JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Physics Teaching Module for Phase-E with the CDT (Component Display Theory) Approach

Pujijana Purnawati[1], Masri Kudrat Umar[1,2*], Tirtawaty Abdjul[1,3]

[1]Master of Physics Education Study Program, Postgraduate Program, Universitas Negeri Gorontalo, Gorontalo, Indonesia.
[2]Physics Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Gorontalo, Indonesia.
[3]Science Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Gorontalo, Indonesia.

Received: September 15, 2023
Revised: November 17, 2023
Accepted: December 25, 2023
Published: December 31, 2023

Corresponding Author:
Masri Kudrat Umar
masrikudrat@ung.ac.id

DOI: 10.29303/jppipa.v9i12.5722

Abstract: This research aims to develop a physics teaching module for phase-E with a CDT approach and to obtain the product's feasibility by meeting the validity, practicality, and effectiveness indicators. The research type is developmental research with a 4D model. This research was carried out at SMA Negeri 1 Wonosari. The average validation scores for the teaching module components were 3.4, indicating that the module is valid and suitable for use. Teacher observation scores for both limited and extensive testing were 96.7% and 88.3%, respectively, while student response questionnaire scores were 83.16% and 85.28%. Both instruments indicated that the teaching module is practical and suitable for use. The average student engagement observation scores for limited and extensive testing were 85.3% and 84.6%, and the average test scores for learning outcomes in both tests were 84.95%. These results suggest that the teaching module is effective and has a positive impact on improving student learning outcomes. Therefore, the development research on the physics teaching module for phase-E with a CDT approach is valid, practical, and effective.

Keywords: CDT; Phase-E; Physics Teaching Module.

Introduction

The Independent Curriculum (Kurikulum Merdeka) was launched by the Minister of Education, Culture, Research, and Technology on February 11, 2022. According to data from the Ministry of Education, Culture, Research, and Technology, as of now, there are a total of 143,265 schools that have adopted the Independent Curriculum. This number is expected to continue to increase as the Independent Curriculum is gradually implemented in the academic year 2022/2023, from preschool to elementary school, junior high school, and senior high school levels. The implementation of the Independent Curriculum is not carried out simultaneously and uniformly. The Ministry of Education, Culture, Research, and Technology provides schools with the flexibility to implement the curriculum according to their readiness levels. One of the programs that support the implementation of the Independent Curriculum is the School Empowerment Program (Sekolah Penggerak). Through this program, the Ministry of Education, Culture, Research, and Technology offers support to schools to ensure a successful experience in implementing the Independent Curriculum (Marlina et al., 2022; Nugraha, 2022).

The Independent Curriculum (Kurikulum Merdeka) is a curriculum designed to nurture children's interests and talents from an early age, with a focus on essential content, character development, and student competencies (Nematillaevna, 2021; Swawikanti, 2022; Butler et al., 2008). The Independent Teaching Platform (Platform Merdeka Mengajar or PMM) serves as an educational platform that acts as a driving force for educators in realizing the ideals of Pancasila students. The Independent Teaching Platform offers features for Learning, Teaching, and Creating to support the

How to Cite:
Purnawati, P., Umar, M. K., & Abdjul, T. (2023). Development of Physics Teaching Module for Phase-E with the CDT (Component Display Theory) Approach. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 12200–12212. https://doi.org/10.29303/jppipa.v9i12.5722

implementation of the Independent Curriculum. It provides various resources for educators to develop their teaching practices in line with the Independent Curriculum (Marsh et al., 2010; Nugraha, 2022).

The Independent Curriculum, as an alternative curriculum, addresses the learning setbacks during the pandemic by granting the freedom of "Independent Learning" to those responsible for the teaching process, namely educators and school principals. They have the flexibility to design, implement the learning process, and develop the curriculum in schools while considering the needs and potential of the students. The key advantage of the Independent Curriculum lies in its focus on essential content and the development of student competencies at various phases (Putri et al., 2023). This allows students to engage in more profound, meaningful, and enjoyable learning experiences without rushing. Remote learning becomes more relevant and interactive through project-based activities, providing a broader opportunity for students to actively explore current issues such as environmental and health-related concerns. This, in turn, supports the development of character and the competencies outlined in the Pancasila student profile (Kricsfalusy et al., 2018; Rees et al., 2019; Rahmadayanti, 2022).

