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

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Abstract: This study aims to develop a learning physics module through contextual learning design based on geothermal areas to improve scientific literacy and scientific communication skills on temperature and heat concepts. The subjects in this study were 27 students 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.

Abstrak: *Penelitian ini bertujuan untuk mengembangkan modul pembelajaran fisika melalui desain pembelajaran yang kontekstual berbasis kawasan geotermal untuk meningkatkan kemampuan literasi sains dan keterampilan komunikasi ilmiah pada konsep suhu dan kalor. Subjek dalam penelitian ini adalah 27 orang mahasiswa Pendidikan Matematika STKIP Gotong Royong Masohi yang mengambil matakuliah Fisika Umum. Metode yang digunakan dalam penelitian adalah Educational Design Research dengan model pengembangan Plomp & Nieveen. Instrumen utama yang dikembangkan dalam penelitian ini yaitu prototipe modul pembelajaran fisika kontekstual berbasis kawasan geotermal. Nilai persentase rata-rata hasil validasi modul pembelajaran fisika kontekstual (prototype-1) dari tiga orang ahli terhadap aspek isi (substansi), bahasa, dan konstuksi adalah 88,41% yang menunjukkan berada pada kategori sangat valid. Hasil uji coba terhadap kepraktisan modul pembelajaran pada uji satu-satu diperoleh nilai persentase*

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rata-rata 95,45%, dan hasil uji coba kelas terbatas (kelas kecil) diperoleh nilai persentase rata-rata 95,88% yang menunjukkan modul pembelajaran yang dikembangkan sangatlah praktis. Hasil tes kompetensi literasi sains mahasiswa pada uji lapangan (kelas besar) diperoleh peningkatan dengan rata-rata N-gain 0,75 yang berada pada kategori tinggi, hasil ini menunjukkan modul pembelajaran yang dikembangkan telah efektif. Hasil implementasi modul pembelajaran fisika kontekstual (prototype-2) di lapangan diperoleh rata-rata total keterampilan komunikasi ilmiah mahasiswa mengalami peningkatan dari 90,95 pada pertemuan pertama meningkat menjadi 92,85 pada pertemuan kedua. Berdasarkan hasil analisis data yang diperoleh, dapat disimpulkan bahwa modul pembelajaran fisika kontekstual yang dikembangkan telah memenuhi kategori valid, praktis, dan efektif, serta mampu untuk meningkatkan kemampuan litrasi sains dan keterampilan komunikasi ilmiah, sehingga layak untuk digunakan dalam proses pembelajaran di lapangan.

Kata kunci: *pembelajaran fisika kontekstual, kawasan geothermal, educational design research, Literasi Sains; Keterampilan Komunikasi Ilmiah.*

▪ INTRODUCTION

Science literacy is one of the skills that students must have in the 21st century. These skills are useful for overcoming the challenges of science and technology development and for ensuring students' competitiveness in the era of globalization (Mukharomah et al., 2021). Based on the Programme for International Student Assessment (PISA) 2022, science literacy skills 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 decline in Indonesia's science literacy score from an average score of 389 to 383 points, and this was due to the Covid-19 pandemic (OECD, 2023). Science literacy skills 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 sciences and use content, procedural knowledge, and epistemics to offer hypotheses about phenomena, scientific processes or make predictions (OECD, 2023). Previous research by Irfani & Hariyono (2021) found that the level of students' physics science literacy skills during the COVID-19 pandemic was classified as "low" with a percentage of 56%. Post-pandemic conditions are not a reason for students' low scientific literacy skills. 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 skills. Developing the scientific literacy of prospective teachers (college students) is a challenge for teaching and learning today (Mukharomah et al., 2021; Sartika et al., 2018). Factors influencing low scientific literacy are teaching materials, learning models, learning environments, worksheets, and science-based assessments (Lederman et al., 2013; Anggraeni et al., 2023).

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). Various daily phenomena in the surrounding environment are closely related to physics (Safitri et al., 2023; Siombone & Niwele, 2023). So far, learning physics concepts of temperature and heat has been dominated by learning in the classroom (indoors), which causes students' scientific literacy related to the reality of physics science to be low. 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. Central Maluku Regency has several prospective geothermal areas, including Tehoru village and Tehoru sub-district (Siombone, 2022). Geographically, the study area is located in zone 52 of the Southern

Hemisphere, with coordinates 3°23'20.59"S and 129°31'54.32"E. The geothermal site is shown in Figure 1. The Tehoru geothermal area has manifestations in the form of hot springs and steamy soil with a surface temperature of ± 74°C–94.3°C (Siombone et al., 2021); (Siombone, 2022), which is considered an object of study in learning the concept of temperature and heat directly. In addition to scientific literacy, the ability to communicate the knowledge obtained during the learning process is needed so that the knowledge obtained can be conveyed to colleagues in scientific activities carried out. The ‘scientific communication skills program focuses on oral and written communication skills, such as speaking, listening, writing and reading. Scientific communication skills are also needed for students to explain conclusions based on scientific evidence constructively (Harisanti, 2019). On the other hand, The "scientific communication” program has three main objectives (or the 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).

