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Development of Guided Inquiry-Based Thermodynamics Devices Integrated With Pottery Making Local Wisdom to Enhance Computational Thinking

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Abstract

This development research aims to produce feasible Thermodynamics learning materials and a valid Computational Thinking (CT) instrument, while determining their effectiveness in enhancing students' skills by integrating Guided Inquiry with the local wisdom of pottery making. Using the ADDIE model, empirical validation involved 327 Grade XII students from three schools in Yogyakarta, analyzed via the Rasch model. Field implementation was conducted at SMAN 1 Piyungan with 108 Grade XI students selected through cluster random sampling. Results indicate that: (1) the developed materials are highly feasible, with an average score of 4.48 (good category) from three expert lecturers and five practitioners; and (2) the materials are significantly effective in improving students' CT skills based on Effect Size analysis. A key finding is that the pottery-making context provides a real-world framework for developing CT aspects: decomposition, pattern recognition, abstraction, and algorithms. In conclusion, physics learning devices integrated with local wisdom of pottery making through a guided inquiry model are both feasible and effective for instructional use. This approach bridges abstract thermodynamic concepts with indigenous knowledge, successfully fostering higher-level analytical systematicity and problem-solving abilities in students within the framework of the Merdeka Curriculum.

Keywords: *Guided inquiry learning; local wisdom; computational thinking ability.*

Pengembangan Perangkat Pembelajaran Termodinamika Terintegrasi Kearifan Lokal Proses Pembuatan Gerabah Dengan Model *Guided Inquiry Learning* untuk Meningkatkan Kemampuan *Computational Thinking*

Abstrak

Kemampuan *Computational Thinking* (CT) siswa dapat ditingkatkan dengan mengintegrasikan pembelajaran *Guided Inquiry* dengan kearifan lokal pembuatan gerabah. Penelitian pengembangan ini bertujuan untuk: (1) menghasilkan perangkat pembelajaran Termodinamika yang layak dan instrumen CT yang valid; serta (2) mengetahui efektivitasnya. Menggunakan model ADDIE, validasi empiris melibatkan 327 siswa Kelas XII dari tiga SMA di Yogyakarta (mewakili level akademik rendah, sedang, dan tinggi), yang dianalisis menggunakan model Rasch. Sementara itu, implementasi lapangan dilakukan di SMAN 1 Piyungan melibatkan 108 siswa Kelas XI yang dipilih melalui teknik *cluster random sampling*. Efektivitas perangkat pembelajaran ditentukan menggunakan analisis *Effect Size*. Hasil penelitian menunjukkan bahwa: (1) perangkat yang dikembangkan layak (kategori baik), dan

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instrumen CT valid serta reliabel; dan (2) perangkat tersebut efektif dalam meningkatkan keterampilan CT peserta didik. Temuan kunci dari penelitian ini adalah bahwa pengintegrasian konteks pembuatan gerabah ke dalam *Guided Inquiry* memberikan kerangka kerja nyata yang signifikan untuk mengembangkan aspek CT: dekomposisi, pengenalan pola, abstraksi, dan algoritma.

Kata kunci: *Guided inquiry, kearifan lokal, berpikir komputasi.*

INTRODUCTION

Rapid advances in technology, globalization, and social transformation characterize the development of 21st-century skills. The 21st-century skills demand adaptation in various aspects of life, especially in education (Aslamiah et al., 2021; Montessori et al., 2023). The education system no longer focuses solely on mastering traditional academic content, but must also equip learners with relevant skills to deal with the complexities of the modern world (Kain et al., 2024; Safitri, 2022; Turner et al., 2024). In this context, the 6C concept emerged as the essential skills framework of the 21st century, namely critical thinking, creativity, collaboration, communication, citizenship, and character (Cantaş, 2024; Kaya et al., 2025) . These six competencies are the main pillars in shaping individuals who are not only intellectually capable but also adaptive, ethical, and who contribute positively to society. Complementing this framework, Computational Thinking (CT) has become a critical skill for systematic problem-solving in the digital era, particularly in understanding complex physical phenomena (Ehab Gouda Tolba, 2025). Therefore, integrating CT into physics education is necessary to prepare students to analyze and solve abstract problems found in topics like thermodynamics.