The implementation of the Independent Curriculum has been carried out in the Gorontalo Province, and as of now, there are 740 educational units that have registered for the Independent Curriculum self-guided pathway for the academic year 2023/2024. Based on data from the Independent Curriculum dashboard as of March 10, 2023, the distribution is as follows: Boalemo Regency has 117 educational units, Bone Bolango Regency has 112 educational units, Gorontalo Regency has 301 educational units, Gorontalo Utara Regency has 77 educational units, Pohuwato Regency has 78 educational units, and Gorontalo City has 55 educational units (BPMP Gorontalo, 2023). In the academic year 2022/2023, SMA Negeri 1 Wonosari has already implemented the Independent Curriculum through the self-guided pathway, utilizing the teaching materials provided by Independent Teaching Platform. However, the researcher still believes there is a need for the development of Phase-E teaching modules concerning the formulation of learning objectives and the flow of learning objectives that align with the characteristics of the school and the students at SMA Negeri 1 Wonosari, with the hope of achieving maximum learning outcomes.

The Independent Curriculum (Kurikulum Merdeka) has introduced new terminology to replace the previous terms. In the previous curriculum, competency standards and basic competencies have been combined into learning outcomes, competency achievement indicators have become learning objectives, and syllabus has transformed into flow of learning objectives. Learning outcomes consist of general achievements and element-specific achievements. Element-specific achievements are further broken down into understanding of content and process skills. These learning outcomes are already provided on the Independent Teaching Platform. However, educators need to formulate the learning objectives and the flow of learning objectives to align with the characteristics of their students and schools. The development of learning objectives, flow of learning objectives, and the procedure for creating teaching materials should adhere to various taxonomies, such as Bloom's, Gagne's, or Merrill's. Bloom's taxonomy is the most commonly used in the 2013 curriculum and comprises three dimensions: cognitive, affective, and psychomotor. On the other hand, Merrill's taxonomy emphasizes the cognitive aspect, consisting of two dimensions: content and performance, which is then referred to as the Component Display Theory (CDT). CDT, although less commonly used, can be used as a reference in the formulation of instructional learning objectives (Moko et al., 2023; Kahar et al., 2023).

The Component Display Theory (CDT) is a taxonomy that emphasizes content and performance, where content presentation should include several elements: facts, concepts, procedures, and principles or rules. Meanwhile, in terms of performance display, it should fulfill the elements of remembering, using, and discovering. CDT appears to be simpler compared to Bloom's taxonomy, but CDT goes into more depth, particularly in the element of discovery. Merrill's taxonomy, which is CDT, is an instructional design that can be applied in the new curriculum, the Independent Curriculum (Kurikulum Merdeka), as it aligns with the demands of learning that emphasize essential content and projects in the Independent Curriculum (Wantu et al., 2022; Cahyanto and Afifulloh, 2020).

From interviews with several educators, the following issues were identified, some educators have not fully mastered the implementation of the Independent Curriculum. There is a lack of teaching materials based on Gorontalo's local wisdom at SMA Negeri 1 Wonosari. Some students are not fully aware of Gorontalo's local wisdom related to potential energy sources. Educators are still using teaching modules provided by Independent Teaching Platform. There has been no development of teaching modules, especially for the subject in Phase-E, with the CDT approach (Heryani et al., 2023; Nasifah et al., 2022). Student learning outcomes on energy source materials, on average, fall within the "satisfactory" category for Class X Phase-E at SMA Negeri 1 Tilamuta and SMA Negeri 1 Paguyaman, as well as for Class XII Odd Semester at SMA Negeri 1 Wonosari. This is because energy source materials are

relatively straightforward but essential and have a significant impact on life in Gorontalo. Although the average learning outcomes are satisfactory, improvement is needed in terms of remembering, using, and discovering the potential for renewable energy sources in Gorontalo, which is part of Gorontalo's local wisdom and should be developed further.

