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Guided Inquiry Worksheets with Teaching Aids: Improving Students' Scientific Literacy

Vina Bekti Utami[1,a)], Wulandari Fitriani[1], Haris Suhendar[2]

[1] Department of Physics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta 13220, Indonesia
[2] Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta 13220, Indonesia

✉: [a)]vina.bekti@unj.ac.id

Abstract

This study aims to improve students' scientific literacy through the use of worksheet integrated with guided inquiry aided by teaching aids. This study used a Pre-Experimental design with a One-Group Pretest-posttest design conducted in 1 class. The subjects of the study were students of Phase D of Mtss Persis Cikalongkulon. Data collection techniques were pre-test and post-test (scientific literacy) and questionnaires. Worksheet-guided inquiry aided by teaching aids was declared very feasible by expert validators and practitioners (science teachers) and effective in improving students' scientific literacy with an N-Gain of 0.51 which is included in the moderate category. The practicality of worksheet has an average score of 35.87 out of a maximum total score of 48 and these results are in the good category. Based on the questionnaire of students' interest in learning, the results showed that 80% of students felt the learning atmosphere was more active and enjoyable.

Keywords: student worksheet, guided inquiry, teaching aids, scientific literacy

INTRODUCTION

Global competition in the Industrial Revolution 4.0 era poses a challenge for all sectors, especially the education sector (Ghobakhloo, 2020). The development of science and technology in learning resources, strategies, and materials has influenced the teaching and learning process. The increasingly advanced development of science and technology also demands specific skills beyond reading, writing, and arithmetic (old literacy) (Anisimova, 2020). Literacy skills influence the success of the younger generation. One of the Indonesian government's policies, the new literacy movement, is scientific literacy. Scientific literacy skills are relatively low in several aspects, such as explaining phenomena scientifically and identifying scientific topics (Yacoubian, 2018; Sutiani, 2021; Valladares, 2021). This is because learning is still oriented towards memorization. The majority of learning is still lecture-based, rarely using interactive media to support the learning process (Keiler, 2018). Teachers often teach formulas rather than conceptual understanding. Learning is more often theoretical than practical/experimental (Kang & Keinonen, 2018; Čavojová et al., 2020). Indicators of scientific literacy relate to problem-solving and the use of scientific evidence (competence) (Valliere, 2022) and knowledge (Queiruga, 2020; Sutiani, 2021). These aspects need to be improved so that students can compare experimental data with theory (Shaffer et al., 2019; del Junco, 2024; Iddy, 2024).

Based on the problems described, teachers need appropriate strategies, learning tools, and media to achieve learning objectives. One of the learning tools needed is a Student worksheet integrated with a

guided inquiry learning model assisted by teaching aids. This model provides opportunities for students to build understanding through scientific exploration (Husnaini & Chen, 2019; Haryadi & Pujiastuti, 2020). Students can develop analytical and problem-solving skills systematically (Kang, 2022). Direct student involvement in this learning process makes students more active and have a more meaningful learning experience compared to lecture learning (Al Mamun et al., 2022). With guided inquiry, students become accustomed to investigating phenomena, interpreting, and analyzing data (important indicators of scientific literacy) (Margunayasa et al., 2019; Wen et al., 2020). In addition to the use of guided inquiry worksheet in learning, spring force teaching aids are also used as interactive media to help students understand abstract concepts. Teaching aids allow students to conduct experiments/practice (Mulhayatiah et al., 2019; Ahmad et al., 2024). Worksheet assisted by teaching aids on spring material was created because the concept of force, Hooke's Law, is still difficult to understand because it is abstract (Hidayatulloh, 2020). By using spring teaching aids, students can directly observe the increase in spring when given mass/force. This will help them understand the relationship between force, elongation, and spring constant.

Several previous studies have shown that guided inquiry-based learning can improve scientific literacy (Kang, 2022) On the other hand, instructional media have been proven to help students in understanding abstract concepts as well as enhancing learning motivation. In addition, the use of interactive quiz platforms such as Quizizz has also been found to foster active student participation and provide a more engaging and real-time evaluation experience (Göksün & Gürsoy, 2019; Anak Yunus & Hua, 2021; Desai & Kulkarni, 2022). Guided inquiry-based worksheets have further been shown to improve students' mathematical communication skills (Fara, 2019). Nevertheless, no study has systematically integrated these three components into a comprehensive instructional design with a primary focus on enhancing students' scientific literacy. Therefore, this study aims to produce student worksheets – guided inquiry assisted by teaching aids so as to improve students' scientific literacy.