Based on the background description, it is essential to integrate the geothermal area environment 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. Contextual physics learning designed with the integration of geothermal area environmental sites aims to make it easier for students to learn and study the concepts of temperature and heat directly in the open nature. Good scientific communication skills directly support scientific literacy because students' knowledge and literacy of physics science can be built in a constructive and conducive learning atmosphere. 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 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 subjects in this study were 27 students of the Mathematics Education Study Program of STKIP Gotong Royong Masohi. The target achievement indicators in this study are the quality of the implementation of the development of a contextual physics learning module based on the natural environment of the geothermal area that is valid, practical, and effective for use in learning/lecturing Physics. 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. 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 (LKM), (2) Non-test instruments such as expert validation sheets (guides), student response questionnaires, and student scientific communication skills rubrics, and (3) Test instruments are multiple-choice questions related to students' scientific literacy competencies, with a request to provide reasons for choosing that option.

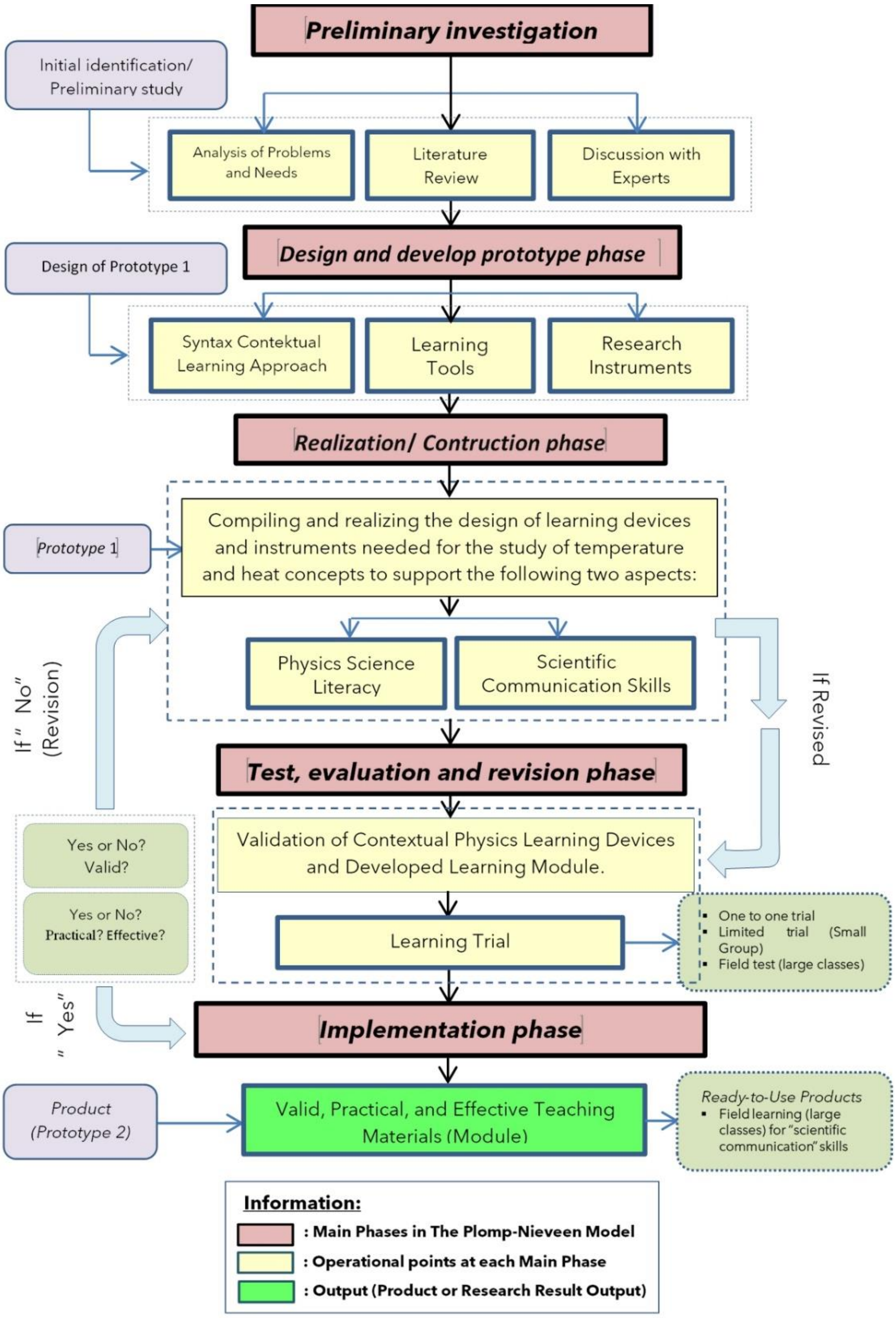


Figure 2. Flow Chart of Research Design.

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:

1. Walkthrough

A walkthrough is a step taken/used to determine the validity of a product developed by involving experts (validators). Each expert will validate the contextual physics learning module covering aspects of content (substance), language, and construction aspects, using the following equation:

$$\text{Validation Value} = \frac{Total\ number\ of\ scores\ achieved}{Maximum\ score} \times 100\ \% \quad (1)$$

After the validation value is obtained, it is then adjusted to the validation criteria category as in Table 1.

Table 1. Validation Criteria for Learning Module

Criteria	**Validity Value (%)**
Very Valid	81 – 100%
Valid	61 – 80%
Quite Valid	41 – 60%
Invalid	21 – 40%
Totally Invalid	0 – 20%