In the last decade, the educational landscape has shifted towards developing key 21st-century competencies, with CT emerging as a critical strategy to enhance the quality of physics learning due to its relevance in modeling scientific concepts (Chusna et al., 2024). Several studies have explored this domain. For instance, recent research has successfully integrated CT into physics through computer simulations and programming-based learning (Smith et al., 2022). Meanwhile, other studies have focused on integrating local wisdom (ethnoscience) into physics instruction to improve conceptual understanding and character, such as using traditional games or batik making (Khusniati et al., 2023). However, research specifically connecting local wisdom with Computational Thinking skills remains limited. Most ethnoscience studies focus

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primarily on concept mastery or conservation attitudes, rarely explicitly utilizing cultural processes as a medium to train CT components like abstraction and algorithm design. This research bridges that gap by offering a novelty: it integrates the specific local wisdom of pottery making into the thermodynamics topic using the Guided Inquiry model. Unlike previous studies, this research proposes that the systematic stages of pottery firing can serve as a concrete context to enhance students' CT skills effectively.

Computational thinking is an additional skill that needs to be built early on in response to the dynamics of the times. Initially, this concept was only applied in the context of computer programming to solve cognitive problems (Lye & Koh, 2014). However, as technology develops, its scope extends to other fields such as mathematics and physics (Wing, 2017). In physics learning, computational thinking is defined as the ability to formulate problems computationally, develop solutions through algorithmic approaches, and integrate systematic logic with problem-solving strategies across contexts (Cansu & Cansu, 2019; Fauji et al., 2023; Juldial & Haryadi, 2024). Thus, this skill not only supports conceptual understanding but also trains students in generating solutions.

Improving computational thinking in physics learning requires the right learning model. One of the models that can enhance computational thinking is the guided inquiry learning model. Studies show that more structured inquiry learning, such as the guided inquiry model, provides the scaffolding necessary for students to understand abstract concepts and develop algorithmic solutions systematically (Jacob et al., 2020). In the context of computer learning and programming, teachers who implemented guided inquiry models by providing worked examples and support in formulating and solving problems successfully improved the quality of computational artifacts produced by students and strengthened their identity in the field of computer science (Ahmed et al., 2025; Jacob et al., 2020) . In addition, the guided inquiry model encourages students to be active in the process of exploration and collaboration, which is crucial in the development of computational thinking skills such as problem decomposition, pattern recognition, abstraction, and algorithm generation. This approach also improves students' critical thinking ability, which contributes to the improvement of learning outcomes in general (Rambe et al., 2020). Thus, the guided inquiry learning model

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applied in a structured manner and supported by scaffolding strategies is effective in improving students' computational thinking skills, especially in the context of science and computer learning.

Based on the preliminary study conducted at three Senior High Schools in Yogyakarta, empirical facts regarding the low CT skills of students were identified. Interviews with physics teachers and classroom observations revealed that students face significant difficulties in decomposing abstract Thermodynamics problems into solvable steps. This indicates a weakness in the decomposition and abstraction aspects of CT. Hypothetically, this difficulty arises because current learning methods are dominated by rote memorization of formulas without emphasizing algorithmic thinking or pattern recognition (Aminatun et al., 2025). This problem is validated by factual data from the daily assessment and final semester assessment scores on thermodynamics material, which showed an average score of 60, well below the minimum completeness criteria of 75. Teachers admitted that time constraints and a lack of understanding of CT integration strategies caused learning to be less contextual. Consequently, students fail to relate thermodynamic concepts to real-world phenomena. If this condition persists, students' ability to solve complex problems and their learning independence will remain low (Ghufron et al., 2023; Kawuri et al., 2019). Therefore, a specific intervention is required through the development of learning tools that explicitly train CT indicators, there are decomposition, pattern recognition, abstraction, and algorithm design within a relevant context.

Learning to improve students' computational thinking can be significantly enhanced by integrating the local wisdom of each region. One promising form of local wisdom is the process of making pottery, which holds rich potential for explaining abstract physics concepts. The pottery-making process aligns directly with thermodynamics. First, the drying stage exemplifies radiative heat transfer, where solar thermal energy evaporates water from the clay (Lumbangaol et al., 2024). This process can be modeled using the Stefan-Boltzmann law and evaporation rate equations (Giddings, 2016). Second, the firing process in a kiln serves as a complex application of thermodynamics involving conduction, convection, and radiation (reaching 1300-1400°C), which can be analyzed using the First and Second Laws of Thermodynamics regarding energy conservation and entropy. Furthermore, the thermal equilibrium between the fire and the pottery

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illustrates the Zeroth Law of Thermodynamics, while heat capacity concepts explain the energy required for temperature changes (Gupta & Dhiman, 2025). Despite this significant conceptual alignment, existing ethnoscience research in physics has predominantly focused on other cultural contexts, such as traditional games, traditional houses, or batik making. However, based on the review of relevant literature, there has been no research that specifically develops physics learning materials integrated with the local wisdom of pottery making on thermodynamics material. This gap highlights the novelty of this research. This study addresses this scarcity by developing a specific learning device that utilizes the systematic stages of pottery making not just as a context, but as a cognitive scaffolding to enhance students' CT skills in thermodynamics.

