar et al., 2022). Second, the LKS used in learning is not designed directly by the teacher but bought from the publisher (Elvionika et al., 2023). This makes LKS a commodity item that must be purchased by students. In addition, LKS purchased from publishers do not meet the needs of students in the teaching and learning process (Lisnawati, 2021). Third, the teaching materials in the LKS are not presented in the form of descriptions, but in the form of summaries or points only and there are practice questions. As a result, students are less able to construct an understanding of the concept of material and only memorize existing formulas (Wulaningrum & Nurhakiki, 2021).

The solution that can be applied is to improve and return the LKS to its true role, namely as an additional learning tool that is useful to assist teachers in carrying out the teaching and learning process. In addition, LKS must be designed directly by the teacher by adjusting the basic competencies, learning objectives, and student needs and containing more complete material that can construct student understanding.

Related to this, so far, students of the Department of Physics Tadris, Faculty of Tarbiyah, and Keguruan UIN Jakarta have developed several titles of LKS with designs based on certain learning stages. The implementation of the LKS was carried out in several schools in the South Tangerang and Bogor areas. The results show that there is an effect of the LKS on learning outcomes, creative thinking skills, and science process skills. However, there is no specific study that summarizes the results of the LKS implementation research. Therefore, feedback was conducted on the results of the LKS implementation research in the previous study. Feedback is done through two steps, namely LKS review and LKS mapping.

The review is intended to state that the LKS developed meets practical criteria. The instrument used to review the LKS is a checklist sheet. The checklist sheet contains the quality of the LKS which refers to the didactic, construction, and technical requirements (Nengsi et al., 2021). Didactic requirements mean that a worksheet must prioritize the principles of effective learning. Construction requirements relate to the use of language, sentence structure, vocabulary, level of difficulty, and clarity in the LKS. Technical requirements relate to the writing, images, and appearance of the LKS (Kartika, 2023). The results of the review indicate that the LKS developed can be applied and used in learning activities with little or no revision.

Mapping is intended to state that the LKS developed meets the effective criteria. Mapping is carried out based on the development design and steps contained in the LKS. The mapping results show that the overall LKS developed is effective and has a positive influence on the targets measured, namely learning outcomes, creative thinking skills, and science process skills.

The results of the LKS review and LKS mapping are then used as the basis for recommending LKS with the following syntax: first, presenting concrete problems. In this phase, students are focused on a phenomenon that is concrete, simple, and related to the concept to be learned. Second, constructing students' knowledge through questions and hypotheses. In this phase, students connect the phenomenon with the information they have collected and then propose a hypothesis. Third, experimentation. In this phase, students are guided to obtain information through experimental activities. The steps of activities that students must carry out, namely in the form of instructions in experimental activities. Fourth, analysis and application. In this phase, the results of experimental activities are analyzed by students and then compared with the previous hypothesis. Furthermore, it is applied to other situations, so that students can better understand the material that has been learned.

The recommended LKS syntax is in line with the 2013 curriculum development draft, which emphasizes the application of the *scientific approach* in the teaching and learning process (Fitri et al., 2021). Therefore, the LKS was developed based on the *scientific approach*. However, the extent to which its implementation can have a positive influence on the measured targets, such as learning outcomes, is not yet known. This study aims to assess the success of physics learning activities in high schools in the South Tangerang area through the trial of LKS based on the *scientific approach*.

2. RESEARCH METHODS

This research was conducted in 4 high schools in the South Tangerang area, namely SMA Negeri 6 South Tangerang, SMA Al-Hasra Bojongsari Baru, SMA Negeri 1 South Tangerang, and SMA Dua Mei. The method used in this research is *pre-experimental*. *Pre-experimental* is a type of method that only has one test group that becomes the experimental group (Arib et al., 2024) . The test group will be given treatment in the form of using LKS based on the *scientific approach.*

Data collection in this study was through the technique of giving tests. The tests used were *pretest* and *posttest*. The test instrument used was a multiple-choice type objective test calibrated through validity, reliability, difficulty level, and differentiating power tests. The data analysis technique consists of:

2.1 N-Gain Test

The *normalized gain* (N-Gain) test was conducted to see the increase in student learning outcomes after being treated (Sukarelawa et al., 2024) . The calculation is based on the *pretest* and *posttest* scores of each class.

