The Effect of Guided Inquiry Learning with Phyphox on Students' Science Process Skills and Learning Interest in Collision Topics

Muhammad Fajri Amrullah*, Agus Suyatna, Blasius Anggit Wicaksono, & Abdurrahman
[1]Physics Education Study Program, University of Lampung, Indonesia
*Corresponding Author: fajriamrllah@gmail.com

Received: 4th July 2025; **Accepted**: 14th August 2025; **Published**: 18th August 2025
DOI: https://dx.doi.org/10.29303/jpft.v11i1a.9328

Abstract - *This research is motivated by the importance of mastering science process skills (SPS) and fostering learning interest in physics, particularly on the topic of collisions, which is often perceived as abstract by students. The lack of learning approaches that actively engage students is one of the factors contributing to low conceptual understanding of physics concepts. In addition, the absence of technology integration in the learning process has hindered the optimal development of students' learning interest. Therefore, this study aims to examine the effect of implementing the Guided Inquiry Learning Model assisted by the Phyphox application on students' SPS and learning interest. The research was conducted at SMAN 1 Banjar Agung using a pre-experimental method with a one-group pretest-posttest design. The research sample consisted of students from class XI.5, designated as the experimental group. The instruments used included essay questions to measure SPS and a closed-ended Likert scale questionnaire to measure learning interest. Data analysis techniques involved normality tests, N-Gain analysis, and Paired Sample T-Test. The results revealed a significant improvement in both SPS and learning interest following the implementation of the learning model. This was evidenced by an N-Gain score of 0.598 for SPS and 0.525 for learning interest, both categorized as moderate. Furthermore, the Paired Sample T-Test results showed a significance value (2-tailed) of 0.000, which is less than 0.05, indicating a statistically significant difference between pretest and posttest results, as well as between students' initial and final interest levels. In conclusion, the implementation of the Guided Inquiry Learning Model supported by the Phyphox application is effective in enhancing students' science process skills and learning interest. This model provides contextual, interactive, and technology-based learning experiences, thereby increasing student engagement and deepening conceptual understanding. The use of digital tools such as Phyphox enables students to observe and analyze experimental data more effectively, contributing to a more meaningful and motivating physics learning process.*

Keywords: *Guided Inquiry, Learning Interest, Phyphox Application, Science Process Skills.*

INTRODUCTION

1. The Urgency of Science Process Skills

Physics is not merely about transferring knowledge, but also about a learning process that involves exploration, deep understanding, and practical application. Physics education emphasizes the importance of the scientific process, starting from observing, measuring, formulating hypotheses, to drawing conclusions from experiments. This process includes experimental activities and problem investigations that allow students to actively participate in the discovery of concepts. Student engagement in inquiry and problem-solving processes has proven to be more effective in enhancing physics understanding (Bao & Koenig, 2019; Uden et al., 2022; Dancy et al., 2024). This is where the role of science process skills becomes crucial.

2. Limited Facilities

The development of science process skills has become an integral component of physics education. These skills are essential for fostering higher-order thinking that emphasizes conceptual understanding of physics (Antonio & Prudente, 2024). Given the complexity of today's global challenges, these skills are also necessary for adapting to an ever-changing world (Ilhami et al., 2023). Real-world challenges in the field show that not all schools are able to provide adequate laboratory facilities. One clear example is found at SMAN 1 Banjar Agung, where physics instruction is still largely delivered through lectures, and the topic of collisions is taught only theoretically without any practical activities due to limited laboratory equipment.

3. Solutions through Technology

To overcome these limitations, the use of technology has become an innovative solution. One form of technology integration in physics education is the use of the Phyphox application, which allows students to conduct physics experiments using sensors on their smartphones. This app utilizes features such as accelerometers, magnetometers, and microphones to directly measure physical parameters (Kramer, 2024). In other words, Phyphox provides a hands-on laboratory experience without relying on conventional lab tools (Staacks et al., 2018). It is important to emphasize that Phyphox is not a replacement for traditional lab equipment but rather a supplementary tool that can enhance measurement accuracy, especially in experiments such as collisions.

