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The Effectiveness of Practicum Method Assisted with PhET Media on Character and Learning Outcomes of IPA

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Abstract: This study aimed to evaluate the effectiveness of a PhET-assisted practical method on the character development and academic achievement of IPA students at SDN Kepandean 03. A quasi-experimental design with a pretest-posttest control group was employed. The sample consisted of 28 students in the experimental group and 28 students in the control group, randomly selected from classes VA and VB. The results indicated that the experimental group, which utilized the PhET-assisted practical method, exhibited significant improvements in both character development (posttest mean: 83.75) and academic achievement (posttest mean: 85.11), compared to the control group (character: 77.71, academic achievement: 74.89). These findings suggest that the PhET-assisted practical method is an effective approach for enhancing students' character and academic performance in IPA.

Keywords: Character; Learning outcomes; Practicum

Introduction

Education is one of the ways to advance and educate people (Rahmatsyah et al., 2021). Education does not only focus on the transfer of knowledge, but also includes character building, spiritual strengthening, and empowering students to become individuals who contribute to society and the nation. The purpose of education is to develop the potential of students to become human beings who believe and fear the one true god, noble, healthy, know-how, capable, creative, independent, and become democratic and responsible citizens (Yuliana et al., 2021).

The learning process is an important stage in achieving learning objectives. Learning includes all efforts made by educators to create an environment that supports and encourages the learning process in students (Setyaningsih et al., 2021). Learning is a complex dynamic that involves interaction between students, educators, and various learning resources in the context of a teaching-learning environment to provide knowledge and knowledge, develop abilities, and build character and self-confidence (Masgular et al., 2021). In the process, learning must be carried out optimally with the help of facilities and infrastructure in order to realize effective learning (Ambarwati et al., 2021). Learning is said to be effective if the learning outcomes are considered complete and the planned learning objectives are achieved. Learning effectiveness is a level of success that has been obtained or achieved in a learning objective (Khanif et al., 2022). Teachers must be wiser in determining an appropriate learning method or model in learning, so that the learning process will be more effective (Azizah et al., 2019). Knowing the effectiveness of learning is important because it will provide an overview of the extent to which learning can achieve goals (Pendy et al., 2021).

The IPA subject is a field of study that introduces students to science that includes the exploration of living and non-living things in the universe, as well as the dynamics of their interactions. IPA learning in the curriculum is certainly carried out in a quality manner by implementing ideal learning (Salsabila et al., 2023). Teachers are encouraged to be observant in selecting

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appropriate methods and approaches and utilizing supporting facilities so that the quality of teaching and learning activities increases (Saifulloh et al., 2020). With the right learning method, learning will be more focused and can achieve the learning objectives that have been designed better (Diana et al., 2020).

Character is a collection of operational values, real values that are reflected in good behavior and actions (Harahap, 2021). Character is the result to be achieved through the education process (Muchtar et al., 2019). In an effort to produce a generation that is intelligent in personality and has good morals, character education is present to support this goal (Suriadi et al., 2021). Character is not just a concept or ideology, but a group of values that are realised through action. Character is not something that is given naturally, but rather the result of an educational process.

The definition of learning outcomes is the level of success of students in understanding subjects as measured by scores obtained from testing instruments on certain subjects (I. Irawati et al., 2021). The learning outcomes are an indicator of the ability or level of understanding of students of what they have learned (Djonomiarjo, 2020). Learning outcomes are a description of the potential or capacity that students have which can be seen from their behaviour, both in the form of understanding knowledge and thinking skills (Marzuki et al., 2023).

Initial research has been carried out by researchers in the form of conducting interviews with homeroom teachers 5A and 5B to further discuss the identification of problems that occur, especially in class 5. The problems conveyed by the sources focus on things that occur during the learning process. It is known that the learning outcomes of grade 5 students are considered quite low, especially in IPA subjects. The resource person described several possible sources of problems that caused the low learning outcomes of grade 5 IPA.

