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The INoSIT (Integration Nature of Science in Inquiry with Technology) Model to Enhance the Scientific Literacy Skills of Junior High School Students: Development of Student Worksheet-Based *Flip PDF Professional*

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ABSTRACT
The research's goal was to create student worksheets based on the INoSIT model with the help of Flip PDF Professional that met the criteria for validity, applicability, and effectiveness to improve junior high school students' scientific literacy competence. The study adopted a research and development (R&D) design with a 4-D model. The student worksheets were tested at Junior High School 10 Kendari using one-group pretest-posttest design involving science teachers as observers. The research subjects for the limited trial were 15 students, and the extensive test was conducted with 27 students. Three validators provided personal validation of the student worksheets, which led to the collection of practicality data through observation sheets on the application of learning, student activities, teacher and student response questionnaires, and effectiveness data through science literacy test instruments. The research showed that the INoSIT model student worksheets fell into valid and reliable categories. For the limited and extensive trials, the n-gain <g> analysis results on measures of science literacy, like being able to explain scientific phenomena, were 0.632 and 0.712, respectively. This means that they were in the moderate to high category. Furthermore, regarding evaluating and designing scientific inquiries, the average normalized gain was 0.541–0.580, indicating an intermediate category. Similarly, on the indicators of interpreting data and scientific evidence, the average normalized gain was 0,510-0,572, indicating a moderate category. Based on this data, the INoSIT model student worksheets were considered practical and effective in improving the scientific literacy competence of junior high school students.

INTRODUCTION

In the 21st century, advancements in science and technology have progressed rapidly, and technology can control everything. The progress of science and technology has positive and negative impacts on human life. Takda & Budi Jatmiko [1] say that positive effects arise due to various conveniences that can enhance the quality of human life. In contrast, global warming, the depletion of energy resources, and the emergence of various environmental pollutants are examples of the negative impacts of progress in science and technology. In facing the negative impacts of the progress in science and technology, there is a need for individuals with a caring and responsive ability toward evolving societal issues. These individuals should possess profound knowledge and understanding to solve problems, making being scientifically literate essential. A scientifically literate person has two abilities: (1) understanding the relationship between the universe, science, and technology, and (2) applying scientific knowledge and skills individually to make decisions and analyze social issues [1]. The OECD defines scientific literacy as learners' competency to explain natural phenomena scientifically, design and evaluate scientific inquiry activities, and interpret data and scientific evidence to make decisions and solve problems [2]. There are three competencies inherent in scientific literacy: (1) explaining phenomena scientifically, (2) evaluating and designing scientific inquiries, and (3) interpreting data and evidence scientifically [3].

Science literacy is a person's skill to understand scientific concepts and processes, ask relevant questions, and make decisions based on scientific evidence in their daily lives [4]. Science literacy includes an understanding of the content of science, scientific methods, and the impact of science on society and the environment. Science literacy can encompass all disciplines. This is one of the critical components in supporting the success of students. However, the latest report shows that literacy skills in Indonesia have remained relatively low over the past five years despite various efforts to improve them. Nathanel [5] report showed a significant improvement in digital literacy research, with a focus on quantitative methods and high school students. However, more digital literacy skills must be developed, especially among teachers and young students. Murdy & Ekawati [6] stated that mathematical literacy among Indonesian students is also a concern, where students show varied competencies and generally perform below international standards. Students can achieve high mathematical skills at a higher level, but the average literacy level still needs to be higher. Implementing the school-based literacy movement (School Literacy Movement) has shown several improvements in literacy competence and character building. But their effectiveness varies, and challenges such as inconsistent reading habits among teachers and students still exist [7].

Meanwhile, digital literacy skills were found to have a dominant impact on students' meta-cognitive listening strategies, which shows this importance in improving literacy [8]. The development of language skills and literary abilities in elementary schools was influenced by teachers, learning techniques, learning materials, and socio-cultural factors [9]. Fayanto et al. [10] present that using student textbooks is one of the causes of students' low levels of scientific literacy. Learning resources in science education are still predominantly limited to textbooks or texts rather than hands-on learning. Relying solely on textual knowledge and the application of scientific literacy only partially engages students, resulting in dull lessons, and students may need help understanding the subject matter in real life. The Policy Research Center recommended several efforts to enhance students' scientific literacy, including promoting student literacy activities through the *School Literacy Movement* (GLS) program and fostering students' reading habits by improving teachers' competence in teaching and enhancing the use of learning resources [11]. Research conducted by Suparya et al. [12] and Rusilowati et al. [13] proposed solutions to improve students' scientific literacy, one of which was the enhancement of textbooks. Teachers must develop their textbooks according to curriculum requirements, applying a scientific approach, innovative models, methods, strategies, and learning techniques. By having these textbooks, teachers could improve students' understanding of the concepts taught by connecting them to the realities of their daily lives. Teachers must be able of innovating to address these issues by developing inquiry-based science teaching materials to enhance students' scientific literacy. One alternative teaching model that teachers can utilize is the INoSIT teaching model.

The INoSIT model is an instructional model that develops inquiry-based teaching with the assistance of information and communication technology (ICT) or in terms of the integrated nature of science (NoS) in inquiry technology (INoSIT). The INOSIT model, also known as the Integration Nature of Science in Inquiry with Technology model, is designed to improve science literacy among students. This model integrates information and communication technology (ICT) with inquiry-based learning (IBL) and the nature of science (NoS) models. It employs a multi-representation method and simplifies the phases of other models like the BSCS 5E and IBL to create a more effective and efficient learning process. The model's syntax includes steps like Eliciting, Hypothesis, Testing Hypothesis, Elucidation, and Reflection, which helps construct students' knowledge and promotes creativity and inquiry-based learning [14]. The INoSIT model can teach scientific literacy for both concrete and abstract concepts. Concrete concepts require the use of laboratory equipment or kits, while abstract concepts necessitate the use of technology in the form of interactive simulations [14]. The advantages of the INOSIT model are that the INOSIT model is designed to improve students' science literacy by integrating information and communication technology (ICT) with inquiry-based learning (IBL) and the nature of science (NoS) models. This approach helps students better understand and engage with scientific concepts [14]; The model is particularly effective for teaching scientific literacy of abstract concepts, which can be challenging using traditional methods [14]. A preliminary study of Amir et al. [14] about the INOSIT model, which combines information and communication technology with inquiry and nature of science (NoS) methods, improving students' science literacy competence. This design simplifies learning and effectively construct students' science literacy knowledge. One of INOSIT's core competencies is students' inquiry ability. In general, inquiry has also improved students' science literacy. For example, inquiry-based learning with a prediction-observation-explanation approach has significantly improved students' science learning performance, impacting their literacy skills [15].

There are many ways to improve literacy and education, starting with digital-based learning facilities, online learning platforms, and digital media [16] [17]. Optimizes things and support learning literacy, learning resources are chosen as a reference to support science literacy, among other things, by providing learning resources and worksheets that are easy to access and use. This is undoubtedly crucial, as accessibility and convenience enable students to access materials from any location while preparing an online worksheet. Student Worksheets are print-based learning media that guide students to do activities or assignments individually and in groups [18]. Sutama et al. [19] student worksheet is one of the teaching materials that aims to improve students' understanding in the classroom through adequate preparation and utilization. Student worksheets are educational tools that encourage students to learn actively. student worksheet has been proven to improve students' thinking skills and social interaction and facilitate learning.