Source: Amaliyah et al. (2023)

2. 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 data obtained will then be calculated using the following equation:

$$\text{Practical Value} = \frac{Total\ number\ of\ scores\ achieved}{Maximum\ score} \times 100\ \% \quad (2)$$

Furthermore, the practicality values obtained are then grouped/adjusted based on the practicality criteria categories as in Table 2.

Table 2. Practicality Criteria of Learning Module

Criteria	**Practical Value (%)**
Very Practical	81 – 100%
Practical	61 – 80%
Quite Practical	41 – 60%
Inpractical	21 – 40%
Totally Inpractical	0 – 20%

Source: Amaliyah et al. (2023)

3. 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 formula used is as follows:

$$\text{SC Skill Value} = \frac{Total\ number\ of\ scores\ achieved}{Maximum\ score} \times 100 \quad (3)$$

Next, the criteria for students' scientific communication skills are shown in Table 3.

Table 3. Criteria for completion of scientific communication skills

Class Group Interval	Predicate
85 – 100	Very good
70 – 84	Good
56 – 69	Quite good
40 – 55	Less
0 – 39	Failed

Source: Siombone & Niwele, (2023)

4. 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 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 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). The equation for calculating the N-gain score can be determined by the following equation (Hake, 1998; Meltzer, 2002):

$$\text{N-gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}} \quad (4)$$

To see the category of the magnitude of the increase in the N-gain score, you can refer to the Normalized Gain criteria in Table 4. Meanwhile, to determine the level of effectiveness of the implementation of the intervention, you can refer to Table 5.

Table 4. Normalized Gain Criteria

N-gain Value	Interpretation
0,70 ≤ g ≤ 1,00	High
0,30 ≤ g ≤ 0,70	Medium
0,00 ≤ g ≤ 0,30	Low
g = 100	No increase
-1,00 ≤ g < 0,00	Decrease

* N-gain = Normalized Gain.
Source: Sukarelawa et al. (2024)

Table 5. Criteria for determining the level of effectiveness

Percentage (%)	Interpretation
>76	Effective
56 – 75	Quite Effective
40 – 55	Less Effective
< 40	Not Effective

Source: Sukarelawa et al. (2024)

▪ RESULT AND DISCUSSION

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.

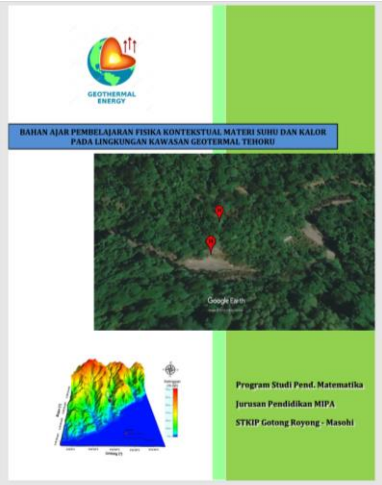


Figure 3a. Display of learning module (prototype-1) before revision.

