25 (2), 2024, 986-1011

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Contextual Physics Learning Based on Geothermal Areas to Improve Scientific Literacy and Scientific Communication Skills

Salman Hamja Siombone[1*], Fitri Ayu Lestari[2], & Wiyono[3]
[1]Department of Mathematics and Natural Sciences Education, STKIP Gotong Royong Masohi Indonesia
[2]Science Education Study Program, Nahdlatul Ulama University, Indonesia
[3]Department of Physics, Brawijaya University, Indonesia

Abstract: This study aims to develop a learning physics module through contextual learning design based on geothermal areas to improve scientific literacy ability and scientific communication skills on temperature and heat concepts. The sample in this study was 27 respondents of Mathematics Education STKIP Gotong Royong Masohi who are taking general physics subjects. The method used in this study is educational design research with the Plomp & Nieveen development model. The main instrument developed in this study is a prototype of a contextual physics learning module. The average percentage value of the validation results of the contextual physics learning module (prototype-1) from three experts on content (substance), language, and construct aspects is 88.41%, which shows that it is in the very valid category. The results of the trial of the practicality of the learning module in the one-to-one test obtained an average percentage value of 95.45%, and the results of the limited class trial (small group) received an average percentage value of 95.88%, which shows that the learning module developed is very practical. The results of the student's scientific literacy competency test at the field test (large class) showed an increase with an average N-gain of 0.75, which is in the high category; these results indicate that the learning physics module developed has been effective. The results of implementing the contextual physics learning module (prototype-2) in the field showed that students' average total scientific communication skills increased from 90.95 at the first meeting to 92.85 at the second meeting. Based on the results of the data analysis obtained, it can be concluded that the contextual physics learning module developed has met the valid, practical, and effective categories and can increase scientific literacy and scientific communication skills so that they are suitable for use in the learning process in the field.

Keywords: contextual physics learning, geothermal area, educational design research, science literacy and scientific comunication skills.

▪ INTRODUCTION

Scientific literacy is one aspect of students' ability to face challenges in the 21st century. These abilities help overcome the challenges of science and technology development and ensure students' competitiveness in the era of globalization (Kwok, 2018; Osborne & Allchin, 2024). Based on the Programme for International Student Assessment (PISA) 2022, science literacy abilities in Indonesia are still relatively low; Indonesia's score dropped 13 points, almost equivalent to the international average of 12 points (Kemdikbud, 2023). As many as 52% of PISA 2022 participating countries experienced a decline in science literacy scores compared to PISA 2018. The results of PISA 2022 showed a decrease in Indonesia's science literacy score from an average score of 396 to 383 points, and this was due to the Covid-19 pandemic (OECD, 2023). Science literacy abilities measured by PISA also include the field of physics. Based on the description of the seven levels of science proficiency in PISA 2022 at Level 6, students can utilize a series of scientific ideas and concepts related to physics, life, and earth

Salman Hamja Siombone
*Email: salmansiombone@gmail.com

DOI: http://dx.doi.org/10.23960/jpmipa/v25i2.pp986-1011
Received: 30 October 2024
Accepted: 12 November 2024
Published: 20 November 2024

sciences and use content, procedural knowledge, and epistemics to offer hypotheses about phenomena, scientific processes or make predictions (OECD, 2023). Previous research by Melinda et al. (2021) shows that online learning during the COVID-19 pandemic, which is not optimal, impacts students' science literacy, the research results obtained, the science literacy profile of students in physics learning during the pandemic is still in the low category, namely 28.38%. Post-pandemic conditions are not a reason for students' low scientific literacy abilities. Efforts to foster a culture of scientific literacy for students in schools must be supported by developing a culture of scientific literacy for educators. Colleges are institutions that produce prospective secondary school teachers and are considered to need adequate scientific literacy abilities. Developing the scientific literacy of prospective teachers (college students) is a challenge for teaching and learning today (Mukharomah et al., 2021a; Sartika et al., 2018).

Figure 1. Field learning in tehoru geothermal area

Students' scientific literacy competence can be supported by contextual learning based on the environment. Environmental-based learning leads to learning that utilizes the environment as a source of learning (Ernawati et al., 2017; Lina et al., 2023). The environment significantly affects the development of scientific literacy, sensitivity, and the formation of students' character (Raksun et al., 2024). Environment-based learning is a component of integrating contextual learning with sources of local wisdom. Contextual learning can be the right solution, namely utilizing the surrounding environment as a learning tool, one of which is a region's local wisdom (Wiyono et al., 2024). Previous research by Santoso et al. (2023) found that applying contextual phenomenon-based learning to the materials of Work and Energy, Momentum, and Fluid at the tertiary level improved scientific literacy. The average N-gain value was obtained on the three materials, namely Work and Energy, Momentum, and Fluid, respectively, 82.3%, 81.6%, and 83.9%, which are in the high category. In addition, research conducted by Hanifha et al. (2023) on "socioscientific issue-based undergraduate student worksheets on scientific literacy and environmental awareness" found that there was an increase in students' scientific literacy and environmental awareness, respectively, 0.57 and 0.67, which are in the moderate category. In addition, Masfufah et al. (2020) research showed an increase in students' scientific literacy abilities by 0.583, which is included in the moderate category in implementing the contextual teaching and learning (CTL) approach containing ethnoscience in physics learning. Based on several research results above, contextual learning can be the right solution, namely using the surrounding environment as a learning tool, one of which is an area's local wisdom.

The local wisdom of an area can be introduced through physics because physics studies the phenomena and intricacies of nature so that nuances of local wisdom can be included in the subject (Wiyono et al., 2024). Local wisdom-based learning is usually applied to provide more contextual examples so that students have skills according to the local potential in their area. Various daily phenomena in the surrounding environment are closely related to physics (Safitri et al., 2023), like temperature and heat concepts. One of the environmental sites that can be used as an object and media for learning physics concepts of temperature and heat is the geothermal area. Maluku Province has 18 geothermal points, one of which is in the Tehoru geothermal area, Central Maluku Regency. The Tehoru geothermal area, which is a local wisdom in the Central Maluku district, has manifestations in the form of hot springs and steamy soil with a surface temperature of ± 74oC–94.3oC (Siombone, 2022; Siombone et al., 2021), which is considered an object of study in learning the concept of temperature and heat directly. The geothermal site is shown in Figure 1. The Tehoru geothermal area can be a cheap, economical, and affordable physics learning medium and environment because it is a tourist area in Central Maluku Regency. In the geothermal area, students can utilize existing thermal manifestation to learn physics, such as measuring the temperature at each hot spring manifestation point, studying the mechanism of heat transfer in nature directly, and collaborating to build a good and constructive knowledge of physics.

Furthermore, integrating local wisdom in contextual learning allows students to work together in small groups to achieve the same academic goals, such as group assignments related to explaining phenomena observed in everyday life (Li & Guo, 2021; Dewi et al., 2021). Learning adapted from local wisdom will certainly be a unique novelty for students. On the other hand, students will find new learning models to overcome the saturation of physics learning and train physics communication skills. In addition to scientific literacy, the ability to communicate the knowledge obtained during the learning process is needed to convey the knowledge obtained to colleagues in scientific activities. Scientific communication skills are also needed for students to constructively explain conclusions based on scientific evidence (Harisanti, 2019). Basically, the "scientific communication" program has three main objectives (or goals), namely: (1) to improve students' performance communication skills and scientific literacy; (2) to equip teachers (lecturers) with teaching materials and activities that can be implemented and integrated into various scientific topics and (3) to design teaching materials that are flexible and suitable for various levels of students, and to meet the different and specific needs of classes and teachers (lecturers) (Levy et al., 2008; Levy et al., 2009). Previous research conducted by (Dewi et al., 2019) found that the Integrated Local Wisdom Learning Model was proven to be effective in improving student scientific communication skills with a significant increase at $\alpha = 5\%$, with low N-gain and moderate category. In addition, the research conducted by Irawan et al. (2023) on Scientific Literacy and Communication Skills is Significant for Enhancing Students' Creative Thinking Skills with a strong correlation and contributing to 45% of students' creative thinking skills. Based on previous studies above, contextual learning with local wisdom can help students achieve better scientific literacy and scientific communication skills.