METHODS

Research Design and Research Subject

The research design used a pre-experimental design with a one-group pretest-posttest design. The research subjects for the application of worksheet – guided inquiry assisted by teaching aids consisted of 32 Phase D students at MTss Persis Cikalongkulon Cianjur. The following research design uses a one-group pretest-posttest in TABLE 1.

TABLE 1. Research Design

Pretest	Treatment	Postest
O_1	X	O_2

O_1 indicates a scientific literacy test given to students before the lesson (pretest). X indicates learning in the form of a guided inquiry worksheet with the aid of teaching aids. Meanwhile, O_2 indicates a scientific literacy test after the students participated in the lesson (posttest). This research was conducted during the learning process of spring force and its application in the 2024/2025 academic year.

Research Procedure

The research procedure consisted of three phases: planning, implementation, and final analysis. The study began with preliminary observations and interviews with science teachers to obtain an overview of the learning context at the school. Observations indicated that MTss Persis Cikalongkulon is equipped with classrooms, a prayer room, a teachers' lounge, and a hall, but lacks a science laboratory and has limited infrastructure, particularly practical equipment. The school has been implementing the Merdeka (Independent Curriculum) for the past year.

Interviews with educators revealed that the predominant teaching methods employed were lectures, discussions, and question-and-answer sessions, with direct instruction being the primary learning

model. The use of instructional media such as presentations, student worksheets, teaching aids, and interactive quizzes was still rarely integrated into the learning process.

At the planning stage, the researchers analyzed the subject matter related to spring force, including its facts, principles, laws, and theoretical foundations, as well as its practical applications. Based on this analysis, student worksheets were developed by incorporating spring balance as a teaching aid, guided inquiry as the learning model, and supplementary media in the form of learning videos and interactive quizzes (Quizizz) for formative assessment.

The scientific literacy assessment instrument was designed in the form of a pretest and posttest, consisting of three descriptive questions on the topic of spring force and its applications. Both the guided inquiry-based student worksheets (supported by teaching aids) and the scientific literacy test instrument were validated by expert reviewers, comprising two university lecturers and one science teacher as a practitioner. Following validation, the instruments were deemed feasible for use in the implementation phase, during which the intervention was carried out to measure students' scientific literacy. The final phase involved data analysis and the formulation of conclusions.

Data Analysis

The improvement in students' scientific literacy after participating in learning through guided inquiry-based student worksheets supported by teaching aids was measured using the normalized gain (N-Gain) score. The N-Gain value was calculated using EQUATION 1 and categories for N-Gain values in TABLE 2.

$$N\ Gain = \frac{postest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (1)$$

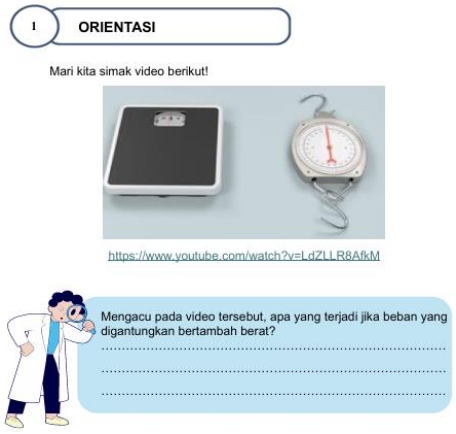
TABLE 2. Classification of N-Gain scores