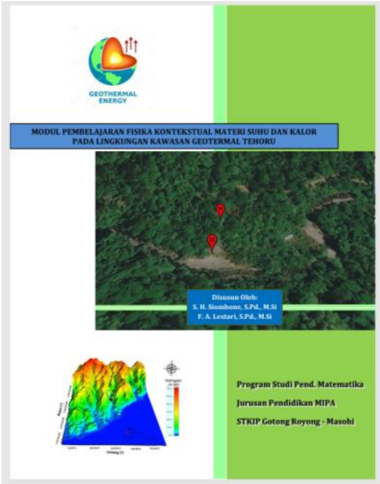


Figure 3b. Display of learning module (prototype-1) after revision.

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.

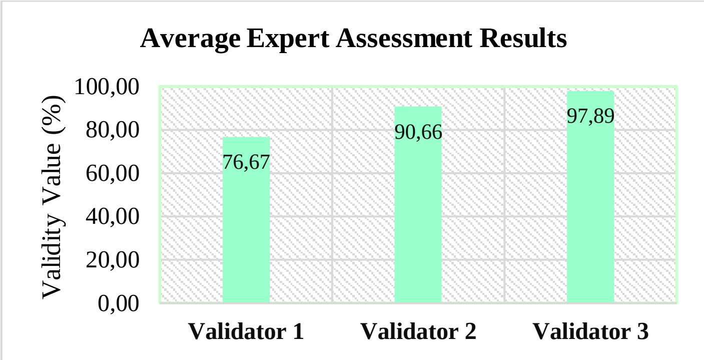


Figure 4. Summary graph of the results of the three Validators' assessments.

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.

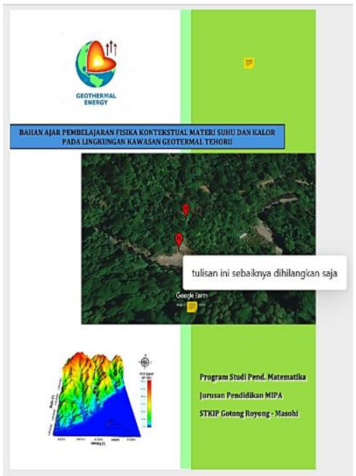
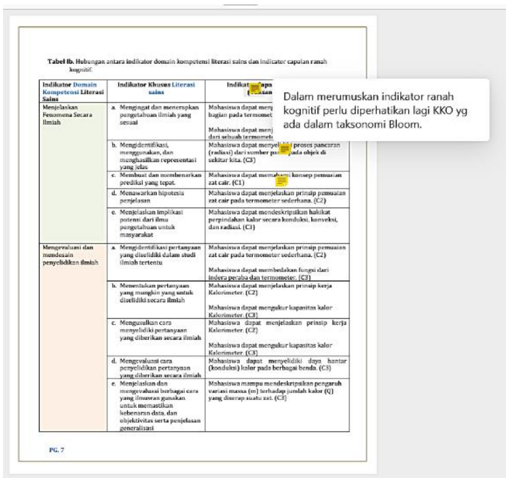


Figure 5a. Suggestions for Construction Aspects.



Gambar 5b. Suggestions for Substantion Aspects.

- **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.

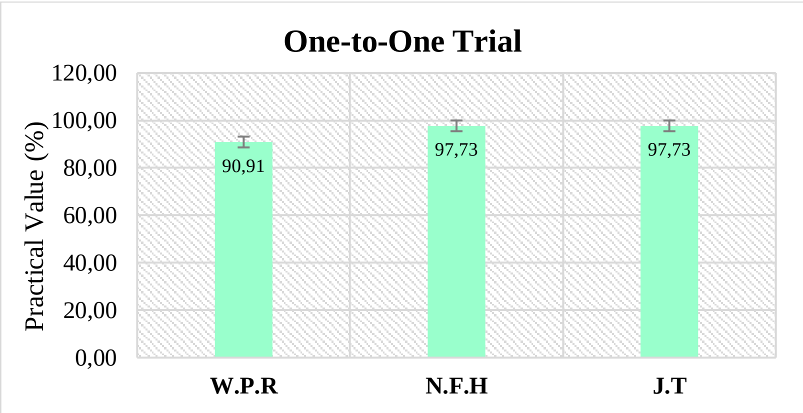


Figure 6a. Graph of the average results of student responses in the One-to-one Trial.

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.