The solution that the researcher has implemented to address the existing issues is to create and develop Phase-E teaching modules with a CDT approach, focusing on the formulation of learning objectives and the flow of learning objectives tailored to the characteristics of the students, the school, and the local environmental wisdom related to renewable energy potential in Gorontalo. The Independent Curriculum emphasizes essential content and project-based activities, which align with the CDT approach comprising two dimensions: content material and performance to meet the curriculum's demands (Illahi et al., 2023; Siregar et al., 2022).

Based on the presentation of the issues and solutions above, it is necessary to conduct research on the Development of Phase-E Teaching Modules with a CDT (Component Display Theory) approach at SMA Negeri 1 Wonosari. The expected outcome of this development is to have a positive impact on both the researcher and the students. The researcher aims to gain the ability to create high-quality teaching modules with the main components of learning objectives and the flow of learning objectives tailored to the students' needs, and to have a significant impact on learning outcomes.

Method

This research is a Research and Development (R&D) study that employs the 4D model developed by Reiser and Mollenda, with the development product being Phase-E teaching modules tested for their quality and suitability. The stages of the 4D development model are illustrated in Figure 1.

Figure 1. 4D Development Model

The research was conducted in Phase-E of the Independent Curriculum for Class X at SMA Negeri 1 Wonosari in the second semester of the academic year 2022/2023. The study involved one limited test class with 25 students and two extensive test classes with a total of 50 students. SMA Negeri 1 Wonosari is located in the village of Jatimulya, Wonosari District, Boalemo Regency, Gorontalo Province. The research instruments used are listed in Table 1.

To collect valid data according to the established data standards, data collection techniques are required (Sugiyono, 2009). The techniques used in this research consist of validity, practicality, and effectiveness, as outlined in Table 2. To determine the level of validation of the developed teaching modules using the criteria specified in Table 3 (Sudiarman et al., 2015).

The practicality of the Phase-E teaching modules is assessed based on the observation sheets for the implementation of the lesson plan at each meeting. The assessment aspect uses two options: "implemented" and "not implemented." To determine the percentage of activity implementation for all aspects of the learning show in Equation 1.

$$\%\ Implementation = \frac{Many\ steps\ are\ carried\ out}{The\ total\ number\ of\ planned\ steps} \times 100\% \quad (1)$$

The assessment of the implementation of learning is conducted by comparing the total average score with the criteria for the implementation of learning, as shown in Table 4 (Arikunto, 2009).

To assess the effectiveness of the Phase-E teaching modules, an analysis of student activity data and learning outcome data is performed. The percentage of student activities in learning, observed through the observation sheets, is analyzed using Equation 2 (Arikunto, 2009) and evaluated based on the criteria outlined in Table 5.

$$\%Student\ activities = \frac{Total\ score\ obtained\ (A)}{Maximum\ score\ (N)} \times 100\% \quad (2)$$

The percentage of student learning outcomes after participating in the learning is analyzed using Equation 3.

$$\%Learning\ Outcome\ Score = \frac{Total\ score\ obtained\ (A)}{Maximum\ score\ (N)} \times 100\% \quad (3)$$

Table 1. Research Instruments

Type of Instrument	Purpose
Teaching materials, Student worksheets, Assessment (evaluation) sheets	Learning, teaching materials, Student Worksheets, assessment (evaluation) instruments.
Student activity observation sheet	The student activity observation sheet is used to assess the extent of students' activities during classroom learning activities.
The lesson implementation observation sheet.	The lesson implementation observation sheet is used to evaluate the steps of activities in classroom learning as outlined in the Lesson Implementation Plan, whether they can be easily applied in the classroom or not.
Questionnaire	Questionnaires are used to assess the responses of both educators and students to the Phase-E teaching modules that have been developed.
Learning outcome assessment sheets	Student learning outcome assessment sheets are used to assess the extent of students' learning improvements regarding the renewable energy content material.