Student worksheets are educational tools designed to engage students in active learning. Using student worksheets has been proven to improve students' thinking skills and social interaction and facilitate the learning process [20] [21] [22]. Typically, they contain exercises, problems, and activities related to the subject matter being taught. Using student worksheets has been proven effective in supporting science literacy in various educational contexts. Student worksheets developed with a science literacy orientation on hydrolysis materials showed high validity, practicality, and effectiveness, with an average N-gain <g> 0.88 in the high category. This indicates that the student worksheet strongly supports the improvement of students' science literacy during the pandemic [23]. Meanwhile, the evaluation showed that this student worksheet effectively improved students' science literacy in Physics and Biology, with a favourable student response [24]. So, by looking at this potential, the support of software or auxiliary tools in supporting student worksheets is significant to get optimal results, one of which is by using Flip PDF professional.

Flip PDF Professional is a software application designed for creating and publishing digital publications with a realistic page-flipping effect. This tool is widely used for developing interactive e-books, e-magazines, e-brochures, and other digital documents. The software allows users to convert PDFs into interactive, media-rich flipbooks with embedded videos, links, images, and animations. Flip PDF Professional has effectively developed interactive e-modules and e-books across various educational contexts. For example, it has been used to create temperature and heat e-modules in physics, which received high validation scores from material experts and positive responses from students and educators [25]. Teaching materials that teachers can use in the learning process include student worksheets. Research shows that e-books created with Flip PDF Professional can significantly improve students' higher-order thinking skills and engagement in learning activities, as demonstrated in science lessons [26]. From a validity perspective, the worksheets were deemed valid, allowing them to be disseminated or utilized as an alternative teaching tool for science learning in junior high schools. Additionally, the study of Exanti & Widodo [27] showed that using guided inquiry activity sheets for students to learn about fluid pressure significantly improved their scientific literacy, with an overall score of 90.12% from three validators, making it a highly valid study.

Recent studies have shown that student worksheets are an effective tool in improving scientific literacy among students. Research involving various subjects, such as biology and physics, shows that using these worksheets can significantly enhance students' understanding. Research has shown that using worksheets in physics classes has become a successful practice, improving students' learning of fundamental physics concepts and problem-solving skills, thereby increasing learning activity [28]. Meanwhile, research has focused on developing and testing student worksheets in biology and physics, with results showing high feasibility and positive acceptance from experts and students [20] [29]. However, there are shortcomings in the research that has been conducted, where most of it is limited to the validation stage of the product without conducting trials to evaluate its effectiveness and sustainability in student worksheets [30] [31] [32]. In addition, the trials carried out are limited to the initial trial stage and have not yet reached the stage of deployment or implementation on a broader scale. In addition, the student worksheets developed are still in print form, so they need to be converted into digital and interactive formats (electronic student worksheets) that can be accessed by students easily and flexibly. Based on the gap analysis results, student worksheets were developed for extensive testing among students and created in a digital format to make them widely accessible. Therefore, a study was carried out to establish student worksheets of the INoSIT model with the help of the Flip PDF Professional application to improve students' scientific literacy competencies in fluid pressure and its application. This study aims to develop student worksheets based on Flip pdf professional to support students' science literacy skills.

METHOD

Reserach Design

Research design using the Research and Development (R&D) method with the adopted 4D model (Define, Design, Develop, Disseminate) is a systematic approach to developing products or learning materials. The first stage, Define, aims to identify development needs and objectives through needs analysis and determination of initial specifications of the product or material to be developed [33]. Furthermore, the design stage involves designing a product or material based on specifications determined at the Define stage. This design includes the structure, content, and format of the product or material [34]. In the development stage, a prototype of a product or material is developed based on the design that has been made, which is then tested to ensure its functionality and effectiveness [35]. The development stage is a limited trial using a one-group pretest-posttest design This study is a research study related to the development of student worksheets, so it is only limited to the development level. Meanwhile, the following study will continue in the final stage, Disseminate, involving the dissemination and implementation of the product or material that has been developed, including final evaluation and adjustments based on user feedback. The dissemination stage is a limited trial using a one-group pretest-posttest design [36]. These 4D models effectively ensure that the product or material developed meets the user's needs and has good quality.

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Population & sample
This study uses a research and development approach conducted in the second semester of the 2022–2023 school year. A limited trial was conducted at one school, SMA Negeri 10 Kendari. In this limited trial, the research subjects comprised 15 grades VIII–4 students. This limited trial identified and corrected deficiencies in material or learning method development. This allows researchers to make necessary revisions and adjustments before conducting a broader trial. Furthermore, this study also involved extensive testing in class VIII-1, with 27 students. The comprehensive test aimed to assess the effectiveness and practicality of the revised learning material or method based on the findings from the limited trial. Through this approach, the researchers hope to obtain more comprehensive data on student acceptance of the material or learning method.

Research Instrument
The instruments used in this study were divided into three parts—the first instrument aimed to assess the feasibility of the developed student worksheets. The second instrument focused on the practicality of using student worksheets, including aspects related to lesson implementation, student activities, and teacher and student responses. The third instrument measured the effectiveness of student worksheets by assessing student learning outcomes through pretests and posttests. The data in this research included the validity of student worksheets, practicality data, and the effectiveness of the INoSIT teaching model. The validity of student worksheets was obtained through validation sheets, while practicality data were collected through instruments assessing lesson implementation, student activities, and questionnaires on teacher and student responses. Effectiveness data were obtained through a science literacy test instrument.

Data analysis techniques
Data analysis techniques employed in this study included analyzing the validity of student worksheets and test instruments, lesson implementation, student activities, teacher and student responses, and science literacy test assessments. Using Aiken's [37] equation, it was possible to evaluate the validity of student worksheets.

Table 1. Validator Agreement Index (*V*)

Validator Agreement Index	Interpretation of Validator Agreement Values
$0.80 < V \leq 1.00$	High
$0.40 < V \leq 0.80$	Medium
$0.00 < V \leq 0.40$	Low

The inter-observer agreement, found through statistical analysis of the percentage of agreement (R), was also used to look at reliability.

$$R = \left(1 - \frac{A - B}{A + B}\right) \times 100\% \tag{1}$$

Where R is the reliability coefficient, *A* is the score of the higher validator, and *B* is the score of the lower validator, an observation instrument is considered good if it has a reliability coefficient of ≥ 75%. An analysis of the data on the implementation of the INoSIT teaching model was obtained from observers, providing a score range from 1 to 4, where a score of 1 means not good, a score of 2 means less good, a score of 3 means good, and a score of 4 means very good. Based on the scores given by the observer, they were subsequently consulted against the established criteria.

Table 2. Criteria for Assessing the Implementation of INoSIT Model Learning

Score indicator	Information
3.25 < Score ≤ 4.0	Very good
2.50 < Score ≤ 3.25	Good
1.75 < Score ≤ 2.50	Less good
1.0 < Score ≤ 1.75	Not good

Students' activities in participating in the INoSIT teaching model were analyzed descriptively and quantitatively in the form of percentages using equation (2):

$$P = \frac{f}{N} \times 100\% \quad (2)$$

Data on teacher and student responses to the teaching was obtained by distributing questionnaires to teachers and students. The percentage data of teacher and student responses were analyzed descriptively and qualitatively using the Guttman scale. If a teacher or student answered "Yes," they were assigned a value of 1; if they answered "No," they were given 0. The assessment categories for teacher and student responses can be seen in Table 3

Table 3. Assessment Category for Teacher and Student Responses

Percentage Vulnerable Assessment	Category
0% - 20%	Not good
21% - 40	Less good
41% - 60%	Pretty good
61% - 80%	Good
81% - 100%	Very good

To determine how well the INoSIT teaching model helped students learn, the normalized gain (n-gain) from the pre- and post-tests on the science literacy competence instrument was analyzed based on the average normalized gain (g).

$$g = \frac{\%(G)}{\%(G)_{max}} = \left(\frac{\%(S_f) - \%(S_i)}{(100\% - \%(S_i))} \right) \quad (3)$$

With the categories in equation (3), the normalized gain value criteria are presented in Table 4.