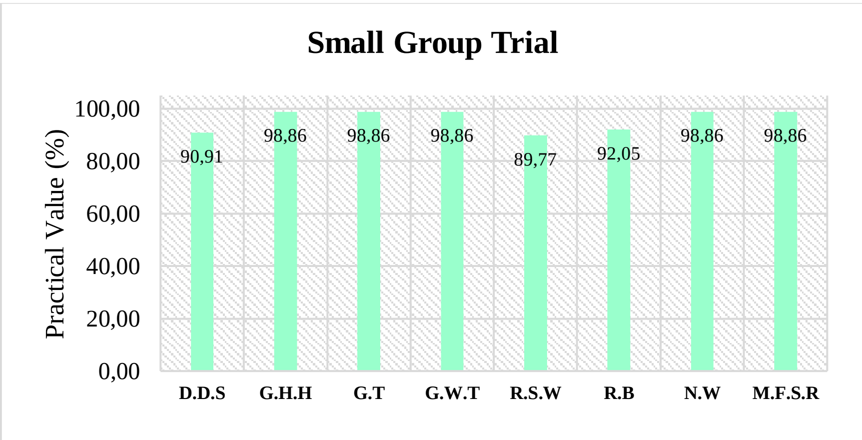


Figure 6b. Graph of the average results of student responses in the Small Group Trial.

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 6.

Table 6. N-gain value and average pre-test and post-test of student scientific literacy competence.

<table>
<tr><th>Pre-test average value</th><th>Post-test average value</th><th>Class of N-gain value</th><th>Number of Students</th><th>Percentage (%)</th><th>Interpret. of N-gain</th><th>Average of N-gain</th><th>Classical interpret. of N-gain</th></tr>
<tr><td rowspan="3">30,28</td><td rowspan="3">82,57</td><td>g > 0,7</td><td>16</td><td>59,26 %</td><td>High</td><td rowspan="3">0,75</td><td rowspan="3">High</td></tr>
<tr><td>0,30 ≤ g ≤ 0,70</td><td>11</td><td>40,74 %</td><td>Medium</td></tr>
<tr><td>g ≤ 0,30</td><td>0</td><td>0 %</td><td>Low</td></tr>
</table>

Based on Table 6, 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.

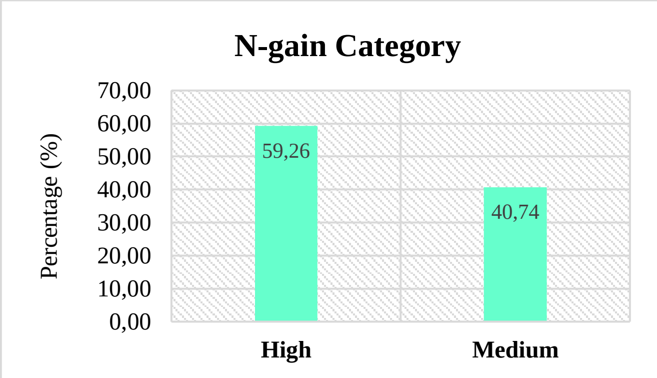


Figure 8. Clasification of N-gain value is based on the students' classical achievements.

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 Table 5. 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.

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 7 presents the results of students' SC skills in each aspect as a class during two meetings.

Table 7. 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 7 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.

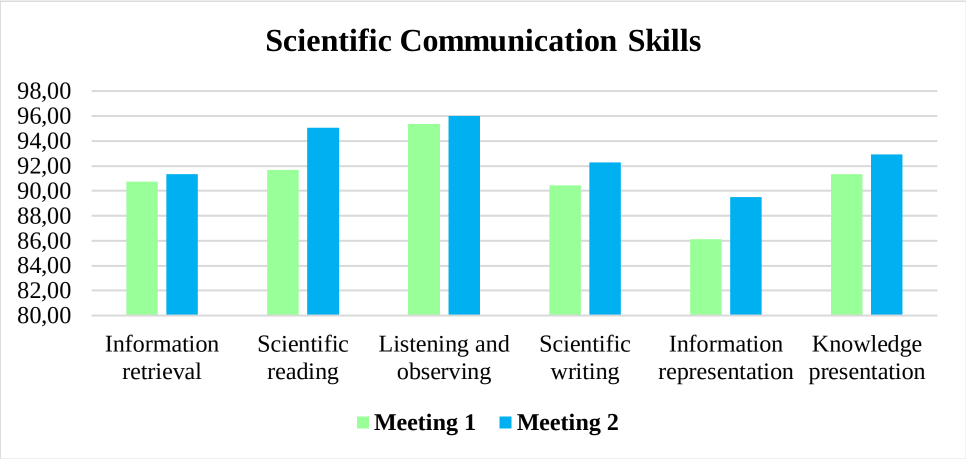


Figure 9. Display of students' Scientific Communication (SC) Skills in each aspect during two meetings.

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 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 6, 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 7 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 7, 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.

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.

▪ 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. The phases in developing this model have been taken 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 obtained a value of 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.

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