Beyond assisting with experiments, the use of this application can also spark students' interest and curiosity (Staacks et al., 2018). Based on observations and exploratory interviews with several teachers and students at SMAN 1 Banjar Agung, only a small proportion of students (approximately 10%) showed a high level of interest in learning physics. The majority of students perceived physics lessons as boring, overly theoretical, and lacking in hands-on activities. These findings highlight the need for more engaging and contextual learning approaches. By providing an enjoyable and interactive learning experience through the Phyphox application, students are more actively involved and motivated to understand physics concepts (Tien et al., 2024).

4. Pedagogical Approaches

However, technology alone is not sufficient. An appropriate pedagogical approach is needed to fully optimize the benefits of Phyphox. This is where the guided inquiry learning model becomes important. This model encourages students to actively investigate and discover concepts through a structured scientific process (Juniar et al., 2017; Nainggolan, 2017). By integrating Phyphox into the inquiry syntax, students not only understand the theory but also directly experience the scientific process.

Recent studies have shown that the combination of the guided inquiry model and the Phyphox application can significantly improve students' science process skills and learning interest (Juniar & Sianipar, 2022; Staacks et al., 2018). Students become more proficient in collecting and analyzing data, and more motivated to learn due to the meaningful experiences they gain.

Therefore, by implementing the Guided Inquiry learning model supported by the Phyphox application, it is expected that students' science process skills and learning interest will improve. The guided inquiry model, through investigation processes, enables students to develop skills in collecting data from collision experiments supported by the Phyphox app. Furthermore, with the right strategies in place, limitations in equipment should not be a barrier to creating active, engaging, and meaningful physics learning.

RESEARCH METHODS

This study employed a pre-experimental method with a one-group pretest–posttest design, involving a single class as the experimental group. The group was given a pretest and posttest to measure Science Process Skills (SPS) and completed a learning interest questionnaire before and after the treatment. The sample consisted of 20 students from class X.5, selected using a purposive sampling technique, based on the consideration that the chosen class met the characteristics required for implementing the Guided Inquiry learning model assisted by the Phyphox application.

The treatment was conducted over four meetings, each with a duration of 70 minutes. Every session was designed with the structured implementation of the Guided Inquiry model and involved active participation from students.

The Guided Inquiry syntax implemented in the learning process followed six stages (Nulhakim et al., 2022), as follows:

1. Orientation: Students describe the context based on the problems presented.
2. Presenting the Problem: The teacher poses questions related to the scientific concepts behind the previously described problem.
3. Hypothesis Submission: The teacher asks students to propose hypotheses related to the questions given earlier.
4. Data Collection Stage: The teacher provides science-related content questions, scientific processes, and scientific attitudes for students to answer, which are used to test their hypotheses.
5. Hypothesis Testing: Students test their hypotheses using the data they have collected.
6. Conclusion Formulation: Students draw conclusions from the hypothesis testing based on the data collected.

The research instruments used in this study included a science process skills assessment in the form of test sheets and a learning interest questionnaire consisting of closed-ended statements with five categories: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), and Strongly Agree (SA). The SPS test was administered during the pretest and posttest and consisted of essay questions designed based on ten science process skills indicators: observing, measuring, inferring, classifying, predicting, communicating, controlling variables, hypothesizing, experimenting, and interpreting data (Zeidan & Jayosi, 2015). The learning interest questionnaire was distributed at the beginning and end of the learning process.

The collected data were analyzed in three parts: analysis of the SPS test, analysis of the learning interest questionnaire, and statistical analysis using several parametric statistical tests, including N-Gain calculation, Normality Test, and Paired Sample T-Test.

RESULTS AND DISCUSSION

Results

Before the test instrument was used, validity and reliability tests were conducted. The validity test results showed that all nine test items assessing Science Process Skills (SPS) on the topic of Collisions were valid, based on the correlation values between each item and the total score being greater than 0.36. Furthermore, the reliability test results showed a Cronbach's Alpha value of 0.644, indicating that the SPS test instrument for the topic of Collisions is considered reliable with a moderate level of reliability.

Table 1. N-Gain Mean Test Results

Class	Type	Score Achievement	
		Average N-Gain	Category
Experimental	SPS	0,59	Medium
	Learning Interest	0,52	Medium

The average N-Gain data presented in Table 1 shows that the experimental class achieved an average N-Gain of 0.598 for the science process skills (SPS) from the pretest to the posttest, which falls into the medium category. Meanwhile, for the learning interest data (questionnaire) from the beginning to the end of the learning process, the class achieved an average N-Gain of 0.525, which also falls into the medium category.