2.2 Prerequisite Test Analysis

The analysis prerequisite test is carried out to determine the statistical formula that will be used in hypothesis testing. The analysis prerequisite test in this study includes a normality test. Normality testing aims to determine whether the data comes from a normally distributed population or not (Noor, 2017) . N-Gain data testing using the Shapiro-Wilk test (W test) with the help of SPSS software.

2.3 Hypothesis Test

Hypothesis testing was conducted to prove the effect of *scientific approach-based* LKS on student physics learning outcomes in South Tangerang area high schools. Hypothesis testing uses a one-way analysis of variance statistical test (Simanjuntak, 2020) .

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 *Pretest and Posttest Score Acquisition*

The results of the calculation of the average *pretest* and *posttest* scores for each concept are presented in Figure 1. In this study, each concept is assumed to have the same level of difficulty.

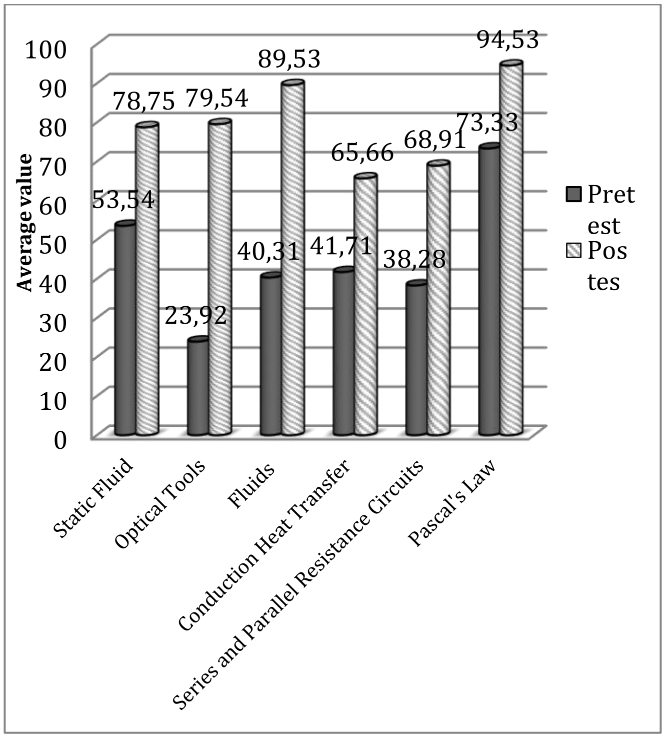

Figure 1. Diagram of average *pretest* and *posttest* scores for each concept

Based on Figure 1, it can be seen that the concept of Pascal's Law obtained an average *pretest* score categorized as quite high, namely 73. This means that the concept of Pascal's Law is sufficiently understood by students, even though there has been no treatment. However, for other concepts, the average *pretest* score is still relatively low, especially on the concept of Optical Instruments.

After being treated in the form of learning by using LKS based on a *scientific approach*, student learning outcomes have increased. This can be seen from the average *posttest* scores obtained by students for all concepts. For the concepts of Static Fluid, Optical Instrument, Fluid, and Pascal's Law, the treatment makes the concept well understood by students. This is evident from the acquisition of the average posttest value for the four concepts, which is > 75. However, for the concept of Conduction Heat Transfer and Series and Parallel Barriers, the treatment only makes students understand the concept in the sufficient category because the average posttest value for the two concepts is< 70.

The description of the difference between the mean *pretest* score and the mean *posttest* score for each concept is shown in Figure 2 below.