One of the main findings from the interview was the low level of learner engagement which is related to the perception that the learning methods applied are still unable to achieve the expected level of interest. Through questionnaires on how the learning process goes, most learners perceive learning to be monotonous and this can affect their level of motivation to follow the learning process. The interviewees stated that most students tend to be passive in the learning process, which certainly affects their interaction and participation in the learning process. Learning in the classroom is very passive if it only relies on aspects of listening to the teacher, doing assignments, and sticking to books (Hasyda et al., 2020). Passive learning clearly reduces the reciprocal relationship between students and teachers, as well as fellow students, which causes learning to be less effective (Ariyani et al., 2021). The learning process cannot be separated from learning methods, the methods implemented are expected to support learning in achieving practical and real goals (Pujiati TM et al., 2024). Learning methods are needed in the learning process, because they support active, creative, and interesting learning for students (Hidayat et al., 2020). In science learning, the practicum method is very good in supporting teachers to direct students in analyzing solutions with their own efforts based on data in the field (Sunardi et al., 2020). Practicum is very suitable in facilitating students to learn through direct experience, because it presents an opportunity for students to gain real experience and appreciate every process, be directly involved in the practice and be responsible for the results (Siagian, 2021). Practical activities are activities that have a very important role in improving students' science process skills (Putri et al., 2022). It is important to strive for a learning process that can motivate students to develop their reasoning power in planning and solving problems faced by providing direct experience (Syukri et al., 2021).

The interview also revealed that the use of learning media is currently considered not fully effective. This is also reinforced by students' responses through questionnaires that have been distributed regarding the media used by teachers in this lesson. Learners argue that the images and videos used by teachers are less effective and less supportive of learning. Along with the times, conventional media is considered less effective for increasing knowledge (Aisah et al., 2021). Learning media that is not suitable for the material and learning can make the direction of learning ambiguous and reduce the enthusiasm and motivation of students to learn (Sevtia et al., 2022). Learning media has an important role in the learning process in the classroom to improve the quality of learning and students' interest in learning materials (Aristaria et al., 2024). The use of learning media will greatly help the effectiveness of the learning process and the delivery of subject matter content (Firdawati et al., 2021). In addition, the lack of facilities that support IPA learning such as the availability of laboratories and practicum equipment causes learning to be less than optimal. The interviewees felt the need to review the type of media used to ensure better understanding of the learning material by the students. Physics Education Technology (PhET), is a simulation media developed by the University of Colorado that presents science learning simulations by emphasising the relationship between real-life phenomena and the underlying science (Sahida, 2022). PhET provides an experience of the activities of a virtual laboratory (Inayah et al., 2021). PhET media makes learning more interesting because it can give students the experience of learning while playing (Isbah et al., 2024).

This study introduces a novel approach by employing PhET simulations to not only enhance academic performance but also cultivate students' character. The interactive nature of PhET, when coupled with hands-on experiments, is expected to create a more immersive learning environment, stimulating students' active involvement.

The urgency of this research is to provide alternative solutions in overcoming problems that exist in the field based on observations and interviews conducted by researchers, such as low student involvement, monotonous learning, and limited facilities and infrastructure such as media and laboratories. By using the practicum method assisted by PhET media, it is hoped that it can also improve the character and learning outcomes of students in science subjects. This is important to provide equal opportunities for all students to obtain quality education despite not having adequate facilities.

Based on the background of these problems, this study aims to analyse whether there is a difference in the character and the IPA learning outcomes of students between learning that applies the practicum method assisted by PhET media with conventional learning on the material of Magnetism, Electricity, and Technology grade V SDN Kepandean 03 Tegal Regency.

Method

This type of research is quantitative research that uses a quasi-experimental approach, with the aim of exploring the impact or results of an action on the subject, in this case students. The research sample consists of two groups, namely the experimental group and the control group. In research activities, each group will get different treatments. The experimental group will be given learning treatment by applying the practicum method assisted by PhET media. The control class is given treatment using conventional learning.

This study used a pretest-posttest control group design. This design has proven to be very effective in examining cause-and-effect relationships. It not only analyses learners' abilities before and after treatment, but also considers differences in learners' abilities. It combines the use of a pretest to assess learners' basic abilities before the treatment is given and a posttest to evaluate learners' final abilities after the treatment is given.