Table 4. Normalized gain Criteria [38]

N-gain score	n-gain criteria
g>0.7	High
0.3< g ≤ 0.70	Medium
g ≤ 0,3	Low

The INoSIT teaching model is considered effective in enhancing scientific literacy competence if the average normalized gain achievement level is at least in the moderate category. Suppose the average normalized gain all below the medium category. In that case, revisions are made based on observer feedback, and the activities are repeated until a minimum moderate category of normalized gain is achieved

Research Procedure

This study uses a research and development (R&D) model with a 4-D approach (define, design, develop, and disseminate) to build student worksheets based on Flip PDF Professional. The aim is to improve scientific literacy skills through the INoSIT model. This study focuses on the limited trial stage within the Development phase. In the define stage, a preliminary analysis is conducted to identify problems through literature reviews and interviews with teachers and students. The needs of students and teachers in learning scientific literacy are determined, along with student characteristics, key concepts, and relevant tasks that can improve scientific literacy. We create the initial design of the student worksheet prototype during the design stage using Flip PDF Professional, considering the results of the previous stage's analysis. A lesson plan is prepared to support the use of student worksheets in the learning process, and an evaluation instrument is designed to measure the effectiveness of the student worksheets in improving students' scientific literacy. In the development stage, the student worksheets' initial product is developed based on the initial design and validated by education and scientific literacy experts. After receiving expert feedback, the product is revised, and a limited trial is conducted with a small group of students. This limited trial aims to identify the strengths and weaknesses of the product. During the limited trial, a small group of students is selected to use the Flip PDF Professional-based Student Worksheets in learning activities. Students are given tasks that are relevant and aligned with the predetermined vital concepts. Data is collected through observations, interviews, and questionnaires to evaluate student engagement, concept understanding, and improvement in scientific literacy. The results of this limited trial highlight some of the product's advantages and disadvantages that need to be addressed. Based on these results, revisions are made to improve the quality and effectiveness of the student worksheets. This entails improving the content, appearance, and interactivity of the student worksheets to ensure they meet the needs of both students and teachers while enhancing students' scientific literacy skills. All research steps, findings, and revisions are documented to ensure the validity and reliability of the results. Through this process, it is hoped that the Flip PDF Professional-based Student Worksheets can be effectively developed to improve students' scientific literacy skills, even on a limited trial scale.

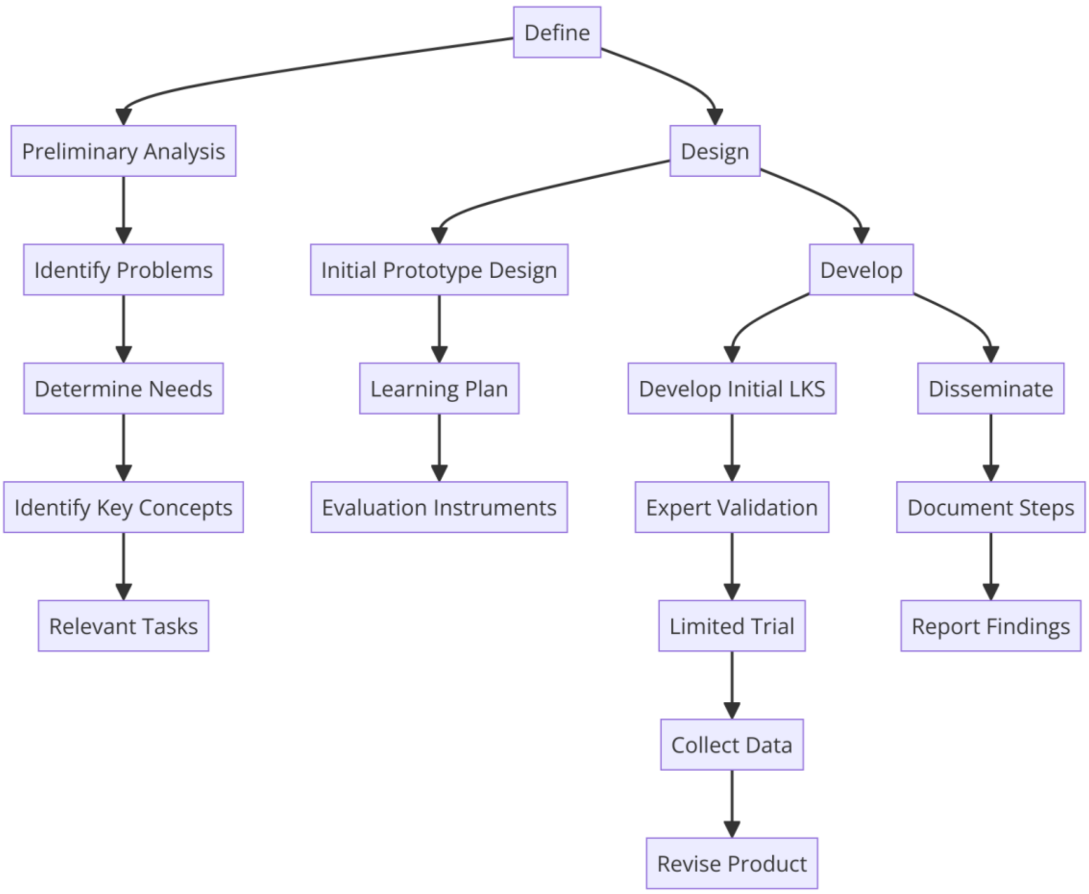


Fig 2. *Procedure development process in this research*

RESULTS AND DISCUSSIONS

The development of scientific literacy skills is one of the essential aspects of modern education. The Innovative Model of Technology-Based Science Learning (INoSIT) is presented as a solution to improve students' scientific literacy skills. The Professional Flip PDF-based Student Worksheet was an innovative and interactive learning tool in this effort. Flip PDF Professional's student worksheet facilitates understanding scientific concepts and encourages students' active engagement by presenting engaging and accessible materials. Flip PDF Professional's student worksheet facilitates understanding scientific concepts and encourages students' active engagement by presenting engaging and accessible materials. Research shows that technology-based digital media can improve students' science literacy and scientific process skills. For example, Rubini et al. [39] found that the group investigation-based scientific inquiry model can significantly improve students' scientific work and science literacy. Students are more actively involved in learning, enhancing their understanding of scientific concepts and science literacy skills. The results of the analysis of student worksheet development based on Flip PDF Professional are presented in Table 5.