Based on this background, this study aims to: (1) produce physics learning devices integrated with the process of making pottery on thermodynamic material with a guided inquiry learning model that is feasible to use to improve students' computational thinking skills; (2) determine the practicality of the student worksheets developed; and (3) determine the practicality of physics learning devices integrated with the process of making pottery on thermodynamic material with a guided inquiry learning model to improve students' computational thinking skills.

RESEARCH METHODS

This study used the research and development method by adapting the ADDIE model developed by Branch (2009). The ADDIE model consists of five stages, namely analysis, design, development, implementation, and evaluation. This model was selected to ensure a systematic approach in producing valid and effective learning devices. The research subjects were classified into two distinct groups. The first group consisted of 327 Grade XII students from three Senior High Schools in Yogyakarta (representing low, medium, and high academic levels) who participated in the empirical validation stage to assess the quality of the Computational Thinking (CT) instrument. The second group comprised 108 Phase F (Grade XI) students at SMA N 1 Piyungan, selected using the cluster random sampling technique, who served as subjects for the field implementation in the experimental and control classes. The specific subject matter developed in this study is thermodynamics, integrated with the local wisdom of pottery making. Data collection was carried out using two main categories of instruments. First,

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validation sheets were used to assess the feasibility of the learning devices (syllabus, lesson plans, and worksheets) by material experts and practitioners. Second, a CT test instrument was employed to measure students' abilities. The data analysis techniques were tailored to each instrument. The validity of the learning devices was analyzed using descriptive quantitative analysis. Meanwhile, the psychometric properties and quality of the CT test instrument items were analyzed using the Rasch Model to ensure item fit and reliability. Finally, the effectiveness of the learning devices was determined by analyzing the increase in students' CT scores after implementation.

The development procedure in this research goes through 5 stages, namely analysis, design, development, implementation, and evaluation. Each stage has several components as described in Figure 1.

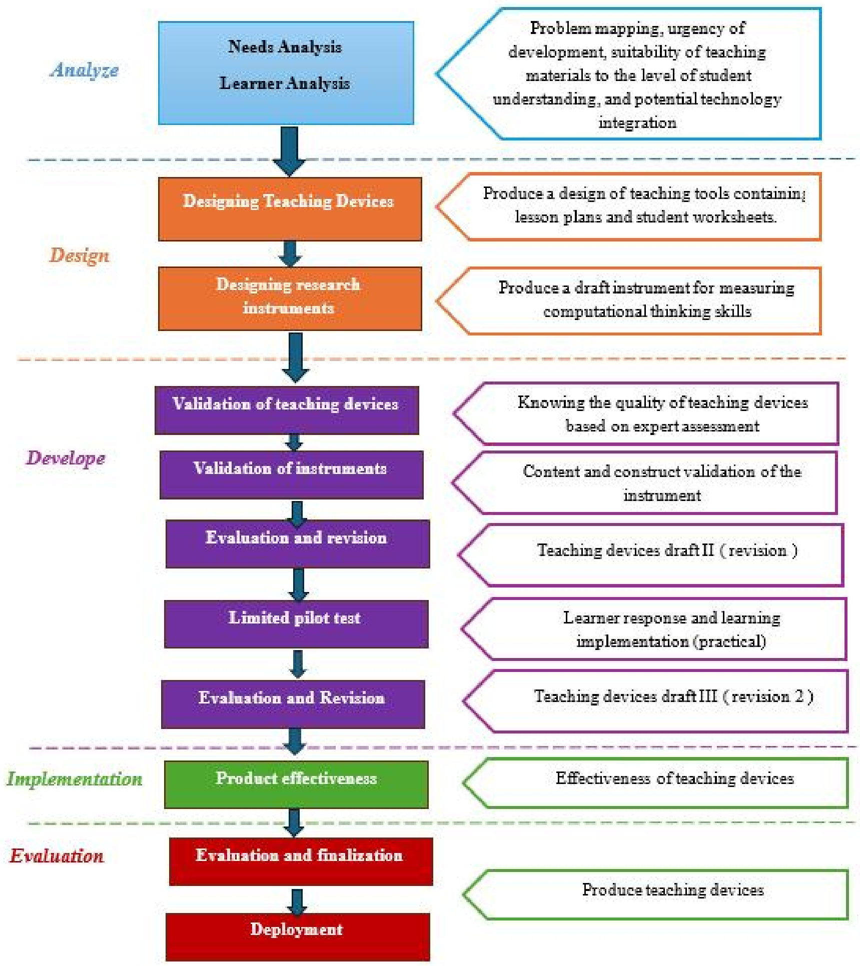

Figure 1 Teaching device development steps

The developed teaching devices underwent several stages of trials, namely empirical trials, limited trials, and field trials. The field test subjects were randomly selected 11th-