Table 1. Research Design

Class	Pre-Test	Treatment	Post-Test
Experiment class	O1	X	O2
Control class	O1	-	O2

Description:

O1 : Pretest, conducted to determine the basic abilities of students before treatment

O2 : Posttest, conducted to determine the final ability of students after treatment

X : Treatment, implementation of learning activities using the practicum method assisted by PhET media

There are provisions in this study that are adjusted to the type of quasi-experimental research, so the provisions in this study are each class gets the same pretest and posttest questions, each class gets the same materials, the duration of learning and delivery of material for each class is the same, and the only difference between the experimental class and the control class is the learning treatment.

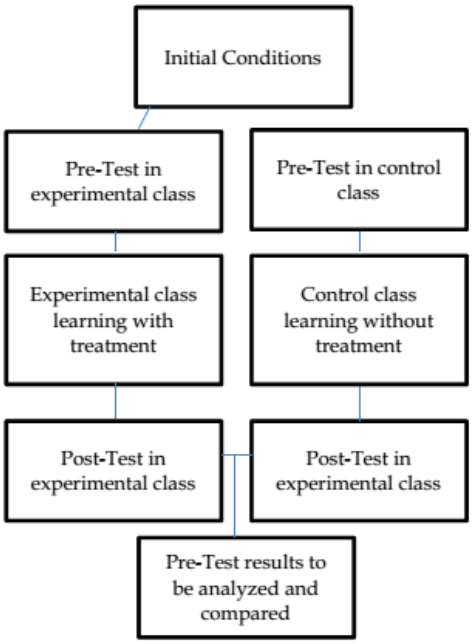

Figure 1. Research flow

Results and Discussion

The focus in this study is learning that applies the practicum method assisted by PhET media to improve the character and learning outcomes of students in the IPA subject of Magnetism, Electricity, and Technology class V SDN Kepandean 03. Practicum is one of the appropriate methods to create a memorable learning experience for students. The practicum method requires students to be active in learning because the focus in practicum learning is on the students themselves so that they are trained to experiment, analyse, and solve problems with their own efforts (Putri et al., 2022). Practicum provides a more meaningful experience than just listening to explanations from teachers and modules that will make the essence of learning remembered

longer (Budiastra et al., 2022). The practicum method is very powerful to support students in finding answers with their own efforts based on data that is in accordance with reality (Rusmini et al., 2021). Practical activities are one of the academic activities that aim to observe, try, understand and apply the theories learned during the learning process by doing direct practice both inside and outside the laboratory environment (Ritonga, 2023).

PhET media is a virtual laboratory that is very useful, especially in science learning and can display animations that can be used in practical activities (Subiki et al., 2022). PhET media displays simulations that are interactive and easy to understand so that students can easily understand and can create active, creative, effective, and fun learning (Idayesti, 2021). PhET media is a virtual laboratory specifically designed to support science learning. As a virtual laboratory, PhET provides a learning experience similar to experiments in a physical laboratory, but in a virtual environment that can be accessed online. By providing simulation and visual interaction, PhET allows learners to understand science concepts in a practical and hands-on way.

Table 2. Lattice of Character Rubric

Profile	Indicators
Independence	• Managing time • Take initiative in independent tasks • Ability to learn independently
Critical Reasoning	• Information identification and analysis • Logic and strength of argument • Courage to express personal views
Mutual cooperation	• Cooperative attitude • Active participation in the group • Respect the opinions and contributions of group members
Creative	• Courage to think outside the box • Ability to create innovative solutions • Curiosity and exploration of new ideas

This research focuses on improving learners' character in learning. The purpose of character education is to help learners experience, acquire and possess desirable strong character traits (Artika et al., 2024). Character is the main foundation in life and is very important for the world of education which can affect the academic ability of students (Jamaluddin et al., 2023). Character education that is being implemented in the independent curriculum is the Pancasila Learner Profile Strengthening Project or what is commonly called the Pancasila Learner Profile. Profil Pelajar Pancasila is the moral characteristics and abilities that learners should have in the modern era (D. Irawati et al., 2022). In the driving teacher programme, the Pancasila learner profile aims to help people understand each other, behave, and have character based on Pancasila values so that Pancasila can remain alive as a guideline and ideology that is interpreted and implemented by students (Kurniawaty et al., 2022). There are 6 profiles in the Pancasila Learner Profile, including faith, global diversity, independence, critical reasoning, mutual cooperation, creativity (Kemendikbud, 2021). In this regard, the researcher has created a character rubric that is adjusted to the research to be carried out by prioritising the profiles of independent, critical reasoning, mutual cooperation, and creative.