Table 5. Student worksheet validation recapitulation results

Rated aspect	the average score of each student worksheet				
	1	**2**	**3**	**4**	**5**
Fill in the student worksheet	0,78	0,82	0,83	0,78	0,80
Didactic requirements	0,75	0,73	0,74	0,73	0,74
Construction requirements	0,77	0,77	0,78	0,73	0,77
Technical requirements	0,82	0,84	0,83	0,83	0,83
Index of each student worksheet activity	0,78	0,802	0,809	0,77	0,79
Criteria	S	T	T	S	S
Mean Aiken index	0,794				
Category	Medium				
Reliability coefficient for each Student worksheet activity	92,20%	92,03%	91,87%	95,38%	93,01%
Category	Rail	Rail	Rail	Rail	Rail
Reliability coefficient	92,90%				
Category	Reliable				

Information: T = High; ST = Very High; Rail = Reliable

Based on the validation results (Table 5) for the student worksheets of the INoSIT model, as presented in Table 5, it is shown that the developed student worksheets, totaling five for three meetings, were assessed by three validators. The results indicate that all aspects evaluated fall into the "moderate" category. The developed student worksheets can be used with an Aiken index of 0.794. Additionally, the reliability coefficient for all assessed aspects is categorized as "reliable," with a reliability coefficient of 92.90%. The inter-observer agreement for this reliability coefficient is above 75%. This means that the validity assessment results for the student worksheet device in the INoSIT teaching model meet the criteria for reliability

Implementation Stage of the INoSIT Learning Model:
Description of INoSIT Learning Model Implementation

This limited trial was conducted in class VIII-4, involving 15 students, while the science teacher observed the implementation during three sessions of the learning process. Throughout the three learning sessions, utilizing the student worksheets of the INoSIT model, the science teacher, acting as an observer, assessed the level of implementation. The detailed evaluation results in categories and percentages regarding the performance of the learning process using the student worksheets of the INoSIT model are presented in Table 6 and Table 7.

Table 6. Implementation of the INoSIT model student worksheet phase in limited trials

No	Phase	Meeting to								
		1			2			3		
		S	I	%	S	I	%	S	I	%
1.	Eliciting	3,5	SB	87,5	3,5	SB	87,5	3,5	SB	87,5
2.	Hypothesis Formula	2,4	KB	60	2,4	KB	60	2,6	B	65
3.	Testing Hypothesis	2,5	KB	62,5	2,5	KB	62,5	3	B	75
4.	Elucidation	2,5	KB	62,5	2,75	B	68,7	3	B	75
5.	Reflection	2,67	B	66,7	3,0	B	75	3,33	SB	83,3
Average		2,67	B	67,8	2,83	B	70,4	3,08	B	77,1

Description: S = Score, I = Criteria, SB = Very good, KB= Less good, B= Good

Table 7. Implementation of INoSIT Model Student Worksheet Teaching and Learning in Limited Trials

No	Phase	Meeting to								
		1			2			3		
		S	I	%	S	I	%	S	I	%
1.	Introduction	3,5	SB	87,5	3,5	SB	87,5	3,5	SB	87,5
2.	Activity	2,51	B	62,9	2,66	B	66,5	2,98	B	83,3
3.	Core	3,0	B	75	3,33	SB	83,3	3,33	SB	83,3
4.	Activity	2,0	KB	50	3,0	B	75	3,0	B	75
5.	Closing	3,0	B	75	3,33	SB	83,3	3,17	B	79,1
Average		2,8	B	75	3,33	SB	79,1	3,19	B	81,6

Description: S = Score, I = Criteria, SB = Very good, KB= Less good, B= Good

The information in Table 6 shows that during the test in class VIII-4, the average rate of using the INoSIT model student worksheets from the first to the third session was between 67.8% and 77.1%, which is considered "good" (B). Thus, the teacher could effectively execute the INoSIT model student worksheet phases in the learning process. Table 7 shows the results of implementing the teaching and learning process, focusing on introduction activities, core activities, closing activities, time allocation, and classroom atmosphere. From the first to the third session, there was an average increase in the implementation of the teaching and learning process, ranging from 75% to 81.6%, which was categorized as "good" (B). The extensive trial was conducted in class VIII-1, involving 27 students. The learning process was carried out using the student worksheets of the INoSIT model for three sessions, with the science teacher acting as an observer. The detailed evaluation results regarding categories and percentages for implementing the INoSIT teaching model are presented in Tables 8 and 9.

Table 8. Implementation of the INoSIT model student worksheet phase in the extensive test

No	Phase	Meeting to								
		1			2			3		
		S	I	%	S	I	%	S	I	%
1.	Eliciting	3,5	SB	87,5	3,5	SB	87,5	3,5	SB	87,5
2.	Hypothesis Formula	2,4	KB	60	2,6	B	65	2,8	B	70
3.	Testing Hypothesis	2,5	KB	62,5	3,0	B	75	3,25	B	81,2
4.	Elucidation	2,75	B	68,7	2,75	B	68,7	3,0	B	75
5.	Reflection	2,67	B	66,7	3,33	SB	83,3	3,33	SB	83,3
Average		2,76	B	69,1	3,16	B	79,1	3,19	B	81,6

Description: S = Score, I = Criteria, SB = Very good, KB= Less good, B= Good

Table 9. Implementation of INoSIT model student worksheet teaching and learning activities in extensive tests

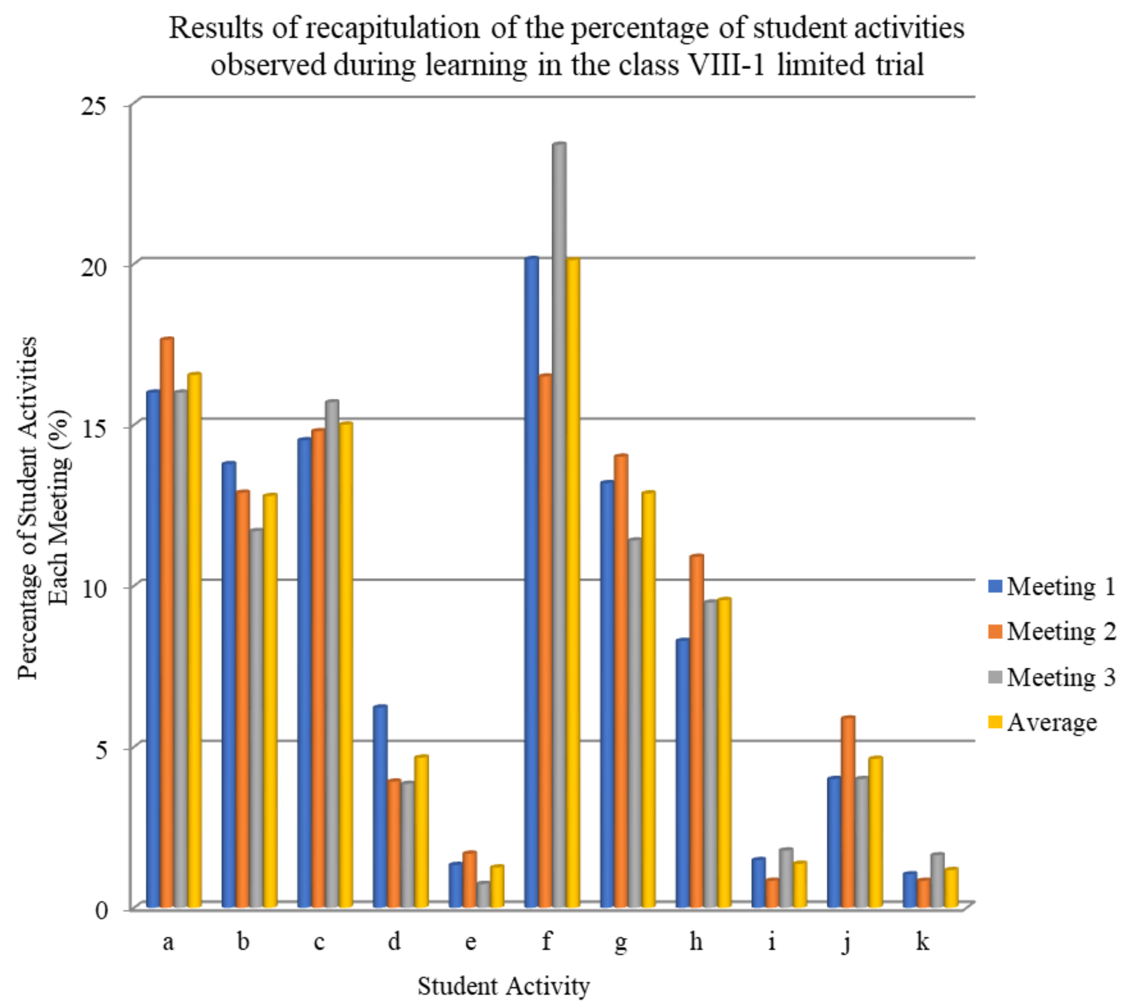
No	Phase	Meeting to								
		1			2			3		
		S	I	%	S	I	%	S	I	%
1.	Introduction	3,5	B	87,5	3,5	SB	87,5	3,5	SB	87,5
2.	Activity	2,62	B	65,7	3,08	B	77,0	3,12	B	80,1
3.	Core	3,33	SB	83,3	3,33	SB	83,3	3,33	SB	83,3
4.	Activity	2,0	KB	50	3,0	B	75	3,0	B	75
5.	Closing	3,17	B	79,1	3,33	SB	83,3	3,33	B	83,3
Average		2,87	B	68,7	3,24	B	81,2	3,26	SB	81,4