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grade students. The research design conducted at the implementation stage was a non-equivalent pretest-posttest group design that used three trial classes. The trial classes applied were one experimental class and two contrast classes (comparison). The three classes both use Merdeka curriculum teaching devices, but with different designs. The implementation design used in this study can be seen in Table 1.

Table 1 Research Design

Group	**Y_1**		
	Pre-test	***Treatment***	***Post-test***
Experiment 1	O_1	X_1	O_2
Control 1	O_1	X_2	O_2
Control 2	O_1	X_3	O_2

The feasibility analysis of teaching devices includes feasibility based on media aspects, material aspects, and teaching modules using a four-scale assessment (Logan et al., 2021). After that, conversion from ordinal data to interval data was carried out using the method of successive intervals (MSI). The conversion results were then analyzed with the SBi scale. The eligibility assessment guidelines can be seen in Table 2.

Table 2 The Eligibility Assessment Guidelines

No.	**Scor Range**	**Category**
1.	$X \geq \overline{X}_i + 1{,}5\,SBi$	Very feasible
2.	$\overline{X}_i < X \leq \overline{X}_i + 1{,}5\,SBi$	Feasible
3.	$\overline{X}_i - 1{,}5\,SBi < X \leq \overline{X}_i$	Not feasible
4.	$X \leq \overline{X}_i - 1{,}5\,SBi$	Very unfeasible

The feasibility test of the question instrument from the empirical test was carried out to determine the quality and characteristics of the question items using the QUEST program. This program aims to determine the number of questions that fit the Partial Credit Model (PCM), which is eligible for use. In addition, it is also necessary to determine the level of difficulty of questions based on the difficulty model with the PCM model, as well as to determine the estimation of item reliability based on Cronbach's Alpha coefficient or internal consistency coefficient.

Question items are declared valid based on QUEST analysis if the Infit Mean Square (INFIT MNSQ) value is in the range of 0.77 to 1.30 (Istiyono, 2020). The INFIT MNSQ value parameters are presented in Table 3.

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Table 3 The INFIT MNSQ value parameters

INFIT MNSQ Value	Parameters	Match Level
> 1,30	Invalid	Not Matched
0,77 – 1,30	Valid	Match
< 0,77	Invalid	Not Matched

Reliability measures the degree of consistency of the instrument when used in data collection. A measuring instrument is considered reliable if it can provide consistent results when used to measure the same thing at different times. The test instrument is said to have good reliability if the test has a reliability estimate of more than 0.70 (Gliem & Gliem, 2003). The results of question reliability in the QUEST program can be seen in the Summary of Item Estimates section in the Reliability of Estimates section.

Table 4 Question Item Reliability Level Category

No	Reliability Coefficient	Reliability Category
1	$R \geq 0,80$	Very Reliable
2	$0,60 < R \leq 0,80$	Reliable
3	$0,40 < R \leq 0,60$	Moderately Reliable
4	$0,20 < R \leq 0,40$	Somewhat Reliable
5	$R \leq 0,20$	Less Reliable

Effect Size analysis was conducted to determine the amount of effective contribution given by learning devices in improving computational thinking skills. The effect size analysis is based on the partial eta squared value in the Hotelling's trace type repeated-measure test analysis. The effect size category range is shown in Table 5.

Table 5 The effect size category range

Effect Size (ES)	Interpretation
$0,00 \leq ES < 0,20$	Ignored
$0,20 \leq ES < 0,50$	Small
$0,50 \leq ES < 0,80$	Moderate
$0,80 \leq ES < 1,30$	Large
$1,30 \leq ES$	Very Large

(Cohen, 1998)

Based on (Yin et al., 2020), the CT indicators in this study comprise four operational aspects: (1) decomposition, requiring students to break down complex physics problems into manageable components and distinct variables; (2) algorithmic thinking, which involves analyzing core issues to design logical, sequential steps for accurate solutions; (3) pattern recognition, defined as identifying trends or relationships in thermodynamic data to select appropriate strategies; and (4) abstraction and generalization, referring to the ability to filter key information and formulate

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generalizable models for efficient application to similar problems.