Table 2 presents the character rubric grid that will be used as a guideline in developing indicators in the form of statements. The results of the character rubric were analysed to obtain the value of each indicator. The results of the analysis of the experimental class students' character rubric are presented in table and the control class in table 2.

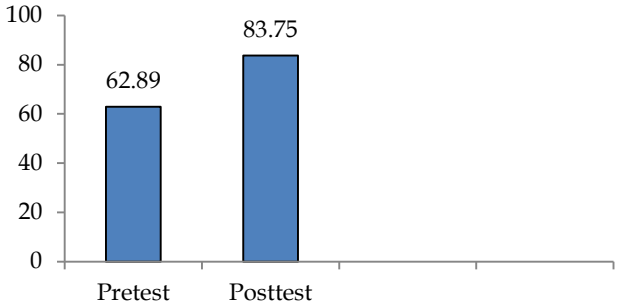

Figure 2. Experimental class character rubric analysis results

The pretest results of the character rubric showed that the experimental class had the lowest score of 47, the highest score of 75, an average (mean) of 62.89 and a standard deviation of 8.171. The posttest results showed that the experimental class had the lowest score of 72, the highest score of 97, an average (mean) of 83.75 and a standard deviation of 7.152. This shows that after being given a learning treatment using the practicum method assisted by PhET media, the character of students has increased significantly.

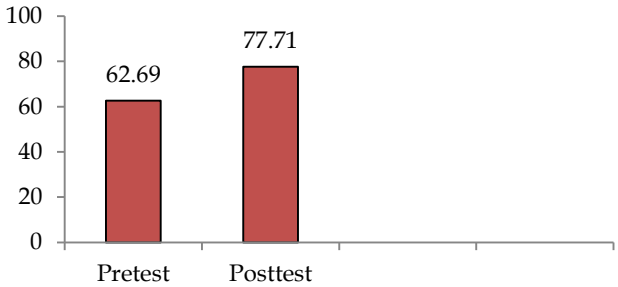

Figure 3. Control class character rubric analysis results

The pretest results of the character rubric showed that the experimental class obtained the lowest score of 47, the highest score of 75, an average (mean) of 62.69 and a standard deviation of 6.531. Then the posttest results obtained the lowest score of 60, the highest score of 90, an average (mean) of 77.71 and a standard deviation of 5,530. This shows that after being given conventional learning treatment, the character of students did not experience a significant increase compared to the class that received the treatment of practicum method assisted by PhET media.

Another focus in this study is learning outcomes. Learning outcomes are changes in behaviour after going through the teaching and learning process which includes cognitive, affective, and psychomotor fields that can be known by carrying out assessments that have been adjusted (Gulo, 2022). Learning outcomes are the result of the development of the potential abilities and understanding capacity of students after learning or getting learning (Novianti et al., 2020). Learning outcomes are the level of understanding of students in receiving learning and selecting information in the process of learning subject matter through value indicators given in each subject during the learning process (Harefa, 2020). Learning outcomes are measured using a test in the form of 40 questions. The questions were developed from Magnetism, Electricity, and Technology materials and increased the cognitive level. Then the 40 questions were distributed during the pretest and posttest.