Description: Score (S), Criteria (I), very good (SB), Less good (KB), Good (B)

The data in Table 8 explains that during the trial in class VIII-1, the average implementation rate of the phases of the INoSIT model student worksheets from the first to the third session ranged from 69.1% to 81.6%, falling into the "good" category (B). Thus, the teacher has effectively executed the INoSIT model student worksheet phases in the learning process. Table 9 shows the results of implementing the teaching and learning process, focusing on introduction activities, core activities, closing activities, time allocation, and classroom atmosphere. From the first to the third session, there was an average increase in the implementation of the teaching and learning process, ranging from 68.7% to 81.4%, categorized as "good" (B) to "very good" (SB)

Description of student activity

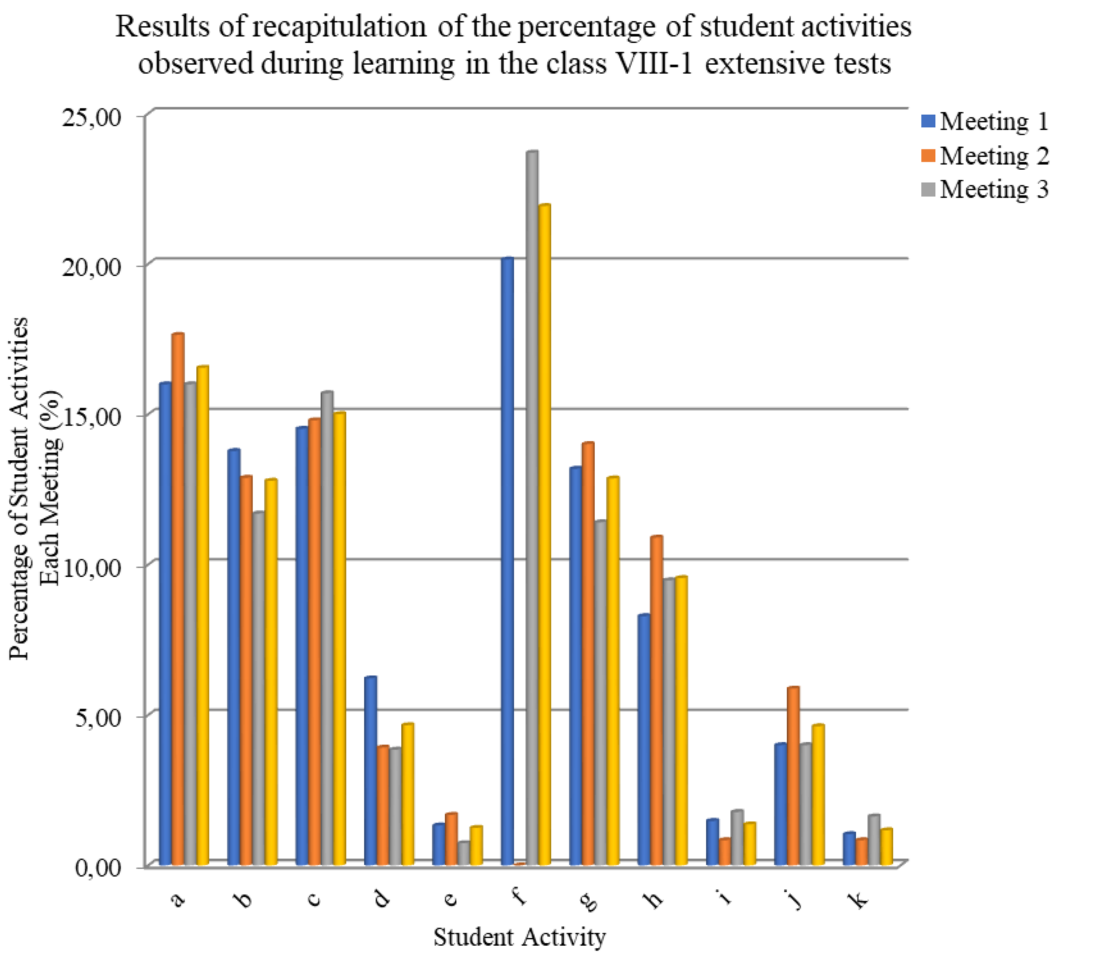
The student's activities during the implementation of the teaching and learning activities provide an overview of the realization of the learning process using the developed INoSIT model student worksheets. Data on student activities are obtained from observations by the science teacher acting as an observer during the learning activities based on the planned steps in the lesson plan. The science teacher observes student activity assessment while implementing the INoSIT model of learning activities. There are 11 components for assessing student activities: (a) listening to or paying attention to the teacher's explanation or media presentation; (b) formulating problems or questions; (c) formulating hypotheses; (d) asking questions to the teacher; (e) answering the teacher's questions; (f) conducting observations or experiments; (g) working on student worksheets; (h) group discussions; (i) presenting observation results; (j) concluding; and (k) behaviour irrelevant to teaching and learning activities. The science teacher served as an observer in each session during the limited trial's implementation of the INoSIT model student worksheets and recorded the activities of the students on an observation sheet. The observer provided assessments in the form of codes (symbols) for each student activity component every 5 minutes during teaching and learning activities on "pressure of substances and its application in daily life," the main topic conducted over three sessions. The profile of student activities frequently and infrequently performed by the students during the limited trial of the INoSIT model student worksheets can be seen in Figure 2.



Information: (a) listening to or paying attention to the teacher's explanation or media presentation; (b) formulating problems or questions; (c) formulating hypotheses; (d) asking questions to the teacher; (e) answering the teacher's questions; (f) conducting observations or experiments; (g) working on student worksheets; (h) group discussions; (i) presenting observation results; (j) concluding; and (k) behaviour irrelevant to teaching and learning activities

***Fig 2**. Students' activities during learning sessions in the Limited Trial*

There are three categories of these activities' percentages: students perform frequently, activities they don't perform as frequently, and activities they perform very infrequently. The highest activities frequently carried out by students during learning through the worksheet of the INoSIT student model are in the assessment components: (1) conducting observations or experiments; (2) listening to or paying attention to the teacher's explanation or media presentations; (3) formulating hypotheses; and (4) working on the student worksheet. Furthermore, somewhat frequent activities include (1) formulating problems or questions, (2) group discussions, (3) asking the teacher, and (4) concluding. Activities that are rarely done are (1) presenting observation results, (2) behaviours irrelevant to students' activities during learning sessions, and (3) answering the teacher's questions. The science teacher observes each meeting while monitoring student activities and implementing the INoSIT student worksheet in the extensive trial. The observer will provide assessments in the form of codes (straight lines) for each student activity component every 5 minutes during students' activities during learning sessions. The profile of student activities that students frequently and infrequently perform during the extensive trial of learning through the INoSIT student worksheet model can be seen in Figure 3.