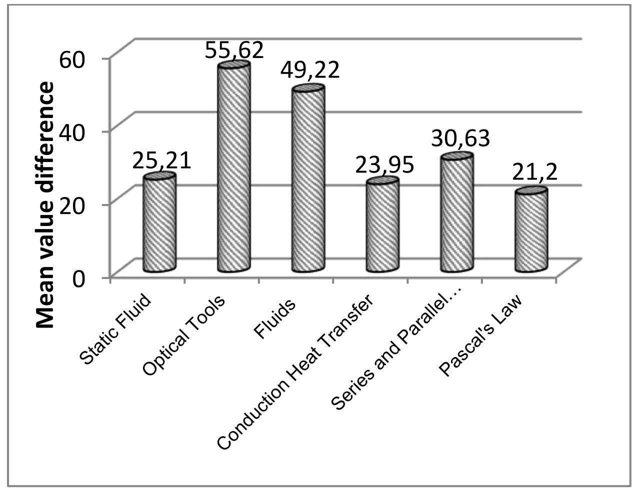

Figure 2. Difference between *pretest* mean score and *posttest* mean score

Based on Figure 2. above, it can be seen that the difference between the average *pretest* score and the average *posttest* score for each concept is in the range of 20-50. The concept of Optical Devices and Fluids obtained a relatively high average value difference (± 50). The other four concepts, namely Static Fluid, Conduction Heat Transfer, Series and Parallel Barriers, and Pascal's Law have a difference in mean scores in the range of 20-30.

3.1.2 N-Gain Score

The description of the acquisition of N-Gain values for each concept is presented in Table 1 below.

Table 1. Descriptive N-Gain for each concept

Concept	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Static Fluid	32	,5006	,21623	,03822	,4227	,5786	,00	,83
Optical Tools	29	,7210	,19891	,03694	,6454	,7967	,22	1,00
Fluids	32	,8175	,10601	,01874	,7793	,8557	,50	1,00
Conduction Heat Transfer	32	,3998	,18838	,03330	,3319	,4678	-,12	,75
Series and Parallel Barriers	32	,5094	,16294	,02880	,4506	,5681	,17	,91
Pascal's Law	30	,7850	,29136	,05319	,6762	,8938	,00	1,00
Total	187	,6189	,25453	,01861	,5822	,6556	-,12	1,00

Table 1. shows that there are differences in the improvement of learning outcomes for each concept after being treated with LKS learning based on the *scientific approach*. The lowest increase in learning outcomes was obtained by the concept of Conduction Heat Transfer, with an average N-Gain value of 0.4. The highest increase in learning outcomes was obtained by the Fluid concept with an average N-Gain value of 0.8.

To make it easier to see the category of N-Gain values obtained by each concept, then the average value of N-Gain for each concept will be presented in the form of a bar chart (Figure 3.). Figure 3. provides information that the increase in student learning outcomes after being treated in the form of learning by using LKS based on the *scientific approach* is divided into two categories, namely high and medium. The high category is obtained by the concepts of Optical Instruments, Fluids, and Pascal's Law, with an average N-Gain value of> 0.7. The concepts of Static Fluid, Conduction Heat Transfer, and Series and Parallel Resistance Circuits obtained an increase in learning outcomes in the medium category because they obtained an average N-Gain value of< 0.7.

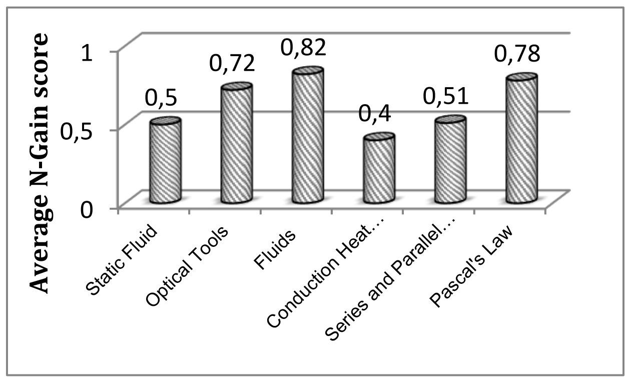

Figure 3. N-Gain diagram for each concept

Information on the acquisition of the N-Gain percentage of each concept based on the category can be seen in Table 2.