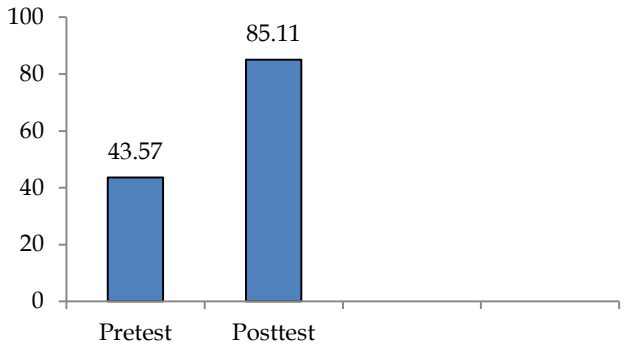

Figure 4. Experimental class pretest and posttest results

The pretest results showed that the experimental class obtained the lowest score of 27, the highest score of 52, an average (mean) of 43.57 and a standard deviation of 7.485. Then the posttest results obtained the lowest score of 80, the highest score of 95, an average (mean) of 85.11 and a standard deviation of 5,580. This shows that there is a significant increase from the learning treatment that applies the practicum method assisted by PhET media to the learning outcomes of students.

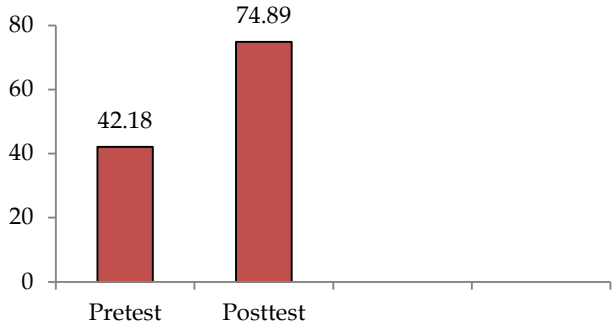

Figure 5. Control class pretest and posttest results

The pretest results of the character rubric showed that the experimental class obtained the lowest score of 30, the highest score of 60, an average (mean) of 42.18 and a standard deviation of 8.331. Then the posttest results obtained the lowest score of 70, the highest score of 85, an average (mean) of 74.89 and a standard deviation of 4,467. This shows that after being given conventional learning treatment, the learning outcomes of control class students did not experience a significant increase compared to the experimental class who received the treatment of practicum method assisted by PhET media.

Normality Test of Character Rubrics and Learning Outcomes

To determine the statistical test to be used in research, a normality test is required. Parametric statistics are used to test hypotheses if the data is normally distributed. However, if the data is not normally distributed, the hypothesis test uses non-parametric statistics. In this study, normality testing was carried out using the SPSS programme. The test criteria are if the significant value (sig.) > 0.05, then H0 is accepted or the data is normally distributed and if (sig.) < 0.05, then H0 is rejected or the data is not normally distributed. The results of the normality test calculation are presented in tables 3 and 4.

Based on the results of the normality test, a significant value (sig.) is obtained for all data in the Saphiro-Wilk test, which is smaller than 0.05. So it can be concluded that the research data is normally distributed so that hypothesis testing can use parametric statistics for the independent sample t test.

Table 3. Calculation of Normality Test of Character Rubric

Character Outcome	Significant value Saphiro-Wilk	Testing Criteria	Conclusion
Experiment pretest	0.138	(sig.) > 0.05	Normal
Experiment posttest	0.167		Normal
Control pretest	0.297		Normal
control posttest	0.599		Normal

Table 4. Calculation of Normality Test of Learning Outcomes

Learning Outcomes	Significant value Saphiro-Wilk	Testing Criteria	Conclusion
Experiment pretest	0.408	(sig.) > 0.05	Normal
Experiment posttest	0.123		Normal
Control pretest	0.088		Normal
control posttest	0.094		Normal

Homogeneity Test of Character and Learning Outcome Rubrics

The homogeneity test was carried out after both samples were declared normally distributed, so that data processing could be carried out using parametric statistics. There are various t-test formulas in parametric statistics so that to determine the most appropriate t-test formula it is necessary to first conduct a homogeneity test. The results of the calculation of the homogeneity test of this variance using the SPSS programme. The homogeneity test in this study used the Levene Test. The sample is said to be homogeneous if the sig. coefficient price on the Levene statistics output is greater than 0.05. The results of the homogeneity test can be seen in tables 5 and 6.