Information: (a) listening to or paying attention to the teacher's explanation or media presentation; (b) formulating problems or questions; (c) formulating hypotheses; (d) asking questions to the teacher; (e) answering the teacher's questions; (f) conducting observations or experiments; (g) working on student worksheets; (h) group discussions; (i) presenting observation results; (j) concluding; and (k) behaviour irrelevant to teaching and learning

***Fig 3**. Students' activities during learning sessions in the extensive tests*

The percentage of these activities is divided into three categories: activities frequently carried out by students, activities less regularly carried out by students and activities rarely performed. The highest activities frequently carried out by students during the implementation of the learning worksheet model INoSIT include the assessment components of: (a) listening to or paying attention to the teacher's explanation or media presentation; (b) formulating problems or questions; (c) formulating hypotheses; (d) asking questions to the teacher; (e) answering the teacher's questions; (f) conducting observations or experiments; (g) working on student worksheets; (h) group discussions; (i) presenting observation results; (j) concluding; and (k) behaviour irrelevant to teaching and learning activities

Student and Teacher Responses to INoSIT Model Learning

Closed questionnaires were used to get teacher and student responses or opinions on using the student worksheet model INoSIT to help Junior High School 10 Kendari students improve their scientific literacy skills. These responses or opinions were gathered during both the limited and extensive trials. Students individually filled out the questionnaires to ensure they did not know each other's reactions to the completed learning management. The types of responses or feedback provided by teachers and students include (1) interest, (2) novelty of the model, (3) ease of understanding, (4) interest in using the model, (5) clarity in learning activities, (6) ease of procedural skills, and (7) ease of using scientific literacy instruments. The analysis of student responses indicates that students' interest in learning components from the first to the fourth meeting is in a good category. This suggests that the learning components are new to the students. The ease of understanding the learning components for students is considered good, indicating that students respond well to the learning components and find them relatively easy to learn.

Furthermore, students' interest in using the INoSIT student worksheet model for the following chapters and other subjects is also quite good. In terms of the clarity of the teacher's explanations and guidance, students can quickly respond and understand them. Additionally, the ease of skills in conducting experiments and following the steps is classified as good

Description of the Effectiveness of the INoSIT Learning Model for improving students' Science Literacy competencies

Students obtained the results of the achievement in scientific literacy competence analysis through pretests, posttests, normalized gain analysis, and learning mastery on the concept of pressure of matter and its application in daily life. The study of scientific literacy competence, considering the percentage of each aspect, namely explaining scientific phenomena (KI), evaluating and designing scientific inquiries (K2), and interpreting scientific data and evidence (K3), can be seen in Tables 9 and 10.

Table 9. Achievement of science literacy competencies in limited trials of INoSIT model student worksheets

No	Competency aspect	Test		n-gain <g>	Category
		Pretest	Posttest		
1.	Explain scientific phenomena	30	75	0,632	Medium
2.	Evaluating and designing scientific inquiry	30	70	0,541	Medium
3.	Interpretation of data and scientific evidence	24,67	64	0,510	Medium

Table 10. Distribution of science literacy competencies in limited trials of INoSIT model student worksheets

No	Competency aspect	N-gain criteria	Total student	Percentage (%)	N-gain average <g>	Category
1.	Explain scientific phenomena	Low	2	13,33%	0,632	Medium
		Medium	7	46,67%		
		High	6	40%		
2.	Evaluating and designing scientific inquiry	Low	3	20%	0,541	Medium
		Medium	7	46,67%		
		High	5	33,33%		
3.	Interpretation of data and scientific evidence	Low	4	26,67%	0,510	Medium
		Medium	8	53,33%		
		High	3	20%		

The achievement of science literacy competencies during the limited trial of the INoSIT worksheet for students over three meetings has improved abilities from the pretest to the post-test. The mean normalized gain <g> values in the aspects of explaining scientific phenomena (K1), evaluating and designing scientific inquiries (K2), and interpreting scientific data and evidence (K3) fall into the moderate category with mean <g> values of 0.632, 0.542, and 0.510, respectively, indicate this. The profile of science literacy competency achievement in the limited trial can be seen in Figure 4.

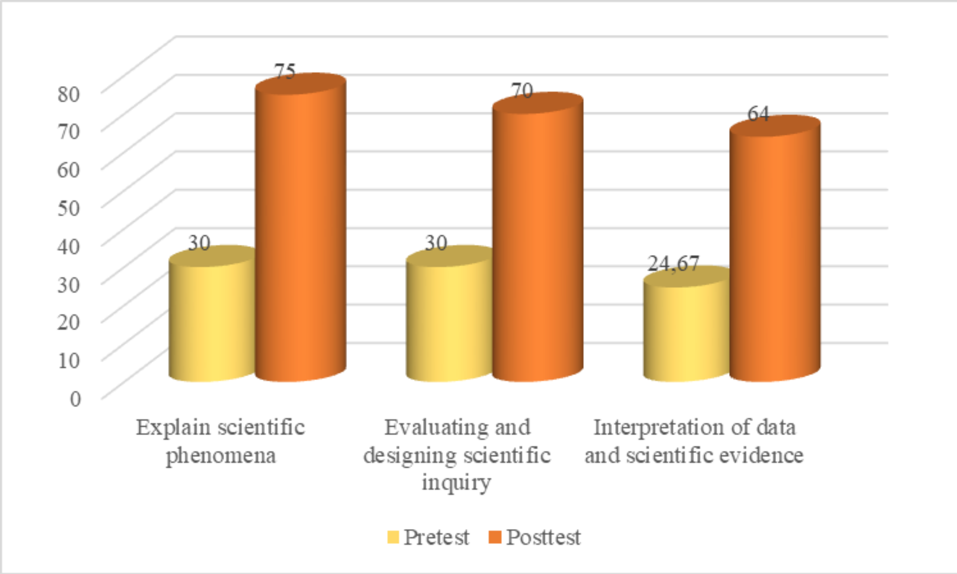


Fig 4. *Profile of scientific literacy competency achievement in limited trials through pretest and post-test*

The results of the analysis of achievement in science literacy competencies obtained by students through pretests, posttests, normalized gains, and learning completeness on the concept of substance pressure and its application in daily life in the extensive trial in class VIII-1, involving 27 students. Tables 11 and 12 show a quick look at the science literacy skills by showing the percentage of each part: explaining scientific phenomena (K1), planning and evaluating scientific investigations (K2), and figuring out what scientific data and evidence mean (K3).