RESULTS AND DISCUSSION

The development of physics learning devices integrated with the local wisdom of pottery making using a guided inquiry learning model followed the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) procedural model. This systematic approach ensures the production of valid, practical, and effective educational tools designed to equip learners with relevant 21st-century problem-solving skills. In the analysis stage, an assessment of student needs, learner characteristics, problem mapping, and the potential for technological integration was conducted. Empirical findings revealed that students possess low CT skills, particularly within the study's specific context where initial assessments showed deficient scores in decomposition and algorithmic modeling (Abdüsselam & Ebru Turan-Guntepe, 2021). Students face significant difficulties in decomposing abstract thermodynamics problems because current pedagogical methods are dominated by rote memorization rather than the development of systematic, algorithmic logic. To address this gap, the integration of pottery-making local wisdom into the thermodynamics curriculum was identified as a strategic solution. This choice is grounded in the principle that indigenous knowledge provides a familiar cognitive framework, enabling students to map abstract physical laws onto tangible, everyday processes (Damanik et al., 2024). Such an approach aligns with existing research asserting that contextual learning involving local potential effectively bridges theoretical concepts with real-world phenomena, thereby sparking student enthusiasm and significantly increasing learning motivation.

The design stage produced the initial draft of the physics teaching instruments, comprising lesson plans, teaching modules, and student worksheets (LKPD) integrated with the Guided Inquiry model. The LKPD was specifically designed as a cognitive scaffolding tool to transition students from passive reception to active discovery, which is essential for internalizing the logical structures of CT (Guntur et al., 2020). Furthermore, an initial draft of the CT measurement instrument was formulated to target specific operational dimensions: decomposition, algorithmic thinking, pattern recognition, and abstraction.

The integration of guided inquiry is pivotal because its structured phases

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observation, data collection, and hypothesis testing directly mirror the iterative processes of CT. Research suggests that the scaffolding provided by guided inquiry effectively supports CT development by allowing students to break down complex phenomena into manageable sub-problems (decomposition) and formulate systematic procedures for problem-solving (algorithmic thinking) (Rambe et al., 2020). Consequently, the guided inquiry model does not merely complement CT but serves as a foundational pedagogical framework that fosters the logical rigor required for computational problem-solving in physics (Thahir et al., 2020).

The development stage involved expert validation and empirical testing to produce a feasible and reliable instructional product through iterative cycles (Revision 1 and Revision 2) (Saepuzaman et al., 2022). The feasibility review by experts and practitioners yielded an average score of 82.17 (Good category) for the teaching modul(Barokatun et al., 2025)e and 96.81 (Very Good category) for the student worksheets, confirming their instructional quality . Furthermore, empirical testing of CT instrument on 282 students was evaluated using the Rasch Model. This analysis confirmed that all items satisfied the model constraints with INFIT MNSQ values ranging from 0.77 to 1.33, which fall within the acceptable range for high-stakes or classroom assessments (Boone & Staver, 2020). Although the person reliability estimate was 0.40 indicating a need for further refinement in person-separation the item fit statistics confirm the instrument is reliable for preliminary data collection. Such a rigorous validation process remains a crucial element in educational research to ensure that measuring instruments provide consistent and accurate evaluations of student latent traits and abilities (Ramadhan et al., 2019).

The physics teaching instruments, integrating the local wisdom of pottery making with a guided inquiry model, were evaluated by eight validators comprising three subject-matter experts and five educational practitioners. The feasibility assessment followed a structured instrument covering four critical dimensions: content validity, pedagogical presentation, linguistic accuracy, and graphical design (Barokatun et al., 2025). This evaluation yielded an average score of 82.17, placing the instruments in the "Feasible" category, indicating that the materials meet the fundamental standards for instructional implementation (Barokatun et al., 2025). During the validation process, experts provided critical feedback regarding the explicit labeling of CT indicators and

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the simplification of thermodynamic formulas to better align with the pottery-making context. Consequently, the module underwent significant refinement, transitioning from a purely theoretical approach to a context-driven inquiry (e.g., shifting from abstract heat transfer equations to the heat conductivity analysis of clay). Specifically, the data analysis and modeling section of the module was enhanced to support CT by requiring students to perform decomposition of the firing process and algorithmic thinking in predicting temperature changes. Finally, a limited field test resulted in an average score of 93.81 (Highly Feasible), confirming that the refined products are practically effective for Grade XI students.