The explanation of the background above has outlined several reasons for students' low scientific literacy skills and has also presented several inputs that can support the improvement of students' scientific literacy. Scientific literacy students collaborate strongly with an environment containing local wisdom, good scientific communication skills, relevant learning models, and teaching materials. This condition is reinforced by previous research conducted by several researchers, such as Rusilowati et al. (2019), Melinda et al. (2021), Arrafi et al. (2023), which state that several factors that influence students' scientific literacy skills include learning models, teaching materials, worksheets, learning media, and evaluation tools, human resources influence students' scientific literacy. Based on the background description, it is essential to integrate the geothermal area environment as local wisdom into contextual physics learning of temperature and heat concepts through "Educational Design Research" with the formulation of research questions: How is the level of validity, practicality, and effectiveness of physics learning module in improving scientific literacy and scientific communication skills of prospective teacher students? The urgency of this research is to improve the quality of the physics learning module through contextual physics learning design based on the natural environment of the geothermal area for prospective teachers and students with the target of improving scientific literacy and scientific communication skills. This study aims to develop a physics learning module based on the geothermal area environment through contextual learning design to improve prospective teacher students' scientific literacy and communication skills on temperature and heat concepts.

▪ METHOD

The population in this study were students of the Mathematics Education Study Program of STKIP Gotong Royong Masohi. The sample in this study was 27 Respondents of second-semester students of the Mathematics Education Study Program who were taking General Physics courses with non-predictability sampling techniques through a saturated sampling approach. Saturated sampling is a sampling determination technique that uses all population members as samples (Sugiono, 2013). The research method used is Educational Design Research based on the Plomp & Nieveen development model. In the case of development studies, educational design research aims to develop research-based solutions to complex problems in educational practice (Plomp & Nieveen, 2013). The Plomp & Nieveen development model has five stages, namely: (1) Preliminary Investigation Phase, (2) Design Phase, (3) Realization/Construction Phase, (4) Test, Evaluation, and Revision Phase, and (5) Implementation Phase. This research was conducted over six months, from May 10 to October 10, 2024. The five development phases in the Plomp & Nieveen model and the implementation period of each phase are shown in Table 1. The main instrument developed in this study is a prototype of a contextual physics learning module designed through five stages in the Plomp & Nieveen model (See Figure 2). The research instruments used in this study generally consist of three main components, namely: (1) Contextual physics learning module equipped with Student Worksheets, (2) Non test instruments such as expert validation sheets (guides), student response questionnaires, and student scientific communication skills rubrics, This type of rubric is adapted and developed from the research results of Levy et al (2009), and (3) Test instruments are multiple-choice questions related to students' scientific literacy competencies, with a request to provide reasons for choosing that option, This type of test instrument is adapted from PISA OECD (2023). The data analysis techniques used in this study were descriptive analysis and N-gain Test (normalized gain) analysis. This descriptive analysis was used to analyze data by describing the data obtained or collected as it is without concluding based on the Benchmark Reference Assessment (PAP) Approach. PAP approach is an assessment of student success determined through criteria set before the test takes place (Magdalena et al., 2023). The collected data was obtained through two techniques, namely, test and non-test techniques. The test technique is the data on students' scientific literacy competency tests. In comparison, the non-test data is the summary data of the results of the student response questionnaire and the data on the student's ability rubric in the field. The N-gain Test statistical analysis is a method commonly used to measure the effectiveness of learning in improving students' scientific literacy learning outcomes. This method provides a strong foundation for evaluating the extent to which a learning program has contributed to students' understanding (Sukarelawa et al., 2024).

Table 1. Stages in developing contextual physics module teaching materials

No	Stage (Phase)	Operating instructions	Execution time
1	**Preliminary investigation phase**	The activities carried out in this Phase involve identifying real conditions in the field through three stages: (1) problem and needs analysis, (2) literature studies, and (3) discussions with experts.	May 10 to 30, 2024
2	Design phase	This phase is the process of designing solutions to the problem of the initial investigation results. In this phase, there are three stages, namely: 1. Studying the syntax of the contextual teaching and learning (CTL) approach. 2. Developing learning tools based on CTL approach syntax. 3. In addition, contextual teaching materials are needed to support developing and improving students' scientific literacy and scientific communication skills during the learning process.	June 01 to 18, 2024
3	Realization or construction phase	This stage is a continuation of the previous phase, where the basic form of the product has been produced as a result of the realization of the design phase, namely contextual physics module teaching materials (prototype 1). In addition, other supporting instruments have also been developed and formed, such as: 1. Expert validation sheet. 2. Student response questionnaire for the prototype 1 trial stage. 3. Student science literacy competency test questions. 4. Student scientific communication skills rubric.	July 20 to 30, 2024
4	Test, evaluation and revision phase	This stage is focused on assessing the validity, practicality, and effectiveness of the developed learning tools. This phase carries out three main activities, namely: 1. Validation of physics module teaching materials by experts. 1. Conducting field trials of prototype 1. 2. Testing students' scientific literacy competency abilities.	August 10 to September 20, 2024
5	Implementation phase	The implementation phase is the final stage in this development model, during which valid, practical and effective contextual physics module teaching materials are	October 05 to 10, 2024

obtained and ready for widespread use. The ready-to-use teaching material product is named prototype 2.

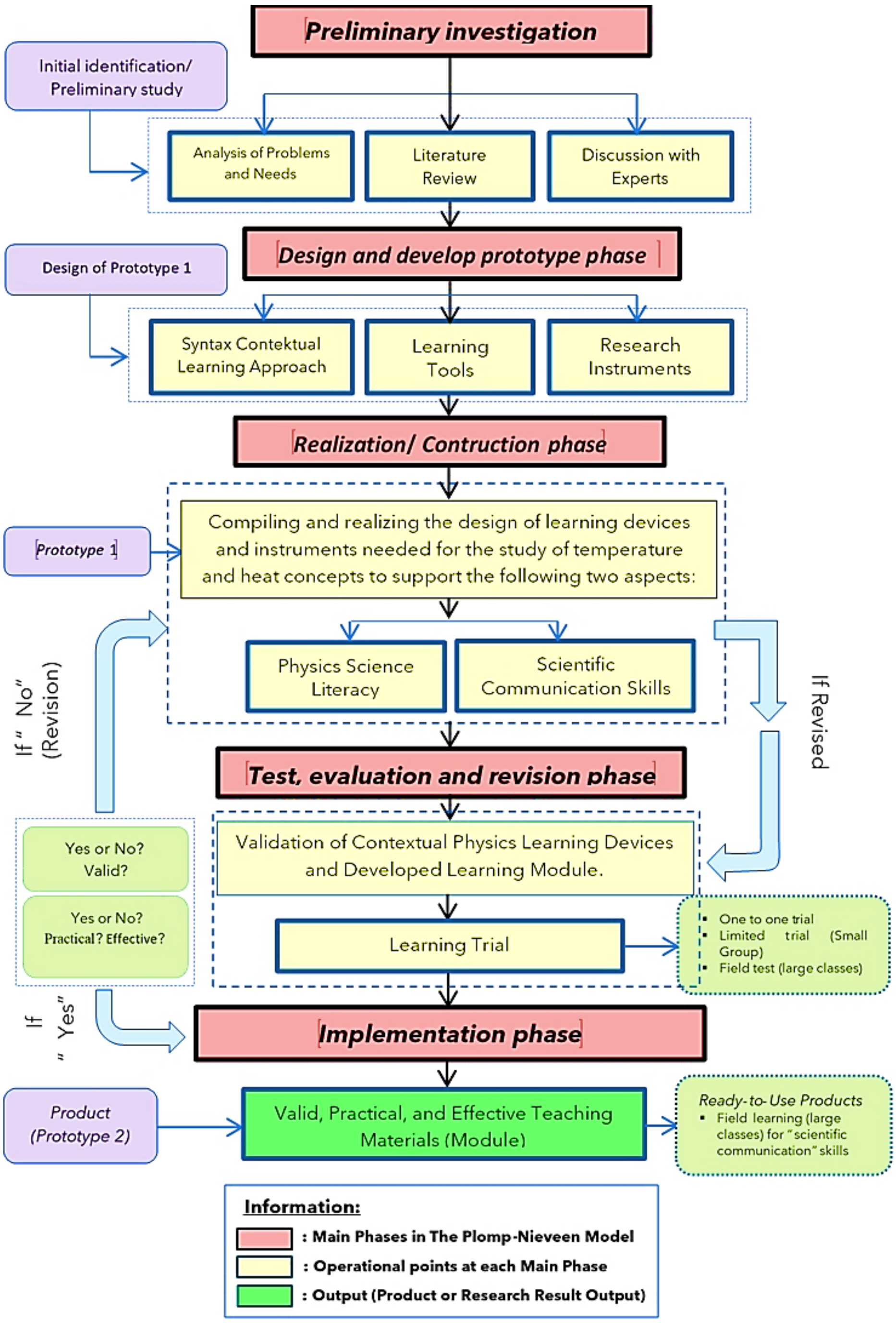


Figure 2. Flow chart of research design

The data analysis techniques used by researchers in this study are walkthrough, student response questionnaires, rubrics and multiple-choice test questions. Some of these components will be explained as follows:

Walkthrough

A walkthrough is a step taken/used to determine the validity of a product developed by involving experts (validators). The validators in validating the contextual learning module teaching materials are one lecturer in physics education and two lecturers in physics science. Each expert will validate the contextual physics learning module, referring to three main indicators: content (substance), language, and construction. The content aspect (substance) consists of six derivative indicators, the linguistic aspect consists of five derivative indicators, and the construction aspect consists of four derivative indicators. Table 2 presents each indicator used as a reference in validating the contextual physics learning module.