Table 2. Descriptive N-Gain category for each concept

Concept	N-Gain Category (%)		
	High	Medium	Low
Static Fluid	25,00 %	56,25 %	18,75 %
Optical Tools	65,52 %	27,59 %	6,90 %
Fluids	91,17 %	8,83 %	-
Conduction Heat Transfer	15,62 %	68,75 %	15,62 %
Series and Parallel Resistance Circuits	15,62 %	75,00 %	9,38 %
Pascal's Law	73,53 %	17,65 %	8,82 %

Based on Table 2. shows that there are three concepts where the percentage acquisition is large enough to improve learning outcomes in the high category, namely> 65%. The three concepts are Optical Instruments, Fluids, and Pascal's Law. Furthermore, the concepts of Static Fluid, Conduction Heat Transfer, Series, and Parallel Resistance Circuits obtained a fairly large percentage (> 55%) for improving learning outcomes in the medium category. While all concepts obtained a relatively small percentage (< 20%) for improving learning outcomes in the low category.

The results of the percentage of the N-Gain category obtained for each concept reinforce the results of the average N-Gain value, namely the use of LKS based on the *scientific approach* in learning successfully improves student learning outcomes in the high and medium categories. Based on the percentage of the N-Gain category, it can be concluded that the highest increase in learning outcomes (> 90%) was obtained by the Fluid concept, while the lowest increase in learning outcomes (< 7%) was obtained by the Optical Instruments concept.

3.1.3 Achievement of KKM

Table 3. presents the results of the effectiveness test of the LKS based on the *scientific approach*. In this study, the LKS is said to be effective if student learning outcomes meet the KKM according to the provisions. In Table 3. it is shown that there are 2 indicators of the success of learning objectives (achievement of KKM), namely the achievement of student KKM scores and the achievement of the percentage of school KKM.

Table 3. Results of the LKS effectiveness test based on the achievement of KKM

Concept	Achievement of KKM			Results
	Value	Classical	School	
Static Fluid	70	75%	75%	Completed (effective)
Optical Tools	73	79,31%	100%	Not complete (not effective)
Fluids	70	100%	75%	Completed (effective)
Conduction Heat Transfer	70	34,4%	75%	Not complete (not effective)
Series and Parallel Resistance Circuits	70	59,4%	50%	Completed (effective)
Pascal's Law	73	100%	100%	Completed (effective)

Based on the results of the effectiveness test, it is known that 4 scientific approach-based worksheets meet the effective criteria because they succeed in completing the learning objectives according to the provisions. This means that the use of the four *scientific approach-based* worksheets has a positive influence on learning activities. The physics learning outcomes of students on each LKS content meet the KKM value with the achievement of the percentage according to the expected target. The four worksheets contain the concepts of Static Fluid, Fluid, Pascal's Law, and Series and Parallel Barriers. Two *scientific approach-based* worksheets that contain the concepts of Optical Devices and Conduction Heat Transfer have not met the effective criteria. Both worksheets have not had a positive influence on learning activities, because they have not succeeded in completing the learning objectives as specified.

3.1.4 The Effect of LKS on Learning Outcomes

To prove the effect of *scientific approach-based* LKS on student physics learning outcomes in high schools in the South Tangerang area, hypothesis testing was carried out. However, before conducting hypothesis testing, an analysis prerequisite test (normality test) is carried out to determine the statistical formula to be used in hypothesis testing.

Normality Test

In this study, normality testing was carried out on six groups of N-Gain data. To test the normality of the six groups of N-Gain data, the Shapiro-Wilk test (W test) was used with the SPSS *software* application. The Shapiro-Wilk test criteria are, if $W_{count} \leq 0.05$ then H_0 is rejected, meaning that the data distribution is not normally distributed. Meanwhile, if $W_{count} > 0.05$ then H_0 is accepted, meaning that the data distribution is normally distributed. The results of normality testing for the six groups of N-Gain data can be seen in Table 4.