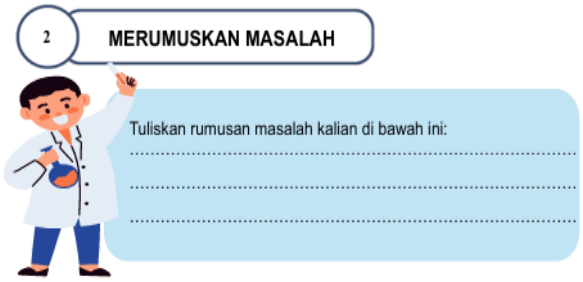
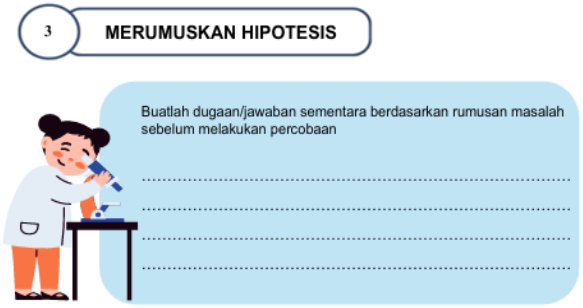
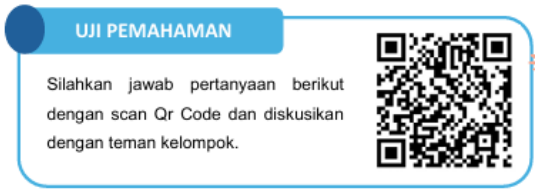
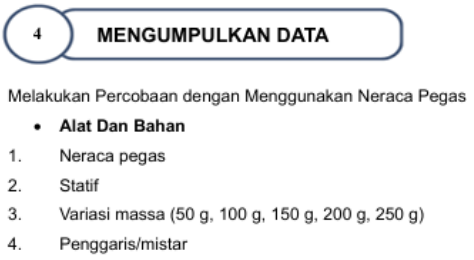
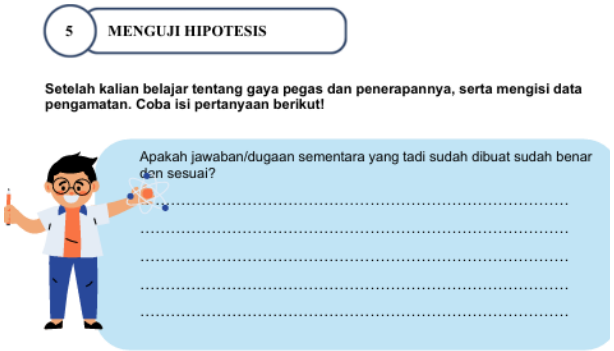
N-Gain scores	Category
$\langle g \rangle \geq 0.7$	High
$0.3 \leq \langle g \rangle < 0.7$	Moderate
$\langle g \rangle < 0.3$	Low

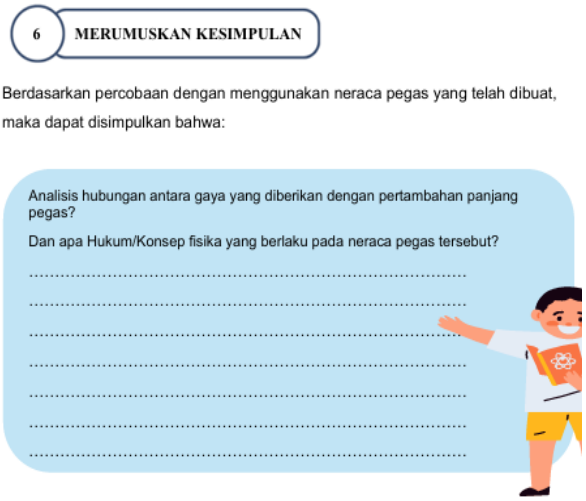
Guided Inquiry

The learning stages in this study used the syntax of the guided inquiry learning model. The syntax of the discovery learning model consists of orientation, problem formulation, hypothesis formulation, data collection, hypothesis testing, and conclusions. Learning activities using the guided inquiry learning model are presented in TABLE 3.

TABLE 3. Syntax of the Guided Inquiry Model

Syntax of the Guided Inquiry	Learning Activities	Design of Student Worksheet
Stage 1: Orientation	Students observe phenomena or the application of spring force in everyday life through videos presented by the teacher.	

Syntax of the Guided Inquiry	Learning Activities	Design of Student Worksheet
Stage 2: Problem Formulation	Students formulate questions or problems that arise from the observed phenomena.	
Stage 3: Hypothesis Formulation	Students write a hypothesis based on prior knowledge and group discussion	
Stage 4: Data Collection	Students conduct experiments, observe, and record the results of the experiment using a spring balance.	 
Stage 5: Hypothesis Testing	Students compare the data with the hypothesis to determine its validity.	

Syntax of the Guided Inquiry	Learning Activities	Design of Student Worksheet
Stage 6: Conclusions	Students draw conclusions based on the results of hypothesis testing and communicate their findings both orally and in written form	

The teacher distributed simple spring balances to five groups, as illustrated in FIGURE 1. Students were instructed to complete the student worksheet by varying the mass using the spring balance and responding to the questions provided. through this activity, students were expected to apply and demonstrate their scientific literacy skills.