Table 2. Main indicator, derivative indicator aspects, coverage/scope, and number of statements from each derivative indicator aspect

Main Indicator Aspects	Aspects of derived indicators	Coverage/scope	Number of statements
Content (substance)	**Suitability of Material with Cognitive Domain Achievement Indicators**	Related to the completeness, suitability, and depth of the material according to the indicators of cognitive domain achievement.	3
	Suitability of Material with Science Literacy Competency Indicators	Related to the suitability of the material with aspects of scientific literacy in the competency domain.	3
	Contextual Nature and Contextual Components	Related to the integration aspect between contextual, scientific literacy, and scientific communication skills in geothermal areas.	4
	Encouraging Curiosity and Scientific Communication	Related to curiosity and scientific communication skills.	3
	Material Accuracy	Related to the accuracy of concepts, definitions, data, facts, examples, images, illustrations, and terms related to the concepts of temperature and heat.	4
	Material Update	Related to using illustrations and examples in everyday life.	2
Language	Straightforward	Correctness of structure, effectiveness of sentences, and standardization of terms	3
	Communicative	Understanding of messages or information and scientific communication skills are developed.	3
	Dialogical and Interactive	Ability to motivate students.	1

	Suitability to Student Development	Suitability to the intellectual development and emotional level of students.	2
	Suitability to Language Rules	The grammar and spelling accuracy is by PEUBEI (General Guidelines for Indonesian Spelling).	2
Construction	Presentation Techniques	Conceptual Collapse.	1
	Presentation Support	Examples of images and illustrations in each learning activity indicator, an introduction, and a bibliography.	4
	Learning Presentation	Student involvement in the learning process, supporting scientific literacy, and activating scientific communication skills in each component of the student activity sheet.	3
	Coherence and Sequence of Thought Flow	Regularity and Integrity of meaning in learning activities / sub-learning activities	2

After the validation value is obtained, it is then adjusted to the validation criteria category, referring to the reference adopted from Amaliyah et al. (2023). Specifically, the very valid criteria are in the range of 81 - 100%; the valid criteria are in the range of 61 - 80%; the Quite Valid criteria are in the range of 41 - 60%; the Invalid criteria are in the range of 21 - 40%, while the very Invalid criteria are in the range of 0 - 20%.

Student Response Questionnaire

A student response questionnaire is a non-test instrument used to check students' responses about the level of practicality of the developed contextual physics learning module. This questionnaire will be used for one-to-one test responses in non-field learning activities and limited class trial responses (small groups) in the field. The product trial (contextual physics learning module) uses a student response questionnaire sheet in the form of a Likert scale. The main aspects observed in the Student Response Questionnaire on the Practicality of the contextual physics learning module consist of three main components, namely (1) Content Quality Aspect, (2) Language aspect, and (2) construction or presentation aspect. The Content Quality Aspect consists of 12 statements related to presentation material, the contextual scope for teaching materials, scientific literacy, scientific communication skills, and examples of contextual phenomena in the geothermal environment. The language quality aspect consists of 5 statements related to ease of access to understand the substance of the module, language style and terms that can motivate readers, ease of access to written messages, supporting scientific communication aspects, and grammatical accuracy. Meanwhile, the construction aspect (presentation) consists of 5 statements related to the sequence of concepts, illustrations, and examples of images in presentation units (worksheets and supporting information), the construction of materials in worksheets can direct student learning activities, space for students involvement in the learning process that can support scientific literacy, order between learning activities / sub-learning activities and the integrity of meaning in learning activities / sub-learning activities. Furthermore, the practicality values obtained are then grouped/adjusted based on the practicality criteria adopted from Amaliyah et al. (2023), namely, the very practical category are in the range of 81 - 100%; the Practical category are in the range of 61 - 80%, the Quite Practical category is in the range of 41 - 60%, the Impractical category is in the range of 21 - 40%, while totally Impractical category are in the range of 0 - 20%.

Scientific Communication (SC) Skills Rubric

Scientific Communication (SC) Skills Rubric is a non-test instrument in the form of an observation sheet developed in the form of a "SC" skills rubric adapted from Levy et al. (2009) concerning six main skills, namely: (1) Information retrieval, (2) Scientific reading, (3) Listening and observing, (4) Scientific writing, (5) Information representation, and (6) Knowledge presentation. Students' SC Skills will be measured on each Student Worksheet (SW), where there are six SWs in the developed module teaching materials, where the concept of temperature consists of three SWs and the concept of heat consists of three SWs. SC Skills will be displayed in classical achievements. Data obtained from the student's SC Skills rubric is quantitative data that will be analyzed descriptively by calculating the score. The criteria for students' scientific communication skills are adapted from STKIP Gotong Royong Masohi student achievement category reference, as in the study by Siombone & Niwele, (2023), namely the Very Good category are in the value range of 85 - 100; the good category is in the value range of 70 – 84, the Quite Good category is in the value range of 56 – 69, the Less category is in the value range of 40 – 55, while Failed is in the value range of 0 – 39.

Physics Science Literacy Competency Test Questions

The test instrument is in the form of multiple-choice questions covering the domain of scientific literacy competency related to the concept of temperature and heat that are contextual to the geothermal area environmental site. The test questions consist of 17 questions, which are then used for the pre-test and post-test. The test items for the physics science literacy ability are developed referring to the OECD (Organisation for Economic Co-operation and Development) science literacy competency domain, namely explaining phenomena scientifically, evaluating and designing scientific discoveries, and interpreting data and evidence scientifically (OECD, 2023). The existing instruments were developed independently without being adapted from other researchers but were developed by referring to relevant scientific literature such as in the research of Hasyim et al. (2022), Mukharomah et al. (2021) and in the book by Widodo et al. (2024). The developed test instrument did not undergo item validation or reliability testing but was developed with an approach to checking the truth/accuracy of the questions from colleagues or experts from relevant scientific fields. Suggestions and input for each question item in the peer or expert checking process will then be used as a reference in revising the developed questions. The indicators for achieving cognitive domain competencies are shown in Table 3a, while the relationship between indicators for the scientific literacy competency domain and indicators for achieving cognitive domain competencies is shown in Table 3b.

Table 3a. Concept structure, student worksheets, and cognitive domain competency achievement indicator

Concept	Student Worksheet (SW)	Cognitive Domain Achievement Indicators (Bloom's Taxonomy)	Cognitive Level
Temperature	SW 01	1. Students can know the function of each part of a thermometer.	C1
		2. Students can explain the parts of a thermometer.	C2
	SW 02	3. Students can differentiate the functions of the sense of touch and thermometer.	C3
		4. Students can compare the results of temperature measurements qualitatively and quantitatively.	C3
	SW 03	5. Students can explain the phenomenon of liquid expansion.	C2
		6. Students can explain the principle of liquid expansion in a simple thermometer.	C2
Heat	SW 04	7. Students are able to explain the properties of liquids when given heat and mass is added.	C2
		8. Students are able to describe the effect of mass variations (m) on the amount of heat (Q) absorbed by a substance.	C3
	SW 05	9. Students can explain the definition of heat capacity.	C2
		10. Students can explain the working principle of a Calorimeter.	C2
		11. Students can measure the heat capacity of a Calorimeter.	C3
	SW 06	12. Students can investigate the heat conduction in various objects in geothermal area.	C3
		13. Students can investigate the flow process (convection) in liquids and solids.	C3
		14. Students can investigate the radiation process from heat sources to objects around us.	C3
		15. Students can describe the nature of heat transfer by conduction, convection, and radiation.in geothermal area.	C3

Tabel 3b. Relationship between indicators of scientific literacy competency domain and indicators of cognitive domain achievement