Table 2. Data Collection Techniques

Techniques	Collection Method	Data Collection Objectives
Validation	Data collection technique that utilizes validation sheets for both individual items and overall validation sheets.	To determine the validity of Phase-E teaching modules.
Practicality	The data collection technique utilizes observation sheets on the implementation of learning, consisting of questionnaires for educator responses and student responses to the developed Phase-E teaching modules.	To assess the level of practicality of the teaching modules.
Effectiveness	The data collection technique uses observation sheets for student activities and learning outcome assessment sheets.	To assess the level of effectiveness of the teaching modules.

Table 3. Criteria for the Validity of Phase-E Teaching Modules

Score Range	Assessment Criteria	Description
$3.5 \leq P < 4$	Highly valid	Can be used without revision
$2.6 \leq P < 3.5$	Valid	Can be used with minor revisions
$1.6 \leq P < 2.5$	Less valid	Can be used with major revisions
$1 \leq P < 1.5$	Not valid	Cannot be used and requires consultation

To test the effectiveness between the Problem-Based Learning model and manual calculations, the normalized gain test (N-Gain) is used. N-Gain is calculated using the formula according to Archambault et al., (2008) as shown in Equation 4.

Table 4. Learning Implementation Criteria

Score (%)	Criteria
81 – 100	Very good
61 - 80	Good
41 - 60	Enough
21 - 40	Less

Table 5. Criteria for the Effectiveness of Phase-E Teaching Modules

Percentage Range (%)	Criteria
81-100	Very good
61-80	Good
41-60	Enough
21-40	Less
0-20	Not much

$$N - Gain = \frac{posttest\ score - pretest\ score}{Maximum\ score - pretest\ score} \times 100\% \quad (4)$$

The calculation results of N-Gain are then interpreted based on the N-Gain interpretation table (Hake, 1999) as shown in Table 6.

Table 6. Interpretation of N-Gain

Score Range (%)	Interpretation
71 - 100	High
31 – 70	Moderate
30 – 70	Low

The measurement of learning outcomes is also conducted through quasi-experimental or pre-experimental experiments with a one-shot case study design to assess the strength of student learning outcomes after the implementation of Phase-E teaching modules. According to Sugiyono (2009), the one-shot case study design is illustrated in Table 7. Description, X is Treatment Administration and O is Observation Results after Treatment. To determine the classical

completion category of students, criteria shown in Table 8 (Sukardi, 2013).

Table 7. One-Shot Case Study Learning Outcome Measurement Design

Subject	Treatment	Post
1 Group	X	O

Table 8. Classical Completion Criteria

Score Range (%)	Interpretation
86 – 100	Very Good
71 – 85	Good
66 – 70	Moderate
0 – 65	Low

Result and Discussion

Define

The definition phase is the first step that needs to be undertaken in the development using the 4D model. In this define phase, an analysis related to the need for module development with the CDT approach is conducted. The analysis of learning objectives is crucial in the development process of teaching modules as it is the main component that determines the process and the learning outcomes to be achieved. The define phase consists of the following steps:

First; Front-end Analysis (preliminary analysis). This activity needs to be carried out to identify the fundamental problems encountered in learning, which require the development of modules with the CDT approach. The researcher conducted open interviews with several science teachers at SMA Negeri 1 Wonosari and analyzed the curriculum needs. The following needs were identified about the development of teaching materials is highly required as a consequence of the Implementation of the Independent Curriculum. There is no development of teaching materials in the school. The development of teaching materials on the "Merdeka Mengajar" Platform is predominantly based on the Bloom's Taxonomy approach (Document of Standard Operating Procedures for the curriculum of SMAN 1 Wonosari). These three fundamental reasons served as the motivation for the researcher to develop Phase-E physics teaching modules with the CDT (Component Display Theory) approach.