The final product of this research is a physics learning device for thermodynamics material, integrated with the local wisdom of pottery-making through a guided inquiry model to enhance students' CT skills. Based on feedback from validators, several key revisions were implemented, including refining the visualization of the pottery firing process and aligning local terminology with scientific physics nomenclature to prevent misconceptions. These improvements are evidenced by the inclusion of specific physical data, such as furnace temperatures and air volume changes in accordance with the First Law of Thermodynamics. This revision process aligns with (Branch, 2009), who emphasizes that instructional material development requires formative evaluation to ensure the accuracy of the educational message. Furthermore, the integration of cultural context (ethnophysics) has proven effective in bridging indigenous knowledge with scientific concepts, making the material more meaningful for students (Wiyono et al., 2024). The module's structure specifically trains CT skills through decomposition, pattern recognition, and abstraction of variables such as heat (Q), work (W), and internal energy (ΔU), culminating in the development of systematic algorithms for problem-solving. This is consistent with (Jacob et al., 2020), who defines computational thinking as a process of formulating problems and their solutions through effective systematic representation.

To ensure the quality of the product, a practicality test was conducted involving educational practitioners and students, yielding an average score of 85%, categorized as highly practical. This result indicates that the learning device is user-friendly and the instructions are well-implemented within the allotted timeframe, fulfilling the quality criteria for educational products as proposed by (Saepuzaman et al., 2022), which

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include validity, practicality, and effectiveness. The use of a guided inquiry model to sharpen these thinking skills is highly appropriate, as it requires students to actively discover concepts through directed investigation (Gradini & Susanti, 2022). The successful implementation is further supported by (Syam et al., 2025), who argue that local wisdom-based learning not only facilitates the understanding of abstract concepts but also increases student engagement due to the direct relevance of the material to their social and cultural environment. The following are several examples of the revised physics instructional materials on thermodynamics, integrated with local wisdom from the pottery-making process, as illustrated in Figures 2 and Figure 3.