Indicators of Science Literacy Competency	Special Indicators of Science Literacy	Cognitive Domain Achievement Indicators	Item No.
Explaining phenomena scientifically	a. Remembering and applying relevant scientific knowledge	○ Students can know the function of each part of a thermometer. ○ Students can explain the parts of a thermometer.	1 & 2

Indicators of Science Literacy Competency	**Special Indicators of Science Literacy**	**Cognitive Domain Achievement Indicators**	**Item No.**
	b. Identifying, using, and producing precise representations	○ Students can investigate the process of radiation from heat sources to objects around us.	4
	c. Making and justifying appropriate predictions.	○ Students can explain the concept of the phenomenon of liquid expansion.	6
	d. Offering explanatory hypotheses	○ Students can explain the principle of liquid expansion in a simple thermometer.	7
	e. Explaining the potential implications of science for society	○ Students can describe the nature of heat transfer by conduction, convection, and radiation.	5
Evaluating and designing scientific discoveries	a. Identifying the questions to be investigated in a particular scientific study	○ Students can compare the results of temperature measurements qualitatively and quantitatively. ○ Students can differentiate the function of the sense of touch and thermometer.	3 & 8
	b. Determining possible questions to be investigated scientifically	○ Students can explain the working principle of a calorimeter.	14
	c. Proposing ways to investigate a given question scientifically	○ Students can measure the heat capacity of a Calorimeter.	15
	d. Evaluating ways to investigate a given question scientifically	○ Students can investigate the heat conduction in various objects in geothermal area.	11
	e. Explaining and evaluating the various ways scientists use to ensure the accuracy of data and the objectivity and explanatory power of generalizations	○ Students can describe the effect of mass variations (m) on the amount of heat (Q) absorbed by a substance.	12
Interpreting data and evidence scientifically	a. Transforming data from one representation to another.	○ Students can describe the nature of heat transfer by conduction, convection, and radiation.	17
	b. Analyzing and interpreting data and drawing appropriate conclusions.	○ Students can investigate the flow process (convection) in liquids and solids.	10
	c. Identifying assumptions, evidence, and reasoning in science-related texts.	○ Students can describe the nature of heat transfer by conduction, convection, and radiation.	13

Indicators of Science Literacy Competency	Special Indicators of Science Literacy	Cognitive Domain Achievement Indicators	Item No.
	d. Distinguishing between arguments based on scientific evidence and theories based on considerations.	○ Students can investigate the conductivity (conduction) of heat in various objects in geothermal area.	9
	e. Evaluating scientific arguments and evidence from various sources (e.g., newspapers, the internet, journals)	○ Students can describe the nature of heat transfer by conduction, convection, and radiation in geothermal area.	16

The effectiveness of the contextual physics learning module is obtained from the analysis of data from the results of product implementation (field test), whether there is an increase in science literacy skills or not. The increase in students' science literacy skills can be measured by calculating the N-gain score based on the pre-test and post-test schemes (Masfufah et al., 2020; Meltzer, 2002). The N-gain (Normalized Gain) score ranges from -1 to 1. Positive values indicate an increase in student learning outcomes after learning, while negative values indicate a decrease in student learning outcomes (Sukarelawa et al., 2024). In this study's Normalized Gain score, the researcher (author) adopted the N-gain equation from research by Hake (1998) and Meltzer (2002). The category of the magnitude of the increase in the N-gain score can refer to the Normalized Gain criteria as referred to in the book written by Sukarelawa et al. (2024), namely high gain criteria with an interval of $0.70 \leq g \leq 1.00$, moderate gain criteria with an interval of $0.30 \leq g \leq 0.70$, low gain criteria with an interval of $0.00 \leq g \leq 0.30$, no gain increase criteria at all $g = 100$, and a decrease in criteria with an interval of $-1.00 \leq g < 0.00$. Meanwhile, the level of effectiveness of the implementation of the intervention of a developed module teaching material can refer to the reference book written by Sukarelawa et al. (2024), where the effective category is in the range of >76%, the Quite Effective category is at a percentage of 56 - 75%, the Less Effective category is at a percentage of 40 - 55%, while Ineffective is at a percentage of <40%

▪ RESULT AND DISSCUSSION

The researcher will present the results and discussion of this study in the form of a description of the process of developing a contextual physics learning module and the results of data analysis obtained during the development process to produce a valid, practical, and effective learning module, as in the stages in the Plomp & Nieveen development model.

Preliminary Investigation Phase

This phase is the initial stage where researchers identify the actual conditions of student needs in the field. The main objective of this phase is to find the best solution to solve the problems faced and to meet/answer the needs in the teaching and learning process of general physics subjects, which is carried out through relevant literature studies and discussions with experts in the field being studied. After analyzing the problems and needs, it was found that students' weak ability to learn general physics was caused by more focused learning in the classroom or the laboratory. Thus, there was minimal opportunity to improve students' scientific literacy and communication skills directly. In addition, contextual learning modules are needed to support developing and improving students' scientific literacy competence and scientific communication skills during the learning process.

Design Phase

The steps taken in this phase are to study the syntax of the contextual teaching and learning (CTL) approach to develop topics from the concept of temperature to the concept of heat, to develop learning tools in the form of Lecture Program Units (SAP) and Semester Learning Plans (RPS). The next step is to design and compile a draft as a compilation of materials consisting of student worksheets on each concept written separately into one unit. The draft is also equipped with components that will be carried out on the prototype-1 contextual physics learning module.

Realization/Construction Phase

This stage is a continuation of the design phase, where in this phase, the basic form of the contextual physics learning module product (called the prototype-1) has been realized. In addition, in this phase, main supporting instruments have been developed and formed, such as Expert validation sheets (walkthrough), Student response questionnaires for the prototype-1 trials, scientific literacy competency test questions, and scientific communication skills rubrics. These main supporting instruments will be implemented in field assessments by experts (validators), respondents (students), and lectures. Figure 3 shows the appearance of the prototype-1 before and after revision.

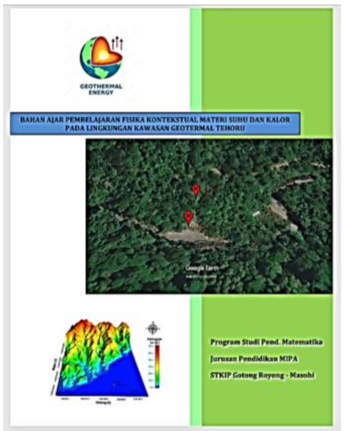


Figure 3a. Display of learning module (prototype-1) before revision.

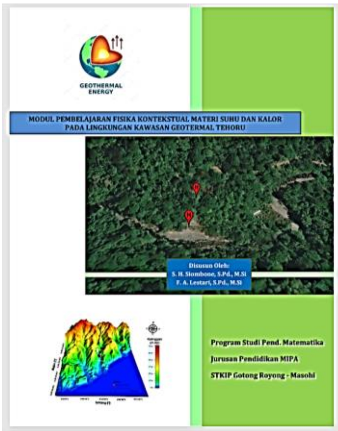


Figure 3b. Display of learning module (prototype-1) after revision.

Test, Evaluation, and Revision Phase

This phase is the most important (essential) in assessing and testing the quality of the developed contextual physics learning module. The stages in this phase include the Validation of the physics learning module by experts, conducting field trials of prototype-

1, and testing students' scientific literacy competency abilities. The stages in this phase will be described as follows:

Validation of Physics Learning Module

This stage is also known as a walkthrough, where the developed learning module (prototype-1) is assessed by experts (validators) covering aspects of content (substance), language, and construction. Three experts validate the developed learning module. In addition, in this stage, the learning module is revised with corrections and suggestions from each expert. The assessment of prototype-1 uses the expert validation sheets in the form of a Likert scale questionnaire. The validation results from the three experts are shown in Figure 4.

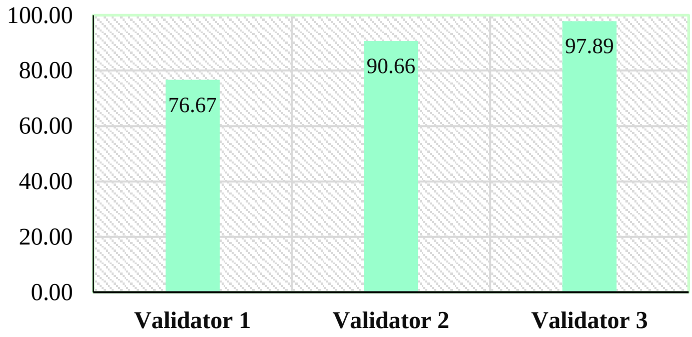


Figure 4. Summary graph of the results of the three Validators' assessments

Based on Figure 4, the average percentage of validation results from the three experts (validators) is 88.41%, which shows that the validation result is very valid. In addition, the average percentage validation result shows that the contextual physics learning module (prototype-1) developed has been good in terms of substance (content), language, and construction aspects so that it can be tested in field learning. On the other hand, the expert provided some corrections and suggestions for revision in substance, language, and construction. Based on these corrections and suggestions, the author considered revising the learning module that was being developed.