FIGURE 1. Spring balance

Figure 1 illustrates the spring balance apparatus used by students in the lesson. The components consist of the spring balance, hook, slotted masses, clamp holder, base support, and retort stand. The student worksheet with a guided inquiry learning model is adapted to the characteristics of MTs students. This worksheet is adapted to the steps of guided inquiry learning, which include orientation, problem formulation, hypothesis formulation, data collection, hypothesis testing, and conclusions. The worksheet is equipped with a video link related to the application of spring force in everyday life. The worksheet directs students to conduct experiments using a spring balance. This learning process is assisted by using teaching aids in the form of spring balance. There are formative evaluation questions using Quizizz in each sub-chapter of the material as shown in FIGURE 2.

FIGURE 2. Quizizz interface used in the learning process

The appearance of the guided inquiry student worksheet assisted by teaching aids can be seen in FIGURE 3 below.

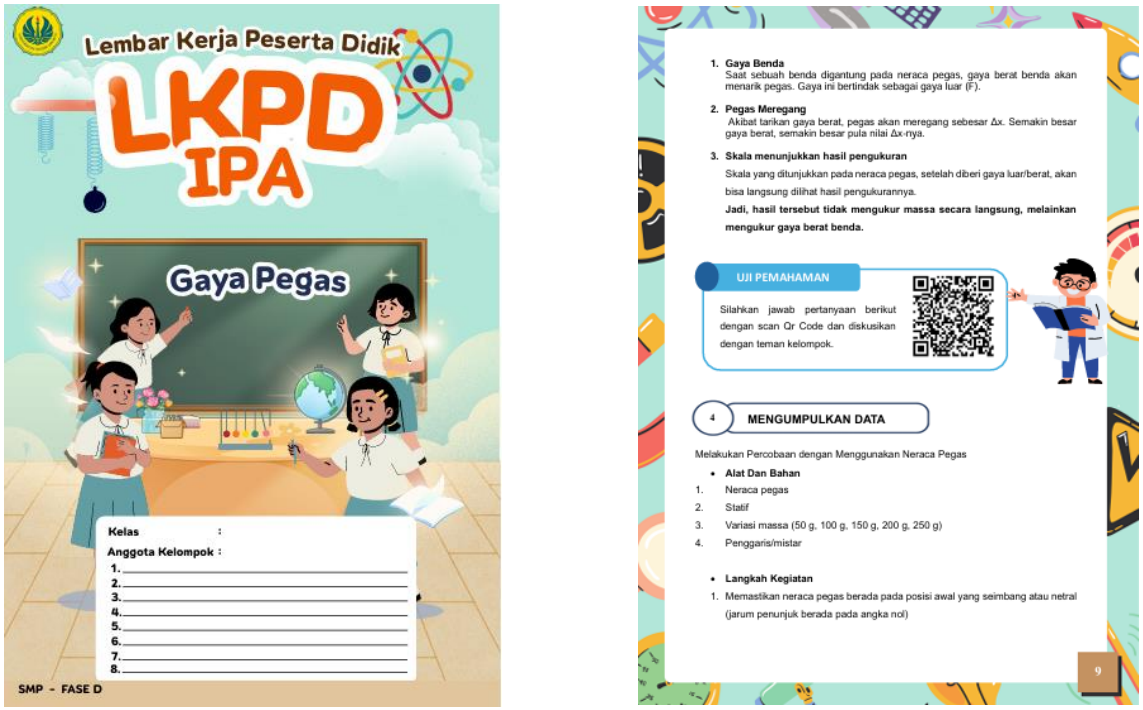


FIGURE 3. Layout of the guided inquiry student worksheet

The scientific literacy assessment instrument consists of a pretest and a posttest. The scientific literacy assessment instrument consists of three descriptive questions on the topic of spring force and its applications. Scientific literacy indicators can be seen in TABLE 4 below.

TABLE 4. Scientific literacy indicators

Question	Aspects of Scientific Literacy	Scientific literacy indicators
Question 1	Content: Understanding of fundamental scientific concepts, such as theories or laws, that are connected to real-world contexts.	Understand scientific concepts/scientific theories that apply in everyday life.

Question	Aspects of Scientific Literacy	Scientific literacy indicators
Question 2	Competence: Interpretation of data and scientific evidence.	Describes a clear and logical relationship between evidence and conclusions or decisions.
Question 3	Context: Understanding of scientific issues or problems in national situations.	Describe the science and technology problems presented in the article

RESULTS AND DISCUSSION

The feasibility of the student worksheets was determined based on the validation scores given by experts and practitioners on a scale of 1 to 4, while the practicality was assessed from students' responses to the worksheets and the learning process. The validation results are presented in TABLE 5.