Table 11. Achievement of science literacy competencies in the INoSIT model student worksheet extensive test

No	Competency aspect	Test		N-gain <g>	Category
		Pretest	**Posttest**		
1.	Explain scientific phenomena	31,08	81,48	0,712	High
2.	Evaluating and designing scientific inquiry	23,46	69,75	0,58	Medium
3.	Interpretation of data and scientific evidence	26,29	70	0,572	Medium

Table 12. Distribution of science literacy competencies in the INoSIT model extensive test

No	Competency aspect	N-gain criteria	Total student	Percentage (%)	N-gain average <g>	Category
1.	Explain scientific phenomena	Low	3	11,11%	0,712	High
		Medium	9	33,33%		
		High	15	55,56%		
2.	Evaluating and designing scientific inquiry	Low	5	18,51%	0,58	Medium
		Medium	14	51,85%		
		High	8	29,62%		
3.	Interpretation of data and scientific evidence	Low	3	11,11%	0,572	Medium
		Medium	12	44,44%		
		High	12	44,44%		

The achievement of science literacy competencies during the extensive trial of the INoSIT worksheet for students over three meetings has already improved abilities from the pretest to the post-test. The mean normalized gain <g> values indicate this, with the aspect of explaining scientific phenomena (K1) falling into the high category and having a mean <g> value of 0.712. The elements of evaluating and designing scientific inquiries (K2) and interpreting scientific data and evidence (K3) are in the moderate category, with mean <g> values of 0.58 and 0.572, respectively. The profile of science literacy competency achievement in the limited trial can be seen in Figure 5.

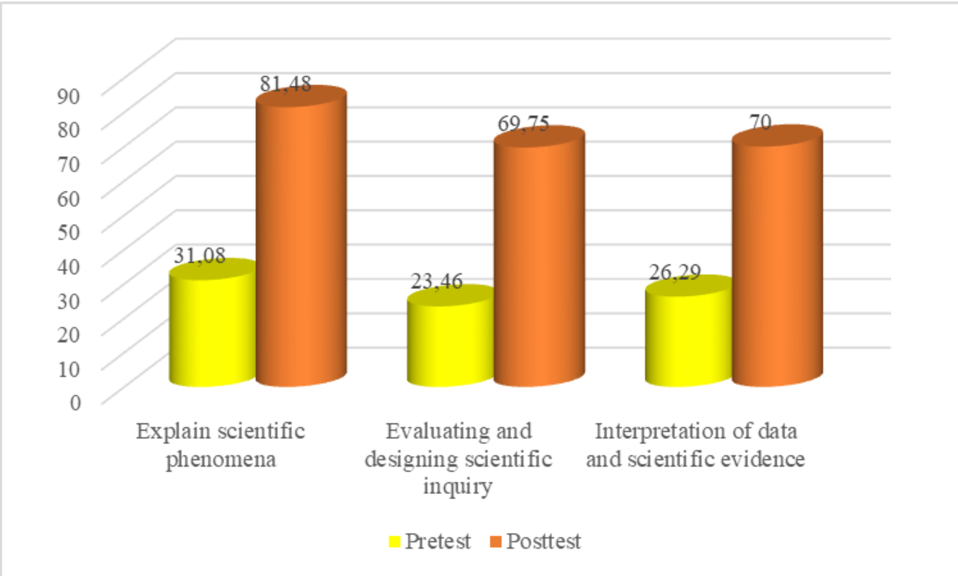


Fig 5. *Profile of scientific literacy competency achievement in extensive test through pretest and posttest*

The validation results by the validator are presented in Table 5 in the research findings section. Based on the validation analysis of the student worksheets, the final agreement index obtained by the validator regarding the validation of student worksheets for all aspects is 0.787, categorized as moderate [40], with a reliability coefficient of 93.58%, categorized as reliable. The reliability coefficient (R) value has met the criteria for inter-observer agreement, with 75% meeting the reliable category [41]. The content quality of the INoSIT student worksheet model for training science literacy is determined by core competencies, essential competencies, indicators, the learning theory of substance pressure and its application, the steps of the INoSIT learning model, and training students' science literacy. Regarding didactic requirements, the questions in the student worksheet are suitable for the cognitive level of junior high school students, and they encourage active participation in the learning process. In terms of construction, the language used in the student worksheet is simple, the sentences are clear and easy to understand, and the questions in the student worksheet are straightforward and meet the demands of the indicators. Regarding technical aspects, the spacing between letters is precise, and the presented images are attractive and relevant to the learning material. The Aiken index (*V*), which measures how well experts agreed on the student worksheet's validity, shows that the developed student worksheet is in the high category with reliability coefficients in the reliable category and can be used with only minor changes based on the validator's suggestions. This is consistent with the research by Dermawati et al. [42], which claims that the development of the INoSIT model learning tool has met the validity element with a very valid category and reliability, making it suitable for implementing the INoSIT learning model in the teaching process. Additionally, a quality student worksheet is deemed suitable for application in learning if it meets the validity standards assessed by experts and specialists. As Nieveen [43] explained, a learning tool is considered valid when it is deemed suitable for use with or without revision by validator.

Implementation of the INoSIT model student worksheet

The data from the analysis of the implementation of the INoSIT student worksheet, both through a limited trial in class VIII-4, as presented in Tables 6 and 7, and through an extensive trial in class VIII-1, as shown in Tables 8 and 9, indicate that teachers were able to execute the components of the INoSIT student worksheet effectively without significant obstacles. The implementation of the INoSIT student worksheet learning activities was scripted, referring to the phases or syntax of the developed INoSIT learning model, consisting of five steps: elicitation, hypothesis formulation, hypothesis testing, elucidation, and reflection. During the limited and extensive trial, teachers successfully conducted the components of the INoSIT student worksheet without significant challenges. The learning activities using the INoSIT student worksheet were scripted according to the phases and syntax of the developed INoSIT learning model, which comprises five steps: elicitation, hypothesis formulation, hypothesis testing, elucidation, and reflection. The first phase is elicitation, with the introductory activity being an apperception exercise. Before the apperception activity, the teacher extended greetings at the beginning of the learning session, and the students responded. The teacher then assigns a student to lead a prayer. This activity is conducted to familiarize students with prayer, exchange greetings at the start of the learning session, and encourage students to respond to greetings, aiming to instil a spiritual attitude. Subsequently, the teacher carries out the apperception activity, which presents a real-life phenomenon regarding using boots and high-heeled shoes in muddy areas. Based on the given phenomenon, the teacher asks students to jot down their initial ideas.

The second phase involves hypothesis formulation, which continues the first phase, allowing students to engage in inquiry-based learning. The main activity is answering questions or addressing issues posed through experimental activities. Before experimenting, students are guided to design the investigation and make predictions about the influence of the independent variable on the dependent variable through hypothesis formulation. Students collaborate in small groups with the teacher to develop their hypotheses and offer justifications using the teacher's worksheet. The second phase of learning (hypothesis formulation) implementation data from the first meeting to the third meeting showed an improvement from the less good (LG) category to the good (G) category. This was seen in both the limited and extensive trials. This indicates that the teacher could sufficiently guide the students in conducting structured inquiry activities to formulate hypotheses. The essence of inquiry-based learning is engaging students in real investigative problems by presenting them with a problem and conducting an inquiry or investigation, helping them identify conceptual or methodological problems within the scope of the inquiry, and asking students to design ways to address the problems [44] [45] [46]. Additionally, involving students in the inquiry process can help them develop scientific literacy and provide opportunities to practice scientific process, critical thinking, and problem-solving skills [47] [48].

The third phase of the INoSIT model involves testing hypotheses based on the hypotheses formulated in the second phase of the INoSIT model. Testing the previously formulated hypotheses (testing hypotheses) can be done through observation and experimentation based on the steps outlined in the student worksheet. Technology-assisted education, in the form of a virtual laboratory using interactive simulations like the PhET simulation, is employed to expedite and enhance the accuracy of hypothesis testing. It was found that from the first meeting to the third meeting, both the limited and extensive trials of the third phase of learning (hypothesis testing) got better, going from the "less good" (LG) category to the "good" (G) category. This indicates that the teacher was sufficiently able to guide students in conducting experiments assisted by PhET simulation technology, following the steps outlined in the student worksheet, and providing guidance in analyzing and testing hypotheses and interpreting data. However, there are still some components that need to be maximally addressed.