The display of Figure 5a and Figure 5b is a suggestion from the validator to improve the Construction and Substance aspects. At the same time, the language aspect is considered good. These suggestions and inputs are constructive in developing a better contextual physics learning module.

The existence of supporting information at the beginning of each concept chapter, brief material at the beginning of the worksheet in the learning module, and student worksheets that have been set in the syntax of the contextual approach are specific components of the module developed to direct students to be able to learn directly in the Geothermal Area gradually following the stages or syntax of the approach. The stages of learning as the syntax of the contextual approach consisting of the stages of constructivism, finding, asking the learning community, modeling, reflection, to the assessment stage have been designed in such a way that they can stimulate students to learn directly in nature (Geothermal Area) so that they have the potential to improve students' scientific literacy skills and can build good scientific communication skills. In

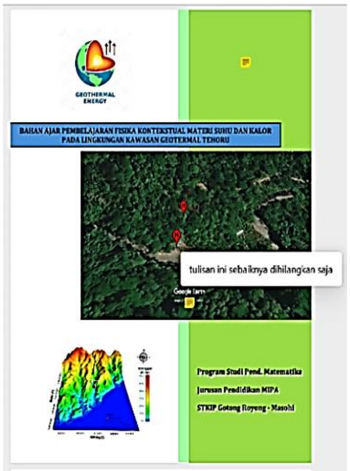
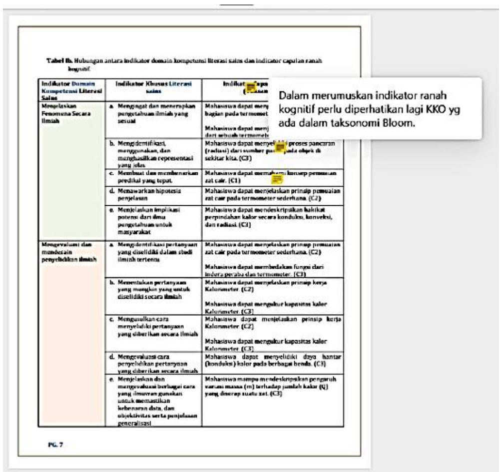


Figure 5a. Suggestions for Construction Aspects.



Gambar 5b. Suggestions for Substantion Aspects.

addition, validation from experts in the form of constructive suggestions and input is very useful for improving prototype 1 of the contextual learning module so that later, it can contribute to the effectiveness of the developed module.

Conducting Field Trials

Validated and revised learning modules, according to suggestions, corrections, and input from validators before being widely produced, must be tested, both tested One to one and then tested on a limited basis (small group). This trial is conducted to determine the level of practicality of the learning module that has been developed. One-to-one trials involve three respondents (students), while small-group trials involve eight. One-to-one trials are conducted without taking students to the field (geothermal area); students are simply asked to study the module (prototype-1), and then students are directed to fill out a questionnaire to determine students’ responses to the prototype-1 module that has been developed. The Prototype-1 module tested one-to-one can then be tested on a limited basis in small groups. Small group trials are conducted by taking students to the field (geothermal area), and then lecturers guide students to study the prototype-1 module. Students are directed to fill out a questionnaire to determine their responses to the prototype-1 module that has been developed. The average results of student responses in the One-to-one and Small-group trial stages are shown in Figure 6a and Figure 6b.

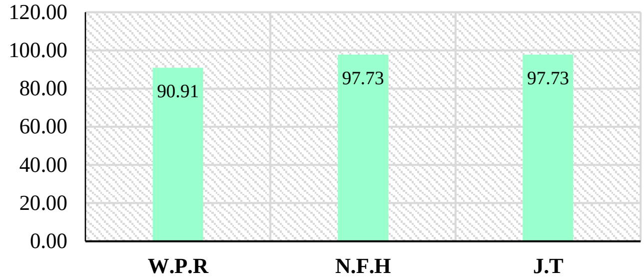


Figure 6a. Graph of the average results of student responses in the One-to-one Trial

Figure 6a shows that the average percentage of student responses to the one-to-one trial questionnaire is 95.45%, which shows that the learning modules developed are very practical. In addition, students gave suggestions and comments on prototype 1.

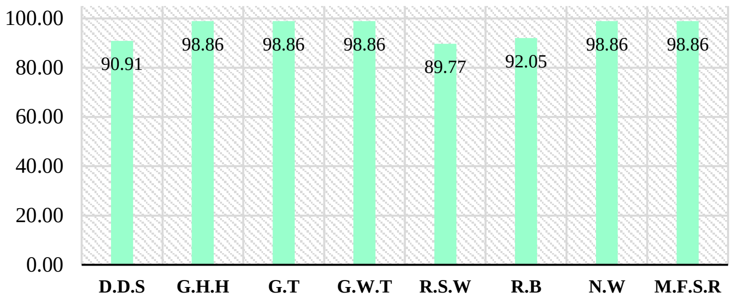


Figure 6b. Graph of the average results of student responses in the Small Group Trial

The data in Figure 6b show that the trial results in small groups show student response percentages ranging from 89.77% to 98.86%. The average percentage of student response results shows that the developed learning module has an average value of 95.88%, which is very practical. Limited trial (small group) activity on the prototype-1 in the field is shown in Figure 7.

Figure 7. Student activities at field learning in small group trial.

Figure 7 shows a student learning activity in the field that implements prototype 1. This student activity is conducted to learn and test each worksheet contextually in prototype 1.

Testing Students' Scientific Literacy Competency Abilities

The student science literacy competency test stage was tested twice in the pre-test and the post-test. This science literacy competency test was tested on 27 2nd semester students taking general physics subjects. The matter tested for student science literacy competence were the concepts of temperature and heat, which was the scope of the material and competencies that must be achieved in learning and studying the contextual physics learning module. The scientific literacy competency test conducted aims to determine the improvement of students' scientific literacy abilities and to measure the effectiveness level of the development of contextual learning modules that have been carried out. The improvement in scientific literacy ability is showing the level of effectiveness of the contextual physics learning module that has been developed. The results of the N-gain value of student learning outcomes based on the pre-test and post-test schemes will be presented in Table 4.

Table 4. N-gain value and average pre-test and post-test of student scientific literacy competence

Pre-test average value	Post-test average value	Class of N-gain value	Number of Students	Percentage (%)	Interpret. of N-gain	Average of N-gain	Classical interpret. of N-gain
30.28	82,57	g > 0.7	16	59.26 %	High	0,75	High
		0.30 ≤ g ≤ 0.70	11	40.74 %	Medium		
		g ≤ 0.30	0	0 %	Low		

Based on Table 4, the average value of students' scientific literacy competency achievement increased from a Pre-test average of 30.28 to a Post-test average of 82.57. In addition, as many as 16 students or 59.26%, had N-gain values in the high category, while 11 students or 40.74%, had N-gain values in the medium category. The average N-gain classically was 0.75, which was in the high category. The increase in scientific literacy skills classically is shown in Figure 8.

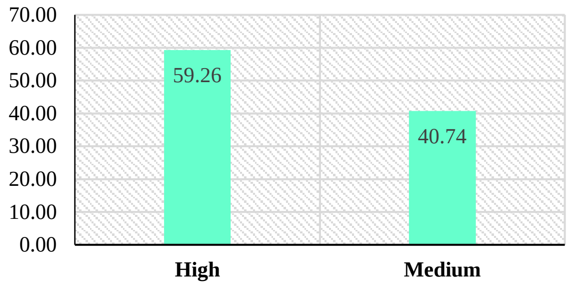


Figure 8. Clasification of N-gain value is based on the students' classical achievements

Figure 8 shows that the increase in student learning outcomes based on classical N-gain achievement is 59.26% in the high category, while 40.74% is in the medium category. Suppose these results are related to the criteria for determining the level of effectiveness in reference book created by Sukarelawa et al. (2024). In that case, the contextual physics learning module developed has been in the effective category because 100% (> 76%) of students classically experienced a significant increase in N-gain values.