Table 2. Normality Test Results

	Sig.
*Pre test*_Experimental	0,57
*Post test*_ Experimental	0,07
*InitialInterest*_ Experimental	0,12
*EndofInterest*_ Experimental	0,09

The normality test results presented in Table 2 indicate that all data are normally distributed, as the significance values (Sig.) for the pretest, posttest, and learning interest in the experimental class are greater than 0.05 ($\alpha > 0.05$).

Table 3. Paired Sampe T-Test Results

	Sig. (2-*tailed*)
*Pre test*_Experimental *Pos ttest*_ Experimental	0,000
*InitialInterest*_ Experimental *EndofInterest*_ Experimental	0,000

The results of the Paired Sample T-Test presented in Table 3 show that the Sig. (2-tailed) value is 0.00 < 0.05. This indicates that there is a significant difference in the improvement of Science Process Skills (SPS) and learning interest before and after being taught using the Guided Inquiry learning model assisted by the Phyphox application in the experimental class.

Discussion

1. Impact on Science Process Skills

Students' Science Process Skills (SPS) in this research were measured using an essay-type test instrument consisting of nine questions, administered during the pretest and posttest. Figure 1 illustrates the improvement in SPS for each indicator, based on the pretest and posttest scores.

The diagram of students' improvement in Science Process Skills (SPS) presented in Figure 1 shows an increase across all SPS indicators in the experimental class after the implementation of the Guided Inquiry learning model assisted by the Phyphox application.

The most significant improvement occurred in the *data interpreting* indicator, which refers to students' ability to represent physics concepts in mathematical form. This skill is essential because, through data interpretation, learners can organize, analyze, and present data in various forms of representation, including mathematical models that quantitatively explain physical phenomena (Novitasari et al., 2023).

This improvement is closely related to the *Hypothesis Testing* stage in the inquiry model, where students directly collect and analyze real-time data using the Phyphox application. This activity is directly supported by Piaget's constructivist theory, which explains how such activities strengthen the active construction of knowledge through direct interaction with concrete data that is digitally visualized (Piaget & Inhelder, 1969).

The overall improvement across all SPS indicators was achieved through the implementation of the Guided Inquiry learning model assisted by the Phyphox application. The Guided Inquiry learning model focuses on students' skills in discovering physics concepts through practical activities. This is in line with Suoth et al. (2023), who state that this learning model involves an investigative process and can be effectively applied in practicum-based physics learning.

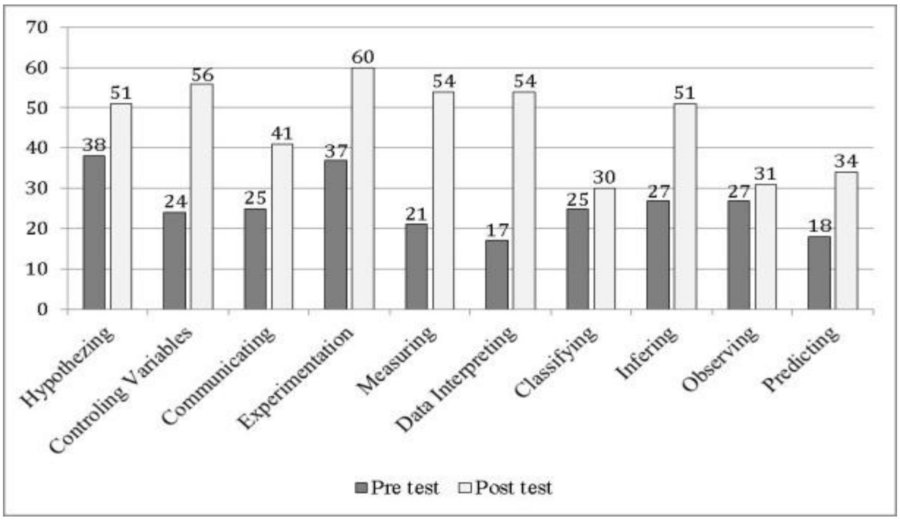

Figure 1. KPS improvement diagram for each indicator

Each stage in the Guided Inquiry learning cycle is connected to specific SPS indicators, such as: *Observing* and *Classifying* in the Orientation stage; *Predicting* in the Presenting the Problem stage; *Hypothesizing* in the Hypothesis Submission stage; *Controlling Variables*, *Experimentation*, and *Communicating* during the Data Collection stage; then *Measuring* and *Data Interpreting* in the Hypothesis Testing stage; and finally, in the Conclusion Formulation stage, the *Inferring* skill is practiced.