The implementation date of the fourth phase, elucidation, in the limited trial from the first to the third meeting showed an improvement from the less good (LG) category to the good category (G). Furthermore, in the extensive trial from the first meeting to the third meeting, it consistently remained in the good category (G). This indicates that the teacher effectively guided students through discussions, debates, sharing with other groups, communicating through presentations, providing arguments, and justifying their explanations based on the findings. The teacher also successfully guided students in discussing among groups the collaborative results presented by each group. The National Research Council (NRC, 2000) emphasizes the significance of claims based on evidence, a fundamental component of scientific argumentation that scientists have used or will use to support this outcome.

The implementation date of the fifth phase, reflection (elucidation reflection), in the limited trial (Table 6) is already in the good category (G). Furthermore, in the extensive trial (Table 8) from the first meeting to the third meeting, it is consistently in the good (G) and very good (VG) categories. This indicates that the teacher can guide students in reviewing the learning process with information and communication technology (ICT) assistance. The teacher has cultivated science literacy through inquiry activities assisted by PhET simulation technology. Furthermore, using the inquiry model enables students to understand science better and become more interested in science when actively involved in scientific activities [49]. According to the learning implementation analysis findings in both the limited and extensive trials of the INoSIT learning model, student activities are predominant. This indicates that the INoSIT learning model has provided a learning environment for students to actively engage in the learning process. Additionally, instructional materials and technology-based virtual laboratory media in engaging simulations that adhere to the INoSIT learning model's principles and are well-accepted by students support the learning process. The students' enthusiastic responses to the learning process and active participation in the learning activities further support this.

The student's activities during the implementation of the limited trial of the INoSIT learning model in class VIII-4 and the extensive problem in class VIII-1 were observed by the science teacher, who acted as an observer in each meeting using an observation sheet. Based on the analysis of the student's activities during the implementation of the INoSIT model in the limited trial (Table 10) and the extensive trial (Table 11), it can be explained that the student's learning activities were generally good. In the learning process, the activities tend to be student-centered. Moreover, the students most frequently carry out observation or experimentation. Through scientific inquiry activities, it is presumed to contribute to the enhancement of students' science literacy competencies.

The five phases—elicitation, hypothesis formulation, hypothesis testing, elucidation, and reflection—in the syntax of the INoSIT model are designed by arranging learning steps that can facilitate teachers in implementing lessons and encourage students to participate in learning actively. Based on the observation data of students' activities in the learning process, it is evident that, in general, students actively participate in learning activities, as described by the researcher during the application of the INoSIT model. Based on this, the developed INoSIT learning model has met the criteria for validity and practicality. The usability and support of a developed learning tool are indicators of its practicality. Whether teachers can use a learning tool in the classroom is another way to judge its practicality

Science Literacy Competency

The science literacy competence in explaining scientific phenomena, based on the level of achievement of normalized gain <g>, falls into the high category. This indicates that the teacher elicited motivation and interest from students to explain the concept of pressure in substances and its application in daily life, understand the learning objectives, and recognize the importance of using technology to study abstract concepts in science. The teacher presented the phenomenon of pressure in substances and its application to stimulate curiosity in inquiry activities and motivate the students [50].

Science literacy competence in evaluating and designing scientific inquiry and interpreting data and scientific evidence is achieved at a moderate level of normalized gain. This is because the teacher guided groups that could have maximized their inquiry activities assisted by PhET simulation technology. Students' actions during the learning process impact their improvement in <g> values. Based on the observer's observations, the highest activity frequently carried out by students is observation or experimentation, formulating problems or questions, and formulating hypotheses. As per the constructivist learning theory, scientific inquiry activities emphasize students investigating their environment and constructing meaningful personal knowledge. Through interactive simulations, students can explore their answers, encode signals for memory, and build new knowledge systems based on their prior knowledge and interests. In interactive simulations, information and communication technology (ICT) will allow students to learn science by engaging in experimental practices, individual abilities, and new technological tools. The research findings of Gormaly et al. [51] and Schwars [52] who stated that teachers should have concentrated on student-centered learning based on scientific inquiry and constructivism to build science literacy in education, supported this. The inquiry model in science learning positively impacts cognitive learning outcomes, process skills, and attitudes toward science [53] [54]. The use of virtual laboratory technology in the form of interactive simulations in teaching strongly influenced students' science literacy achievement [55] [56]. The achievement of students' science literacy competence with an average n-gain <g> in explaining scientific phenomena tended to be in the high category. In contrast, in the aspects of evaluating or designing scientific inquiry and interpreting data and scientific evidence, it fell into the moderate category. These results indicated that implementing the INoSIT learning model effectively enhanced science literacy among equivalent-level junior high school students. Additionally, a study by Dermawati et al. [42] results indicating that the implementation of the INoSIT learning model fulfilled the elements of effectiveness in its application as it significantly impacted improving students' science literacy competence. This was evident from the average n-gain <g> scores for students' science literacy competence, which were in the moderate category

CONCLUSION AND SUGGESTION

The development results of the student worksheet model INoSIT, developed with an average score of 0.794, fell into the high category with a reliability coefficient of 92.90%, placing it in the reliable category. Based on these results, the developed student worksheet model INoSIT was valid for learning. Implementing the INoSIT model in the application phase of science education was considered practical. The execution of the INoSIT model as learning steps was carried out effectively, enabling the teaching of science to enhance students' science literacy competence. Additionally, the level of implementation of the INoSIT model and students' activities participating in the learning process were categorized as good. The application of the INoSIT learning model fulfilled the elements of effectiveness, as it significantly impacted improving students' science literacy competence. This was evident from the average n-gain <g> scores for students' science literacy competence, which fell into the high and moderate categories, and there was a significant difference between pretest and posttest scores.

Recommendation: Based on the research findings, it will be recommended that future researchers conduct further studies by increasing the sample or using schools as implementation sites with different materials. This will provide a more comprehensive understanding of the effectiveness of the INoSIT learning model in enhancing the science literacy competence of junior high school students.

Suggestion for future research: The following experimental study can be carried out by evaluating the effectiveness of the INoSIT model in improving students' science literacy skills compared to conventional methods. Further studies can also compare learning outcomes between two groups of students: one group uses the INoSIT model, while the other uses traditional learning methods. The analysis will be carried out to identify significant differences in improving the understanding of science concepts and students' ability to apply this knowledge. In addition, an in-depth analysis was also carried out related to the needs of students in developing science literacy. The focus is on identifying aspects of science literacy that may be more difficult for students to understand or require a more specific approach to learning. The findings of this analysis will help make further adjustments to the INoSIT model to be more responsive and effective in meeting the overall needs of students' science education.

Limitations: From a scientific point of view, limitations can arise in controlling variables that affect the results of experiments, whereas unexpected factors can affect the accuracy of the findings. Generalizing the study's results is also a problem, as the experiment's findings may only apply to specific populations or contexts, especially if the sample size needs to cover more variation. On the other hand, theoretical limitations include the INoSIT model, which is based on the assumption that its theory is consistent and valid in supporting science literacy. However, the weakness lies in the model's theoretical validity, which may not prove robust, as well as the variations of the theories underlying the science literacy approach depending on the specific educational context, such as level, curriculum, or school policy. This can limit the generalization of research findings to other academic contexts, creating challenges in interpreting and applying these research results more broadly

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