Table 4. Normality test results of six groups of N-Gain data

Concept	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Static Fluid	,103	32	,200*	,947	32	,119
Optical Tools	,187	29	,011	,904	29	,012
Fluids	,184	32	,007	,897	32	,005
Conduction Heat Transfer	,127	32	,200*	,950	32	,140
Series Parallel Barriers	,133	32	,158	,978	32	,726
Pascal's Law	,236	30	,000	,758	30	,000

Based on Table 4. shows that there are three groups of N-Gain data whose distribution is normally distributed because it meets the criteria $W_{count} > 0.05$. *First*, the Fluid concept N-Gain data group has a significance of 0.119. *Second*, the N-Gain data group of the Conduction Heat Transfer concept has a significance of 0.140. *Third*, the N-Gain data group on the concept of Series and Parallel Resistance Circuits has a significance of 0.726. While the other three groups of N-Gain data are not normally distributed, because they meet the criteria of $W_{count} \leq 0.05$. *First*, the N-Gain data group for the concept of Optical Instruments has a significance of 0.012. *Second*, the Fluid concept N-Gain data group has a significance of 0.005. *Third*, the N-Gain data group of Pascal's Law concept has a significance of 0.000.

Hypothesis Test

The normality test results for the six groups of N-Gain data show that the data are not normally distributed. By these conditions, the hypothesis test to be used is non-parametric, namely the Kruskal-Wallis test. The Kruskal-Wallis test is used if the data distribution is not normally distributed in three or more samples. The Kruskal-Wallis test hypothesis is if Sig> 0.05 then H_0 is accepted, meaning that there is no difference in the average N-Gain in the data group. Meanwhile, if Sig < 0.05 then H_0 is rejected, meaning that there are at least two unequal N-Gain averages in the data group. The following are the results of the Kruskal-Wallis test with the SPSS *software* application in Table 5.

Table 5. Kruskal-Wallis test results of six groups of N-Gain data

	N-Gain of Learning Outcomes
Chi-Square	83,300
Df	5
Asymp. Sig.	,000

From the results of the Kruskal-Wallis test on the six groups of N-Gain data, the significance value< is 0.05, namely 0.000, so that H_0 is rejected. That is, there are at least two N-Gain averages that are not the same in the data group. So it can be concluded that there is an effect of *scientific approach-based* LKS on student physics learning outcomes in high schools in the South Tangerang area.

3.2 Discussion

Based on the average pretest scores for each concept, it is known that the samples have different initial abilities. Therefore, statistical analysis was conducted on the N-Gain data. From the results of the analysis or hypothesis testing, the significance value< 0.05 is obtained, meaning that H0 is rejected, it can be said that there are at least two N-Gain averages that are not the same in the data group. These results prove that there is an effect of *scientific approach-based* LKS on student physics learning outcomes in high schools in the South Tangerang area.

According to Nieveen (1999), a device can be said to be of quality if it meets several aspects, one of which is effective. In this study, LKS based on a *scientific approach* is said to be effective if it has a positive influence on the achievement of student physics learning outcomes which include: the acquisition of posttest scores, the acquisition of N-Gain scores, and the achievement of KKM. Based on the average posttest scores for all concepts, it can be seen that the physics learning outcomes of students have increased after being treated in the form of learning using LKS based on a *scientific approach.*

The stages in the *scientific approach-based* LKS are in line with the 2013 curriculum development draft, which suggests that the desired teaching and learning process is learning that emphasizes personal experience through observing, asking, reasoning, trying, and communicating, with the nature of learning is contextual (Reskiani et al., 2023). In the LKS based on the *scientific approach, the* teaching and learning process is designed in such a way that students can think logically, sequentially, and systematically. In addition, the stages in the LKS based on the *scientific approach* can be used to develop the teaching and learning process.

The first stage, exposing concrete problems. At this stage, students are invited to build knowledge and experience by first focusing on a phenomenon that is concrete, simple, and related to the concept to be learned. According to Pratiwi (2018) Given the problem, students have the opportunity to try, apply knowledge, adopt new knowledge, and gain experience as inventors. This is in line with the theory of constructivism which interprets that student knowledge is largely built based on real experience (Hidayati, 2025). While Lestari et al. (2025) revealed that learning that involves real experiences can help students gain a more meaningful understanding, not just a transfer of knowledge.

The second stage is constructing knowledge through questions and hypotheses. Asking questions related to the problems taken will improve students' thinking skills. This is because questions are the basis for students to seek further information. Meanwhile, hypotheses invite students to predict what will be observed. In this case, the teacher can guide students in determining hypotheses that are relevant to the problem and prioritize hypotheses that are the main thing in the investigation.