Based on the data in Table 4 and visualized in Figure 8, it shows that the implementation of the results of the development of contextual physics modules based on Geothermal Areas can improve student learning outcomes with a very significant increase in the average science literacy ability from 30.28 in the Pre-test to 82.57 in the post-test. If referring to the average N-gain score of 0.75, this result shows a relatively high increase in science literacy competency, where the majority of students, 59.26%, are in the high category, and the remaining 40.74% are in the medium category. If referring to the category of effectiveness of a learning process in the book by Sukarelawa et al. (2024), the module developed 100% effectively impacts student learning outcomes. The findings in this study are in line with the results of research conducted by Maryam et al. (2023) on the topic of developing contextual learning and teaching modules on soil and sustainability of life materials to improve scientific literacy skills, with the findings of the development of CTL-based Science Modules also stated to be effective by obtaining an n-gain of 0.82 with high criteria. The results of the same study conducted by Hanifha et al. (2023) on the topic of developing socioscientific issue-based undergraduate student working papers on scientific literacy were able to contribute to scientific literacy with an increase in N-gain of 0.57, which is in the moderate category. In addition, the same results research by Pursitasari et al. (2019) with the title of developing teaching materials containing in-depth contexts to improve students' scientific literacy contributed to increasing literacy in the moderate category with an N-gain of 42.11%. The findings of this study show that the development of teaching materials that refer to the environment or local wisdom sources can help improve students' scientific literacy skills.

Implementation Phase

The implementation phase is the final stage in this development model, during which valid, practical, and effective contextual physics learning modules are obtained and ready for widespread use. The ready-to-use teaching material product is named the prototype-2. This phase has been carried out extensively by producing prototype 2 to be applied to the learning process in the field. In this phase, prototype 2 assesses students' scientific communication (SC) skills. Learning is carried out in two meetings (face-to-face) to implement a contextual physics learning module (prototype-2). The first meeting focuses on students' SC skills regarding the concept of temperature, and it consists of three student worksheets (SW). Besides, the second meeting, which consists of three SWs, is focused on students' SC skills in the concept of heat. These skills are monitored using the "SC skills" rubric. The skill aspects observed from this skill consist of 6 aspects, namely: (1) Retrieving information, (2) Scientific reading, (3) Listening and observing, (4) Scientific writing, (5) Information representation, and (6) Presentation of knowledge. Table 5 presents the results of students' SC skills in each aspect as a class during two meetings.

Table 5. Students' scientific communication skills classically in each aspect

Meeting	**Aspects of Scientific Communication (SC) Skill**						**Average of Total SC Skills**
	Information retrieval	Scientific reading	Listening and observing	Scientific writing	Information representation	Knowledge presentation	
Meeting 1	90.74	91.67	95.37	90.43	86.11	91.36	90.95
Meeting 2	91.36	95.06	95.99	92.28	89.51	92.90	92.85
Average Each Aspect	91.05	93.36	95.68	91.36	87.81	92.13	

Table 5 shows that the average ability of students' scientific communication skills is very good. In addition, there was an increase in the achievement of each aspect of their skills from meeting 1 to meeting 2. It can be shown by the average achievement of students' total scientific communication skills at meeting one, which was 90.95, increasing to 92.85 at the second meeting. Figure 9 presents students' scientific communication skills in each aspect of skills in two meetings.

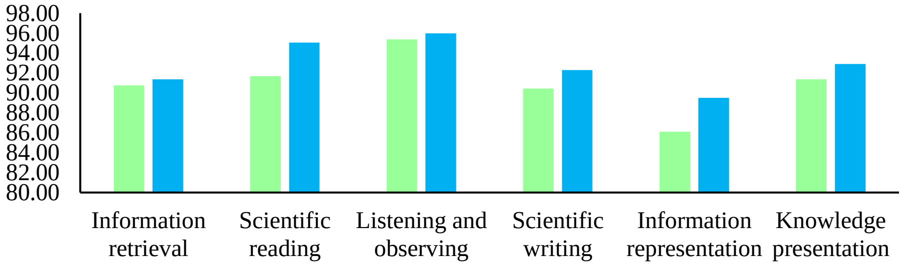


Figure 9. Display of students' Scientific Communication (SC) Skills in each aspect during two meetings

Figure 9 shows that the results of implementing the contextual physics learning module (prototype-2) can improve students' SC skills in all existing aspects. The increase can be seen from the profile graph of each aspect of students' SC skills from the first meeting to the second meeting. The highest increase in SC skills achievement is in the Listening and Observing aspect, with an average value of 95.68, while the lowest is in the information representation aspect, with an average of 87.81. The Listening and Observing aspect skills showed a very prominent increase because they were related to the basic ability to listen and observe phenomena in the surrounding environment, which was quite easy to do. Meanwhile, the information representation aspect skills obtained lower results because this skill aspect was very complete and complex because it involved elements of understanding integration and the ability to process and analyze data (Harisanti, 2019). As seen in the graph of Figure 9, several aspects of scientific communication skills have experienced a fairly significant increase in achievement, namely in the scientific reading skill, with an average achievement of 93.36, and in the Knowledge presentation skill, with an average achievement of 92.13. These three abilities have quite prominent improvements because they relate to fundamental interaction skills, namely reading, writing, and observing; these three components are interrelated (Dewi et al., 2019). The increase in achievement of each aspect of SC skills is supported by the contextual physics learning module (prototype-2), tested for validity, practicality and effectiveness. The learning process activities in the geothermal field in the implementation of prototype-2 to monitor and assess students' SC skills are shown in Figure 10.

Figure 10. Implement contextual physics teaching modules (prototype-2) in the geothermal field of Tehoru village to monitor and measure students' SC skills.

Figure 10 shows student activities in field learning using the contextual physics teaching module (prototype-2) to complete each student worksheet related to temperature and heat concepts. Lecturers still guide field learning activities to direct student learning activities, such as the syntax of the contextual approach and achievement indicators of each student worksheet in the module. In addition, lecturers and observers (colleague lecturers) still monitor students in the process of group learning to monitor and assess each student's SC skills.

The developed contextual physics learning module has undergone a validation process by experts and has been tested in both one-on-one trials and limited class trials (small group) and field trials to the final stage, namely the implementation of prototype 2. This learning module (prototype-2) has been developed following the stages created by the Plomp & Nieveen model. Based on Table 4, it can be seen that the developed contextual physics learning module can improve the scientific literacy competencies of STKIP Gotong Royong Masohi students related to the concepts of temperature and heat. The measured physics science literacy ability (concepts of temperature and heat) is in the competency domain, referring to OECD PISA 2022. The increase in students' scientific literacy competencies is in the high N-gain category of 59.26%; in comparison, the medium category is 40.47%, while the average classical N-gain is 0.75, which is in the high category. These results indicate that the developed contextual physics learning module based on the Geothermal Area has effectively improved students' scientific literacy competencies on temperature and heat concepts. The increase in students' scientific literacy competencies shows that the developed contextual physics learning module was valid and practical, and it potentially has a positive effect in helping to improve scientific literacy competencies as expected. This is in line with (Sari et al., 2022) research, which states that contextual learning can improve students' scientific literacy skills because the characteristics and stages of contextual learning are suitable for training students' scientific literacy skills. Contextual learning improves scientific literacy skills through the learning process obtained through direct experience (concrete) and reality in a geothermal area environment. In addition, Astiti. (2019), in his research, stated that contextual-based teaching materials provide opportunities for students to discover concepts through events/incidents related to everyday life with a contextual approach.

The learning module, designed with a contextual teaching and learning (CTL) approach arrangement, allows students to process more deeply and study the concept of temperature and heat directly in geothermal areas through the stages/syntax of the CTL approach. The syntax of the CTL approach consisting of (1) constructivism, (2) inquiry, (3) asking, (4) learning community, (5) modelling, (6) reflection, and (7) authentic assessment is expected to direct students to build their knowledge, find concepts and prove them, train students to express curiosity about real concepts in the field, train students to discuss with their peers in understanding concepts, provide models/examples to students to train students in overcoming problems, to find out the ability or understanding related to the concepts that have been learned, and to find out the students' actual abilities (Astiti, 2019). The syntax of the CTL approach is included and designed in the learning module's body to form good scientific communication skills for students. The scientific communication skills program focuses on oral and written communication skills, such as speaking, listening, writing, and reading. These basic communication skills are then broken down into (1) Retrieving information, (2) Scientific reading, (3) Listening and observing, (4) Scientific writing, (5) Information representation, and (6) Presentation of knowledge. Good scientific communication skills can certainly support the formation of good scientific literacy. This is in line with Levy's research (2009), which states that one of the goals of the "scientific communication" program is to improve students' scientific literacy. In addition, Levy et al. (2009) also said, "The scientific communication skills teaching model can be applied to teaching other high-level and advanced skills such as thinking skills, investigations, and problem-solving skills. Thus, our general model can enable teachers and educators to promote good scientific literacy acquisition.