TABLE 5. The validation results

Aspect	Score	Category
Validation by learning experts		
Learning Alignment	3.87	Very Feasible
Integration of Guided Inquiry	4	Very Feasible
Validation by media experts		
Design of the Worksheet Layout	4	Very Feasible
Quality of Content/Instructional	3.75	Very Feasible
Interactivity and Student Engagement	3.67	Very Feasible
Integration of Teaching Aids	4	Very Feasible
Validation by subject-matter experts		
Content	4	Very Feasible
Integration of Guided Inquiry	4	Very Feasible
Language	3.83	Very Feasible
Teaching Aids	3.83	Very Feasible
Validation by practitioners		
Content	3.7	Very Feasible
Layout and Design	3.7	Very Feasible
Usability	4	Very Feasible
Language	4	Very Feasible
Integration of Teaching Aids	4	Very Feasible

Based on the assessment of the feasibility of the student worksheets by expert validators and practitioners, the results obtained were that the assessments from all validators for the student worksheets were in the very feasible category. The pretest was administered before the class received the guided inquiry worksheets with aids, while the posttest was administered after the lesson. The scientific literacy descriptive test instrument consists of three descriptive questions. Validity assessment of the questions found that all questions were valid for measuring scientific literacy skills. Students' scientific literacy skills were measured using pretest and posttest results. The average pretest and posttest scores are presented in TABLE 6.

TABLE 6. Average Score of Pretest - Posttest of Scientific Literacy

Pretest			**Posttest**		
Min	Max	Mean	Min	Max	Mean
55	70	65.78	75	85	83.22

Based on the table, the results show that the average posttest score is higher than the average pretest score. The results of the pretest and posttest of scientific literacy are presented in the form of a diagram in FIGURE 4.

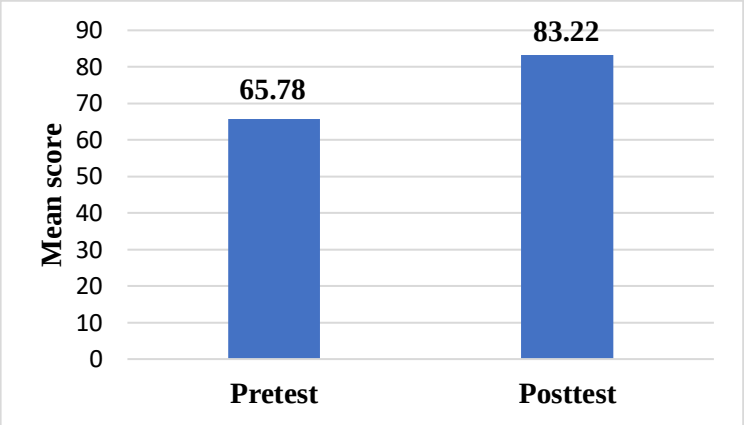


FIGURE 4. Pretest and posttest of scientific literacy

The increase in scientific literacy skills can be obtained through the normalized gain (N-gain) value. Using the equation, the N-gain is 0.51, which is in the moderate category. Therefore, it can be concluded that there was an increase in students' scientific literacy between before and after using the student worksheet. Therefore, it can be concluded that the use of student worksheets is effective in facilitating learning and in enhancing students' scientific literacy. This finding is consistent with the results reported by Syamsidar (2021).

The practicality of the student worksheets was assessed by students by completing a questionnaire. Data and analysis of student responses to the readability of the student worksheets showed that the student worksheets obtained an average total score of 35.87 out of a maximum total score of 48 and these results were in the good category. Based on the student interest questionnaire, the results showed that 80% of students were happier and more active in learning activities and understood the material better. The present pre-experimental study may serve as a foundation for subsequent research by adopting a more rigorous research design and involving a larger sample to strengthen the validity and generalizability of the findings.

CONCLUSION

The findings of this study indicate that the use of guided inquiry-based student worksheets supported by teaching aids is effective in improving students' scientific literacy. This is evidenced by the increase in the average pretest and posttest scores, with an N-Gain value of 0.51, categorized as moderate. The developed worksheets were evaluated as highly feasible by expert and practitioner validators and demonstrated good practicality, with an average score of 35.87 out of 48. Furthermore, 80% of students reported that the learning process became more active, enjoyable, and helped them better understand the material. Therefore, the student worksheets developed in this study are not only feasible and practical but also have a positive impact on students' scientific literacy and engagement in learning. Given that this study employed a pre-experimental design with a limited sample, future research is recommended to adopt more rigorous designs. Expanding the research to include larger and more diverse student populations from different schools or educational levels would provide broader insights.

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