Figure 2. Student Practical Activities

Through involvement in scientific activities, students are able to construct their own understanding and knowledge throughout the learning process. When knowledge is gained independently, the learning becomes more meaningful. Students also need to be actively engaged in the learning process, including during practicums, to get accustomed to facing various challenges. The application of the Guided Inquiry model, based on constructivist theory, facilitates active engagement and student reflection through the stages of exploration, investigation, and data analysis. This reinforces that the Guided Inquiry model is effective in developing SPS, as each stage of the model systematically promotes the improvement of students' scientific skills (Adirahayu & Wulandari, 2021; Putri et al., 2022; Ilham & Tiodora, 2023).

2. Impact on Learning Interest

The use of the Phyphox application in physics experiments has been proven to significantly increase students' learning interest. Learners felt that the lessons became more enjoyable, interactive, and less monotonous compared to conventional learning.

The integration of smartphone-based experiments allows students to directly engage with the processes of data collection and analysis. This enhances their motivation and curiosity, as reflected in their active participation in both discussions and experiments. These findings are consistent with Sahlan et al. (2021), who reported that physics learning assisted by Phyphox can substantially improve students' interest.

Furthermore, peer discussions and interactions with teachers during activities fostered a more meaningful and collaborative learning atmosphere, while also encouraging students' emotional engagement in the learning process.

3. Theoretical Alignment

The results of this study are consistent with constructivist learning theory, particularly Piaget's idea that students build knowledge through active interaction with their surrounding environment. The Guided Inquiry model supported by Phyphox provides appropriate scaffolding, enabling students to develop conceptual understanding through experience, exploration, and reflection.

This learning process also reflects Vygotsky's concept of the Zone of Proximal Development (ZPD), in which students, through guidance from the teacher and collaboration with peers, are able to accomplish tasks that would initially be difficult to complete independently (Salsabila & Muqowim, 2024).

The real-time data visualization provided by Phyphox serves as an effective cognitive tool in the internalization of scientific concepts. This reinforces the view that technology, when meaningfully integrated into inquiry-based learning, can deepen the construction of concepts and the development of scientific skills.

4. Pedagogical Implications

This study highlights the pedagogical potential of integrating the Guided Inquiry model with digital technology in physics learning. The Phyphox application offers a practical and cost-effective solution for conducting experiments, especially in schools with limited laboratory facilities. Teachers are encouraged to adopt this approach to: enhance students' active participation and scientific thinking skills, address low interest in learning physics, and provide an effective and easily accessible alternative for practical work.

This model also encourages deeper understanding, improves process skills, and strengthens students' learning motivation. Therefore, it is highly relevant for implementation in modern physics education.

The above discussion shows that students taught using the Guided Inquiry learning model assisted by the Phyphox application are empowered to connect new experiences with prior knowledge. This model focuses on students' skills in discovering physics concepts through practical activities, which are carried out through investigative processes and can be applied in practicum-based physics learning. Through practical activities, students can become more motivated to learn, verify the basic theories studied in class, and enhance their skills (Suoth et al., 2023).

CONCLUSION

The results of this research indicate that the Guided Inquiry learning model assisted by the Phyphox application is effective in improving students' science process skills and learning interest on the topic of collisions. This is evidenced by the average N-Gain scores of the experimental class, which was taught using the Guided Inquiry model with Phyphox assistance, reaching 0.59 and 0.52 respectively.

The hypothesis testing results, particularly the Paired Sample T-Test, produced a Sig. (2-tailed) value of 0.000 < 0.05, confirming a significant improvement in students' science process skills and learning interest before and after being taught using the Guided Inquiry model assisted by the Phyphox application.

Recommendations for future research include implementing or developing instructional modules using the Guided Inquiry model assisted by the Phyphox application, specifically designed for other physics practicum needs such as Raw Sensors, Acoustics, Everyday Life, Timers, Tools, and other topics in Mechanics. This would enable more complex practicum activities and support the enhancement of students' skills.

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