Table 5 shows that the average total of students' scientific communication skills at the first meeting for the concept of temperature is in the very good category, which is 90.95. In contrast, there was an increase at the second meeting for the concept of heat, which was 92.85. This increase is because the stages of the contextual teaching and learning (CTL) approach can provide a vast space for students to develop their scientific communication skills. Based on the data in Table 5, it shows that the average of each aspect of scientific communication skills is in the very good category; the aspect with the lowest achievement is the information representation skill, which is 87.81, while the aspect with the highest achievement is the listening and observing skill with a value of 95.68. In this study, the information representation aspect received a lower score than the other aspects because the aspect of this skill is more complex and requires students to be able to create tables, create investigation schemes, and present data in graphical form; this process also requires students to understand the concept on each worksheet in more depth. These results are in line with research by Mustika (2023), which examines scientific communication skills from verbal and writing aspects, where the verbal aspect related to the ability to "Present images, graphs, equations and tables" obtained the lowest score of 56 while writing for the ability to "Draw graphs, equations and tables" also obtained the lowest score of 76. Listening and observing skills are aspects of scientific communication skills with the highest achievement because this aspect contains instructions that are not as complex as the information representation skills aspect. Listening and observing skills are related to the ability to observe, listen to explanations from lecturers, observe readings and connect between theory and reality in the field, and listen to directions from group leaders. Concrete examples of aspects of Listening and observing skills observed in the assessment rubric are Observing the conditions of the surrounding environment or the object being studied, listening to explanations from instructors, lecturers, and group leaders, Observing readings, and linking the relationship between theory and natural conditions in the field; and Listening to directions from the group leader and explanations from other group members. These Listening and observing skills are the most striking achievements because they are related to basic instructions and are very connected to environmental aspects or local wisdom during the learning process in the field. (Dewi et al., 2019).

Other skill aspects in scientific communication skills, such as Information retrieval skills, Scientific writing, Knowledge presentation, and Scientific reading, respectively, have an average achievement of 91.05, 91.36, 92.13, and 93.36, which are very good categories. These aspects of communication skills achieve the highest achievement because these skills can be carried out well by students; in addition, student worksheets in the learning module provide space for students to process contextually at the geothermal field, where this approach directs students to link physics concepts to real-world contexts (Sari et al., 2022). This condition shows that the development of contextual physics learning modules based on geothermal areas can directly support, stimulate, and shape the achievement of better scientific communication skills. According to Yolanda et al. (2021), contextual teaching modules can build meaningfulness in experience-based learning; students are guided through inquiry, can build scientific thinking skills and good scientific communication skills, provide solutions to every student's learning problem by asking questions, and guide students in reviewing the material that has been taught. The availability of quality teaching modules tested for validity, practicality, and effectiveness will significantly support the success of a learning process.

Apart from the achievement of increasing the ability of scientific literacy competency and high scientific communication skills of students during the learning process in the field, there are several challenges faced by teachers (lecturers) in implementing this geothermal area-based contextual learning module, namely the need for clear technical implementation instructions, the need for training for teachers to become more established in implementing learning modules. In addition, there are other obstacles, such as mobilization or access to geothermal locations, considering that the Tehoru Geothermal Area is quite far from the location of universities or related agencies. In addition, if it is to be implemented in the world of education in high schools or junior high schools, adequate funding is also needed from sponsors or funders because it will only be possible if implemented independently with sponsorship from funders.

▪ CONCLUSION

The development of contextual physics learning modules based on geothermal areas using the Educational Design Research method through the Plomp & Nieveen development model has been carried out to obtain valid, practical, and effective contextual physics learning modules. The average percentage of validation results from three experts for the content, language, and construct aspects was 88.41%, indicating that the developed learning module is in the very valid category. The results of one-to-one and limited class trials of the learning module obtained average percentages of 95.45% and 95.88%, indicating that the developed learning module is in the practical category. The field test results in the form of a science literacy competency test for the concept of temperature and heat through the pretest and posttest schemes can increase classical science literacy abilities with an average N-gain of 0.75, which is in the high category. In addition, the field test results showed competency achievement, where 59.26% were in the high category, and 40.74% were in the moderate category. These results indicate an increase in scientific literacy competency by 100% (> 76%) after implementing the contextual physics learning module based on geothermal areas. The increase in scientific literacy competency ability shows that the learning module developed has been in the effective category so that it can be implemented/produced on a large scale. The results of implementing the contextual physics learning module (prototype 2) in the geothermal field showed that every aspect of scientific communication skill measured was in the very good category. In addition, there was an increase in the average total achievement of students' scientific communication skills from the first meeting with a value of 90.95 to the second meeting with a value of 92.85. The research result data shows that developing the contextual physics learning module based on the geothermal area can improve students' physics science literacy competency and scientific communication skills.

▪ ACKNOWLEDGEMENT

Gratitude is expressed to the Directorate of Research, Technology, and Community Service (DRTPM) of the Ministry of Education and Culture of the Republic of Indonesia for funding the implementation of the research. Gratitude is also expressed to LLDikti Region 12, which has patronized every institution or higher education institution in the Maluku and North Maluku regions in the implementation of research initiated by the DRTPM of the Ministry of Education and Culture of the Republic of Indonesia. In addition, the author would like to express his gratitude to the Research and Community Service Institute (LPPM) Division of STKIP Gotong Royong Masohi for fostering and supporting the smooth implementation of the research.

▪ REFERENCES

Arrafi, W. Q. L., Wasis, W., Ningsetyo, M., Amiruddin, M. Z. Bin, Desysetyowati, N., & Sunarti, T. (2023). Implementation of probolinggo local wisdom-based problem-based learning model to improve the science literacy skills of high school students. Physics Education Research Journal, 5(1), 35–42. https://doi.org/10.21580/perj.2023.5.1.14285

Astiti, K. A. (n.d.). *Pengembangan bahan ajar fisika sma berbasis kontekstual pada materi suhu dan kalor.* Jurnal Pembelajaran Sains VOLUME, 3(1). http://journal2.um.ac.id/index.php/jpsi/

Baiq Muli Harisanti. (2019). *Implementasi model integrasi kearifan lokal dalam pembelajaran untuk mendeskripsikan keterampilan komunikasi ilmiah siswa.* Bioscientist: Jurnal Ilmiah Biologi, 7(2), 182–191. https://doi.org/DOI:10.33394/bioscientist.v7i2.2378

Dewi, I. N., Ibrahim, M., Poedjiastoeti, S., Prahani, B. K., Setiawan, D., & Sumarjan, S. (2019). Effectiveness of local wisdom integrated (LWI) learning model to improve scientific communication skills of junior high school students in science learning. Journal of Physics: Conference Series, 1157(2). https://doi.org/10.1088/1742-6596/1157/2/022014

Dona M. (2023). *Analisis keterampilan berpikir kritis, berpikir kreatif, komunikasi ilmiah dan kolaborasi mahasiswa pendidikan fisika.* GRAVITASI Jurnal Pendidikan Fisika dan Sains, Vol 6(02), 1–9. https://doi.org/https://doi.org/10.33059/gravitasi.jpfs.v6i02.8993

Ernawati; Sahputra, R., & Lestari, I. (2017). *Pengaruh model pembelajaran kontekstual berbasis lingkungan terhadap minat dan hasil belajar siswa pada koloid SMA.* Khatulistiwa: Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK), Vol 4(No 12), 1–12. https://doi.org/http://dx.doi.org/10.26418/jppk.v4i12.13076

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics, 66(1), 64–74. https://doi.org/10.1119/1.18809

Hanifha, S., Erna, M., Noer, A. M., & Talib, C. A. (2023). Socioscientific issue-based undergraduate student worksheets on scientific literacy and environmental awareness. Jurnal Pendidikan IPA Indonesia, 12(4), 504–513. https://doi.org/10.15294/jpii.v12i4.45817