Table 5. Homogeneity Calculation of Character Rubric

Significant	Conclusion
0.057	Homogeneous

Table 6. Homogeneity Calculation of Learning Outcomes

Significant	Conclusion
0.810	Homogeneous

Based on tables 5 and 6, it can be concluded that each data is said to be homogeneous because the significant coefficient value in Levene's output is greater than 0.5 (sig. > 0.5).

Hypothesis Testing

To find out whether there are differences in the character and learning outcomes of students taught with the practicum method assisted by PhET media with conventional learning, hypothesis testing is needed. This hypothesis test was conducted to see the difference in student test results from the two groups. The hypothesis in this study was tested using independent sample t test statistics with the help of the SPSS programme. The hypotheses in this study are

H0 : $\mu 1 = \mu 2$

Ha: $\mu 1 > \mu 2$

While the H0 hypothesis states that there is no difference in character and learning outcomes, the Ha hypothesis states that the average posttest score of the experimental class (μ1) is greater than the average score in the control class (μ2). This shows that the character and learning outcomes of students who get the treatment of practicum method assisted by PhET media are better than students with conventional learning.

The criteria are if the significant value (sig-2 tailed) > 0.05, then H0 is accepted and Ha is rejected. If the significant value (sig-2 tailed) <0.05, then H0 is rejected and Ha is accepted. The results of the Paired Sample T Test analysis can be seen in tables 7 and 8 below.

Table 7. Paired Sample T Test Analysis of Character Rubric

Class	Std. Deviation	Df	Sig.
Experiment pretest-experiment posttest	11.188	27	0.000
Control pretest-control posttest	8.829	27	0.000

Table 8. Paired Sample T Test Analysis of Learning Outcomes

Class	Std. Deviation	Df	Sig.
Experiment pretest-experiment posttest	4.451	27	0.000
Control pretest-control posttest	10.728	27	0.000

Based on tables 7 and 8, it can be concluded that there is an effect of the implementation of the practicum method assisted by PhET media. This can be seen through the smaller probability value (sig.) of 0.000.

The results showed that learning using the PhET media-assisted practicum method obtained an average posttest rubric character result of 83.75 and an average learning outcome of 85.11, while the class taught with conventional learning only achieved an average posttest rubric character result of 77.71 and an average learning outcome of 74.89. Thus, the class that followed learning with the practicum method assisted by PhET media gave better results than the class that followed conventional learning.

Using the Independent Sample T Test, hypothesis testing found a significance value (2-tailed) of 0.000. This significance value falls in the rejection zone of the null hypothesis (H0), which means that the average score of learning outcomes and character rubrics in the experimental class given the treatment is higher than the control class with conventional learning treatment. Therefore, it can be concluded that the experimental class that followed the learning with the practicum method assisted by PhET media achieved better results than the control class that used conventional learning.

Conclusion

Based on the analysis that has been carried out, it can be concluded that there is a positive effect of the

application of practicum method assisted by PhET media on the character and learning outcomes of students on the material of Magnetism, Electricity, and Technology at SDN Kepandean 03. This is evidenced by hypothesis testing using the Independent Sample T Test which obtained a significant value (2-tailed) of 0.000. The significant value (2-tailed) falls in the rejection zone of the null hypothesis (H0) which means that the experimental class that was treated had a higher average character and learning outcomes than the control class. Thus it can be concluded that the experimental class that followed learning with the practicum method assisted by PhET media provided an increase in character and better learning outcomes than the control class that followed conventional learning. The results showed that learning with the PhET media-assisted practicum method obtained an average character posttest result of 83.75 and learning outcomes of 85.11, while the class taught with conventional learning obtained an average character posttest result of 77.71 and learning outcomes of 74.89. It can be concluded that the class that participated in learning with the practicum method assisted by PhET media provided an increase in character and better learning outcomes than the class that followed conventional learning.

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Author Contributions

BIP; designed the research concept, drafted the methodology, analysed the data, wrote the article, and carried out the research activities. SS; reviewing and evaluating every progress in article writing and research implementation.

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Conflicts of Interest

The authors declare no conflict of interest.

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