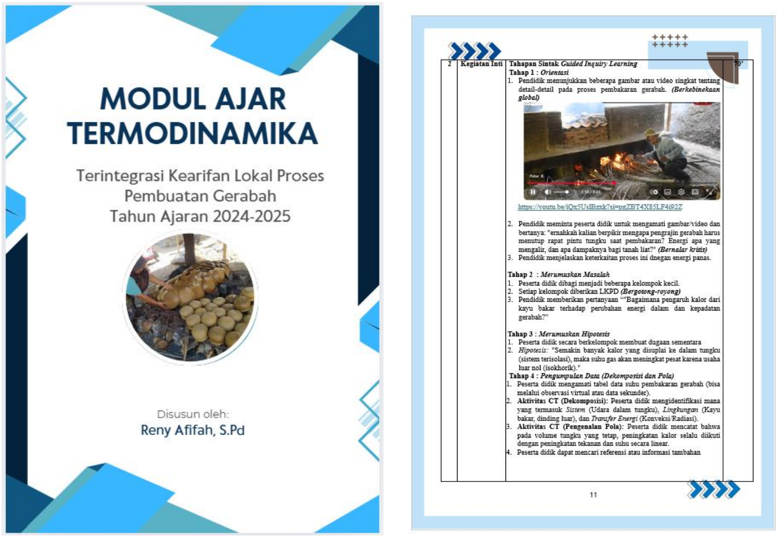

Figure 2 Teaching Module

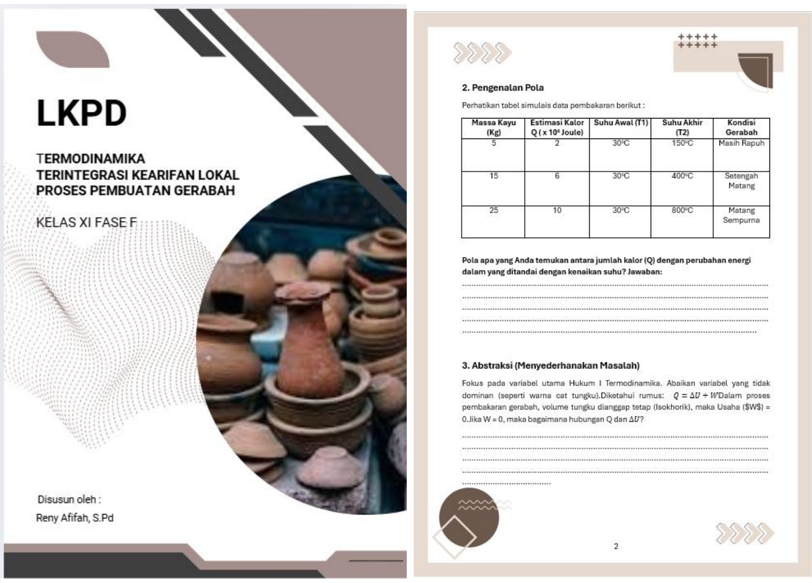

Figure 3 Student Worksheet

Figures 2 and 3 are examples of the results of the feasibility of measurement

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instruments, consisting of the results of the feasibility review of computational thinking test questions, the results of the feasibility review of the learner response questionnaire, the results of the review of teaching devices, and the results of the review of student worksheets. The results of the feasibility review of computational thinking test questions consist of computational thinking test instruments in the form of 9 essay questions, consisting of 4 pretest questions, 4 posttest questions, and questions as anchor items. The feasibility assessment is carried out by looking at 3 aspects, namely material, construction, and language (Fatmawati et al., 2023). The validation results are calculated using the equation in Aiken's V coefficient (Aiken, 1985).

Table 6 Recapitulation of Computational Thinking Test Feasibility Test Results

Item	Aiken's V	Description
Computational Thinking Ability Test Questions		
6	1,00	Valid
1, 2, 4*, 7	0,96	Valid
3, 8	0,92	Valid
5, 9	0,88	Valid

Based on table 6, the results of Aiken's V calculation, it shows that all items of computational thinking ability meet the criteria for the critical value of Aiken's V> 0.8. This condition illustrates that all questions in computational thinking test are valid and can be used. Furthermore, the review process was carried out to determine whether the teaching devices used in the study were feasible. This feasibility was assessed by 3 experts (physics lecturers) and 5 practitioners (physics teachers). The assessment sheet uses a 4-point scale to assess the teaching device components. The feasibility assessment data were analyzed using the average ideal standard deviation (SBi) equation and converted into an interval scale with MSI (method of successive intervals) for mathematical calculations (Febriana & Setiawati, 2024). The results of the feasibility analysis are presented in Table 7.

Table 7 Results of Feasibility Review of Teaching Devices

Teaching Device Component	**Component Value**	**Category**
General Information	92,47	Very Good
Indicator Formulation	74,23	Fair
Learning Objectives	77,45	Good
Selection of Teaching Materials	89,05	Very Good
Selection of Learning Resources	77,35	Good
Learning Media Selection	79,01	Good
Learning Model Selection	64,97	Less
Learning Activities	79,88	Good

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Teaching Device Component	Component Value	Category
Assesment	100,00	Very Good
Presentation Technique	87,34	Good
Average	**82,17**	**Good**

Table 7 shows that all components of teaching devices have a good category in terms of feasibility, except for the formulation of indicators (sufficient category) and the selection of learning models (less category) based on SBI calculations (Sani & Wh, 2021). Revisions were made to both components according to the reviewer's input. Overall, the teaching devices obtained an average score of 82.17 with good criteria, making them suitable for use in the learning process. The results of the feasibility review of student worksheets were assessed by 3 experts (physics lecturers) and 5 practitioners (physics teachers). The assessment sheet uses a 4 (four scale to assess the components of the student worksheet. The student worksheet feasibility assessment data were analyzed using the average ideal standard deviation (SBI) equation and converted into an interval scale with MSI (method of successive intervals) for mathematical calculations (Febriana & Setiawati, 2024). The results of the feasibility analysis of the student worksheet components are presented in Table 8.

Table 8 Student Worksheet Feasibility Assessment Results

Student Worksheet Components	Component Value	Category
Construction	93,13	Very Good
Content	100,00	Very Good
Technical	97,30	Very Good
Average	96,81	Very Good

Table 8 shows that all components of the student worksheets have very good category scores in the feasibility of student worksheets. The feasibility of teaching devices is influenced by how to connect the concept of material with the experience of students in the surrounding environment. The learning process that involves disclosing local potential in a real-life environment can spark enthusiasm for learning and increase students' learning motivation (Firda et al., 2024; Reka Nurjanah et al., 2024; Sari et al., 2024). Students who have an interest and enthusiasm in learning are able to realize the formation of active learning because they have the ability to apply computational thinking in analyzing the problems given (Alfatonah et al., 2023; Holidun et al., 2018).The realization of students' activeness in the classroom in the learning process is influenced by the understanding of concepts that students have (Fixen & Wald, 2021;

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Thahir et al., 2020).

The empirical trial encompasses the validation analysis of the computational thinking ability test and the reliability of its corresponding items. This feasibility test involved 282 students from grade XII as respondents. The results of the Quest analysis, as presented in Table 9, indicate that the item fit was determined based on the average values of INFIT MNSQ and their standard deviations.