Heni Masfufah, F., Ellianawati Jurusan Fisika, E., & Matematika dan Ilmu Pengetahuan Alam, F. (2020). *Peningkatan literasi sains siswa melalui pendekatan contextual teaching and learning (ctl) bermuatan etnosains.* Unnes Physics Education Journal Terakreditasi SINTA, 9(2). http://journal.unnes.ac.id/sju/index.php/upej

Wasis, Rahayu, Y. S., Sunart, T., & Indana S. (2020). *HoTs dan literasi sains (konsep, pembelajaran dan penilaiannya* (Tim Kun Fayakun, Ed.; Pertama, Vol. 1). Kun Fayakun. https://pusatstudiliterasi.unesa.ac.id/post/hots-dan-literasi-sains

Mutahharah Hasyim, M. A Martawijaya, Helmi, Taqwin, M., Herman, N. M., & Wahid. T. (2022). *Pengembangan instrumen soal berbasis literasi sains dan kearifan lokal pada siswa sekolah menengah atas.* In Research and Community Service Institute (Ed.), Proceeding of National Seminar (pp. 2046–2056). LP2M Universitas Negeri Makasar. https://ojs.unm.ac.id/semnaslemlit/article/view/40674

Irawan, F., Adawiyah, R., Zubaidah, S., & Arsih, F. (2023). Scientific literacy and communication skills a-re significant for enhancing students' creative thinking skills. AIP Conference Proceedings, 2569. https://doi.org/10.1063/5.0112412

Kemdikbud. (2023). PISA 2022 *dan Pemulihan Pembelajaran di Indonesia* (Vol. 1, Issue 1). https://www.kemdikbud.go.id/main/blog/2023/12/peringkat-indonesia-pada-pisa-2022-naik-56-posisi-dibanding-2018

Levy. S, O., Eylon, B. S., & Scherz, Z. (2008). Teaching communication skills in science: Tracing teacher change. Teaching and Teacher Education, 24(2), 462–477. https://doi.org/10.1016/j.tate.2006.10.009

Levy, S. O., Eylon, B. S., & Scherz, Z. (2009). Teaching scientific communication skills in science studies: Does it make a difference? International Journal of Science and Mathematics Education, 7(5), 875–903. https://doi.org/10.1007/s10763-009-9150-6

Lina, S. R. , R. Eko. , M. R. (2023). *Penerapan model pembelajaran kontekstual berbantuan media pembelajaran komik etnosains application of contextual learning model assisted by ethnoscience comic* (Vol. 12). http://jurnal.unimed.ac.id/2012/index.php/jpf

Magdalena, I., Arwindi, S., & Nayla Hasan, S. (2023). Developing assessment instruments for learning outcomes. review of multidisciplinary education. Review Of Multidisciplinary Education, 3(1). https://ojs.transpublika.com/index.php/ROMEO/

Melinda, V., Hariyono, E., Erman, E., & Prahani, B. K. (2021). Profile of students' scientific literacy in physics learning during COVID-19 pandemic. Journal of Physics: Conference Series, 2110(1). https://doi.org/10.1088/1742-6596/2110/1/012031

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. American Journal of Physics, 70(12), 1259–1268. https://doi.org/10.1119/1.1514215

Mukharomah, F., Wiyanto, W., & Darma Putra, N. M. (2021a). *Analisis kemampuan literasi sains fisika siswa sma pada materi kinematika gerak lurus di masa pandemi* *covid-19*. Journal of Teaching and Learning Physics, 6(1), 11–21. https://doi.org/10.15575/jotalp.v6i1.10391

OECD. (2023). PISA 2022 Results (Volume I): The state of learning and equity in Education: Vol. I. OECD. https://doi.org/10.1787/53f23881-en

Osborne, J., & Allchin, D. (2024). Science literacy in the twenty-first century: informed trust and the competent outsider. International Journal of Science Education. https://doi.org/10.1080/09500693.2024.2331980

Plomp, Tj., & Nieveen, Nienke. (2013). Educational design research. Part A : an introduction. SLO.

Pursitasari, I. D., Suhardi, E., Ardianto, D., & Arif, A. (2019). *Pengembangan bahan ajar bermuatan konteks kelautan untuk meningkatkan literasi sains siswa*. Jurnal IPA & Pembelajaran IPA, 3(2), 88–105. https://doi.org/10.24815/jipi.v3i2.14847

Raksun, A., Putu Artayasa, I., Hadiprayitno, G., & Sukri, A. (2024). Developing context-based teaching materials and their effects on students' scientific literacy skills. In Pegem Journal of Education and Instruction (Vol. 14, Issue 1). https://orcid.org/0000-0002-5430-8399

Ratna Sari, E., Fery Haryadi, E., & Lestari, N. (2022). *Pembelajaran kontekstual untuk melatih kemampuan literasi sains siswa* (Vol. 2, Issue 1).

Rusilowati, A., Astuti, B., & Rahman, N. A. (2019). How to improve student's scientific literacy. Journal of Physics: Conference Series, 1170(1). https://doi.org/10.1088/1742-6596/1170/1/012028

Safitri, A. N., Sarwanto, S., & Harjunowibowo, D. (2023). *Pengembangan modul pembelajaran fisika berbasis kearifan lokal pada materi suhu dan kalor*. Jurnal Materi Dan Pembelajaran Fisika, 13(1), 32. https://doi.org/10.20961/jmpf.v13i1.60093

Santoso, A. N., Sunarti, T., & Wasis, W. (2023). Effectiveness of contextual phenomena-based learning to improve science literacy. International Journal of Current Educational Research, 2(1), 17–26. https://doi.org/10.53621/ijocer.v2i1.205

Sartika, D., Kalsum, U., & Arma Arsyad, A. (2018). *Analisis kemampuan literasi sains mahasiswa program studi pendidikan fisika Universitas Sulawesi Barat*. 3(2), 8–12. https://doi.org/https://doi.org/10.17509/wapfi.v3i2.13722

Siombone, S. H. (2022). *Analisis suhu permukaan dan kondisi geomorfologi kawasan geotermal tehoru menggunakan Landsat-8 dan DEM*. JGE (Jurnal Geofisika Eksplorasi), 8(3), 210–224. https://doi.org/10.23960/jge.v8i3.243

Siombone, S. H., & Maba, M. U. S. (2021). Land cover, land surface temperature and geomorphology structure at tulehu geothermal area, ambon, Indonesia. In IJISET-International Journal of Innovative Science, Engineering & Technology (Vol. 8). www.ijiset.com

Siombone, S. H., & Niwele, A. (2023). *Studi korelasi kemampuan awal matematika mahasiswa dengan pencapaian kognitif fisika umum konsep gerak peluru pada tingkatan berpikir aplikasi (C3) dan Analisis (C4)*. Jurnal Pendidikan Fisika, 12(2), 116. https://doi.org/10.24114/jpf.v12i2.49418

Sugiono. (2013). *Metode penelitian pendidikan (pendekatan kuantitatif, kualitatif, dan R & D)* (16th ed., Vol. 1). Alfabeta.

Sukarelawa, M. I., Pd, M., Toni, K., Indratno, M., Pd, S., Suci, M., Ayu, S., & Km, M. P. H. (2024). N-Gain vs Stacking.

Maryam, & Kusasi, M. I. M. (2023). *Pengembangan modul berbasis contextual teaching and learning pada tanah dan keberlangsungan kehidupan untuk meningkatkan kemampuan literasi sains SMP*. JCI Jurnal Cakrawala Ilmiah, 02(12), 4731–4742. https://doi.org/https://doi.org/10.53625/jcijurnalcakrawalailmiah.v2i12.6429

Wiyono, K., Andriani, N., Fitonia, A., Nadia, H., Meitasari, D., Nazhifah, N., Bustan, M. Z., & Jaya, P. (2024). *Raya Palembang-Prabumulih KM 32 Indralaya, Ogan Ilir*. 30862. https://doi.org/10.21009/1

Xiao, L. (2012). Exploring the use of contextual modules for understanding and supporting collaborative learning activities: An empirical study. Computer Science and Information Systems, 9(2), 961–981. https://doi.org/10.2298/CSIS111128019X

Yolanda, Y., Lovisia, E., Amin, A., Studi, P., Fisika, P., Pgri Lubuklinggau, S., Kota, A., Jalan, L., Toha, M., Kuti, K. A., Sumatera, P., & Kode, S. (2021). *Pengembangan modul praktikum fisika dasar berbasis kontekstual materi alat-alat optik sebagai sumber belajar mahasiswa.* /National Conference Of Islamic Natural Science Vol XX, 89–106. http://proceeding.iainkudus.ac.id/index.php/NCOINS/index