In the third stage, students are guided to obtain information through experimental activities. The steps of activities that must be carried out by students are in the form of instructions in experimental activities. The main purpose of conducting experiments is to obtain real evidence because students are allowed to observe concrete processes related to the concepts being studied. In this experimental activity, students construct understanding through experience, so that students can connect new knowledge and old knowledge. This is in line with the opinion of Wulandari et al. (2021) which states that students more easily understand complex and abstract concepts if accompanied by concrete examples that match the conditions faced through experiments and concept discovery.

The final stage is analysis and application. At this stage, the experimental activities are analyzed for results. Furthermore, at the application stage, new problems are presented in the form of questions related to other forms of experiments that can be done to understand the concepts being studied.

The stages in the LKS based on the *scientific approach* have met the scientific criteria. The teaching and learning process that meets scientific criteria falls into three domains, namely attitude, knowledge, and skills. In the realm of attitude, students are invited to know why. In the realm of knowledge, students are invited to know what. While in the realm of skills, students are invited to know how. This means that the LKS based on the *scientific approach* makes learning activities a scientific process that is carried out by students and teachers. Learning that can provide scientific process experiences can develop student understanding to be more meaningful and remembered longer because it attracts curiosity (Qomariyah & Subekti, 2021).

The stages in the *scientific approach-based* LKS are effective in improving student learning outcomes. This can be seen from the acquisition of the average N-Gain value after being treated in the form of learning by using LKS based on the *scientific approach*. Based on the average value of N-Gain, it is known that the increase in student learning outcomes is in the high and medium categories. The results of this study are in line with Nugroho et al. (2022) which states that LKS with a *scientific approach* can improve students' mathematical problem-solving skills.

When viewed from the acquisition of the percentage of the N-Gain category, it can be said that learning by using LKS based on the *scientific approach* is enough to help students understand the material. This is evidenced by the acquisition of a large enough percentage for N-Gain in the high and medium categories, namely 65%, and 55%. These results are to the information provided by the Ministry of Education and Culture (2013), which states that the results of *scientific approach-based* learning research are more effective than conventional learning. The results showed that in conventional learning, contextual understanding was obtained by 25%. While in *scientific approach-based* learning, contextual understanding is obtained by 50 - 70%.

Measurement of learning effectiveness must always be related to the achievement of learning objectives (Daulay et al., 2021) . Fatmawati et al., (2023)states that learning using LKS can make it easier for students in the teaching and learning process to achieve learning objectives. Based on the results of the effectiveness test, it is known that of the 6 worksheets tested, 4 scientific approach-based worksheets meet the effective criteria, because they succeed in completing the learning objectives as specified. This means that the use of the four *scientific approach-based* worksheets has a positive influence on learning activities. The physics learning outcomes of students in each LKS content meet the KKM value with the achievement of the percentage according to the expected target. The results of this study are in line with the results of research conducted by Ramadhani et al., (2021) which proves that the application of LKS has a positive effect on student learning outcomes in science and physics lessons. Overall, it can be said that the *scientific approach-based* LKS has acted as a student worksheet that can help teachers and students in learning activities. In line with the opinion of Frans & Wasis (2022)which states that the use of LKS makes it easier for teachers to monitor student success in achieving learning objectives. In addition, LKS helps teachers to direct students to solve problems through activities independently.

4. CONCLUSIONS

Based on the results of the study, it can be concluded that the physics learning outcomes of students have increased after being treated in the form of learning by using LKS based on a *scientific approach*. The increase can be seen in the acquisition of the average *posttest* score and the acquisition of the average value of N-Gain in the high and medium categories. In addition, the results of the analysis or hypothesis testing obtained a significance value of< 0.05, meaning that H_0 is rejected, it can be said that there are at least two N-Gain averages that are not the same in the data group. These results prove that there is an effect of *scientific approach-based* LKS on student physics learning outcomes in South Tangerang area high schools.

This research only looks at the quality of *scientific approach-based* worksheets based on effective aspects. Further research can be done by looking at the quality of *scientific approach-based* worksheets based on practical aspects. The instrument used to review the LKS in practical aspects is a checklist sheet containing the quality of the LKS which refers to didactic, construction, and technical requirements.

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