Table 9 Determination of Fit Items About Thinking Ability

Fit Statistic	Value	Standard Deviasi	Range	Rasch Model Terms	Description
Infit mean square	1,00	0,06	1,16 - 0,84	0,77 - 1,33	Fit
Outfit mean square	0,98	0,06	1,14 - 0,82	0,50 - 1,50	Fit
Infit means of infit t	0,12	1,05	1,27 - 1,35	$-2,0 \leq t \leq 2,0$	Fit
Outfit means of outfit t	-0,17	0,73	0,94 - 1,12	$t \leq 2,0$	Fit

Based on the data in Table 9, the values for INFIT MNSQ, OUTFIT MNSQ, and their respective t-statistics fall within the established requirements of the Rasch model. Consequently, it can be concluded that all items are empirically valid and demonstrate a good fit with the model. Furthermore, the reliability analysis of the computational thinking items yielded a reliability estimate of 0.40, while the item difficulty levels ranged from -0.20 to 2.00, placing the instrument in the good category. These findings align with (Chan et al., 2020), who state that an item is considered valid in the Rasch model if it meets the outfit mean square criteria, ensuring that the instrument is stable and capable of measuring the targeted construct. Although a reliability value of 0.40 is considered moderate, it remains acceptable for research purposes in early development stages, as suggested by (Istiyono, 2020), provided the items effectively cover the intended difficulty spectrum. This indicates that the instrument is empirically robust and ready for broader implementation in assessing students' computational thinking processes. Following the empirical test, a limited trial was conducted with 29 grade XI students to review the readability of the teaching devices. The results demonstrated that all aspects of the instructional materials achieved a "very feasible" category based on the ideal standard deviation criteria, ensuring that the devices are communicative and suitable for the learning process.

The implementation phase of the revised learning devices (Revision 2) demonstrated a significant impact on enhancing students' CT skills. The amount of treatment contribution to improving computational thinking ability can be seen from the results of

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the SPSS output analysis in the Hotelling's Trace type multivariate test section.

Table 10 Multivariate Test Results of Hotelling's Trace Type

Variable	Class	F	Sig.	Partial Eta Square	Effect Size	Description
Computational Thinking	Eksperiment	90,004	<0,001	0,539	1,081	*Large*
	Contras 1	4,702	0,033	0,058	0,248	*Small*
	Contras 2	23,780	<0,001	0,236	0,556	*Large*

Multivariate analysis using Hotelling's Trace (as detailed in Table 10) revealed that the experimental group achieved a partial eta squared of 0.539 with an effect size of 1.081, indicating a "Large" effect. This translates to an effective contribution of 53.9%, which substantially outperforms Contrast Class 1 (5.8%) and Contrast Class 2 (23.6%). The experimental group also showed a 15% higher achievement in the "Excellent" category compared to the control groups, which only reached the "Good" category. These results empirically validate that integrating local wisdom into a guided inquiry framework provides a superior cognitive stimulus compared to conventional direct instruction. This finding is consistent with (Makhrus et al., 2025), who argue that leveraging local potential in physics education significantly bolsters students' systematic analytical capabilities.

The high level of effectiveness observed in this study is attributed to several critical factors, primarily the contextualization of abstract thermodynamics through the traditional pottery-firing process. By engaging with a familiar cultural environment, students were able to intuitively practice core CT pillars, such as decomposition (breaking down the firing stages) and pattern recognition (identifying temperature trends relative to fuel types) (Muliyati et al., 2022; Zakwandi & Istiyono, 2023). Furthermore, the guided inquiry model provided the necessary scaffolding for students to navigate complex problem-solving tasks within a structured yet explorative environment (Shute et al., 2017). The integration of indigenous knowledge not only bridged the gap between theoretical physics and real-world application but also fostered deeper cognitive engagement and analytical systematicity (Gambrell & Brewe, 2024; Weller et al., 2022). Consequently, the synergy between ethno-physics and inquiry-based learning serves as a robust catalyst for developing high-level computational thinking in the context of the curriculum.

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CONCLUSION

Based on the results of research and development of physics learning devices integrated with local wisdom of pottery making with guided inquiry learning model on thermodynamic material, it can be concluded that: (1) learning devices for thermodynamics integrated with local wisdom of pottery making with guided inquiry learning models are feasible to use to improve computational thinking skills. Based on the assessment of three expert lecturers and five practitioners gave an average score of 4.48 which is in the good category; (2) thermodynamic learning devices integrated with local wisdom of pottery making with guided inquiry learning models are effectively used to improve computational thinking skills.

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