Second; Student Analysis. The student analysis activity involves an analysis of the characteristics of the students, which is then aligned with the design and development of the module using the CDT approach. The conditions of students at SMA Negeri 1 Wonosari are as follows: Students at SMA 1 Wonosari come from various ethnic backgrounds, Phase-E students are in the age range of 16-18 years and possess logical thinking abilities, Students fall into the regular category, and there are no special needs students, Students have not been exposed to the CDT approach previously, and the average test scores from the previous year were 80.25 (Class A score list for the 2022 Academic Year). These five student condition analyses motivated the researcher to conduct research on the development of Phase-E physics teaching modules using the CDT approach.

Third; Concept Analysis. This concept analysis aims to identify, measure, and systematically arrange relevant concepts. Determining the types of concepts needed includes: The teaching module in the independent curriculum is defined as a teaching module, which is a set of learning guides containing Learning Outcomes, Learning Objectives, Learning Objective Flow, learning steps, instructional media, including Student Worksheets, Reading Materials, and assessment. Teaching modules can assist teachers in Guiding teachers in conducting lessons, Simplifying, facilitating, and improving the quality of learning, Serving as a reference for teachers in carrying out learning activities, Providing a framework that describes the procedure and organization of learning in accordance with learning outcomes, and Supporting the achievement of competencies within the learning outcomes and the profile of Pancasila learners at each stage of development in a subject (Kemendikbudristek, 2022).

Phase-E is the phase of students aged 16-18 years with logical thinking maturity. The phase in the independent curriculum is different from classes. The phase indicates the level of competence of each student in a particular learning (Hamdi et al., 2022). Phase-E of the Independent Curriculum is intended for grade 10, whether at the high school, vocational school, or equivalent level. In this phase, students are required to recognize their potential and talents before moving on to a higher class. It is the responsibility of each student to choose at least one Arts and Crafts subject (Camelia et al., 2023). Phase-E was chosen as the object of module development because the Phase-E class is in the second year of the implementation of the Independent Curriculum. This allows for a comparison of the differences in learning outcomes between the first and second years. On the other hand, it also allows for a comparison of the application of teaching modules using Bloom's taxonomy and Meriil's taxonomy (CDT).

The physics material that aligns with Learning Outcomes in Phase-E includes measurement, alternative energy, and global warming topics. Therefore, the researcher chose the material on alternative energy and global warming for development. This material falls under the category of essential topics. The alternative

energy and global warming topics are closely related to global issues and are directed toward achieving the goals of sustainable development (Sustainable Development Goals/SDGs). By the end of Phase-E, students are expected to have the ability to respond to global issues and actively contribute to solving problems (Kemendikbudristek, 2022).

CDT (Component Display Theory) elaborates learning objectives by combining content type taxonomy and performance taxonomy (Laliyo, 2015). The CDT approach is a taxonomy approach with a focus on learning performance and content, which is the focal point of developing the physics teaching module product. Performance consists of remembering, using, and discovering. Content includes facts, concepts, procedures, and principles. The CDT approach is not widely used, which is why the researcher was motivated to conduct research using the CDT approach.

Fourth; Learning Objective Analysis. Learning objectives describe the achievement of three competency aspects (knowledge, skills, attitudes) that need to be developed through one or more learning activities (Kemendikbudristek, 2022). The Component Display Theory (CDT) details learning objectives by combining content-type taxonomy and performance taxonomy (Laliyo, 2015). The activities carried out in the objective analysis process include: Comparing various teaching modules, indicating that neither the independent curriculum nor the 2013 curriculum has developed teaching modules using the CDT approach and Bloom's taxonomy for learning objectives consists of 6 cognitive levels, starting from C1 (knowing), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), C6 (creating), whereas CDT's learning objectives consist of 3 cognitive levels: remembering (I), using (G), and discovering (T). However, these cognitive levels must be matched with the content being taught, resulting in 10 learning objective formulations referred to as CDT learning target matrices (IF, IK, IP, IR, GK, GP, GR, TK, TP, TR). Bloom's taxonomy for learning objectives is predominantly used by educators, and CDT learning objectives have yet to be implemented in SMA Negeri 1 Wonosari. Therefore, the researcher is highly motivated to conduct research in developing a teaching module product using the CDT approach.

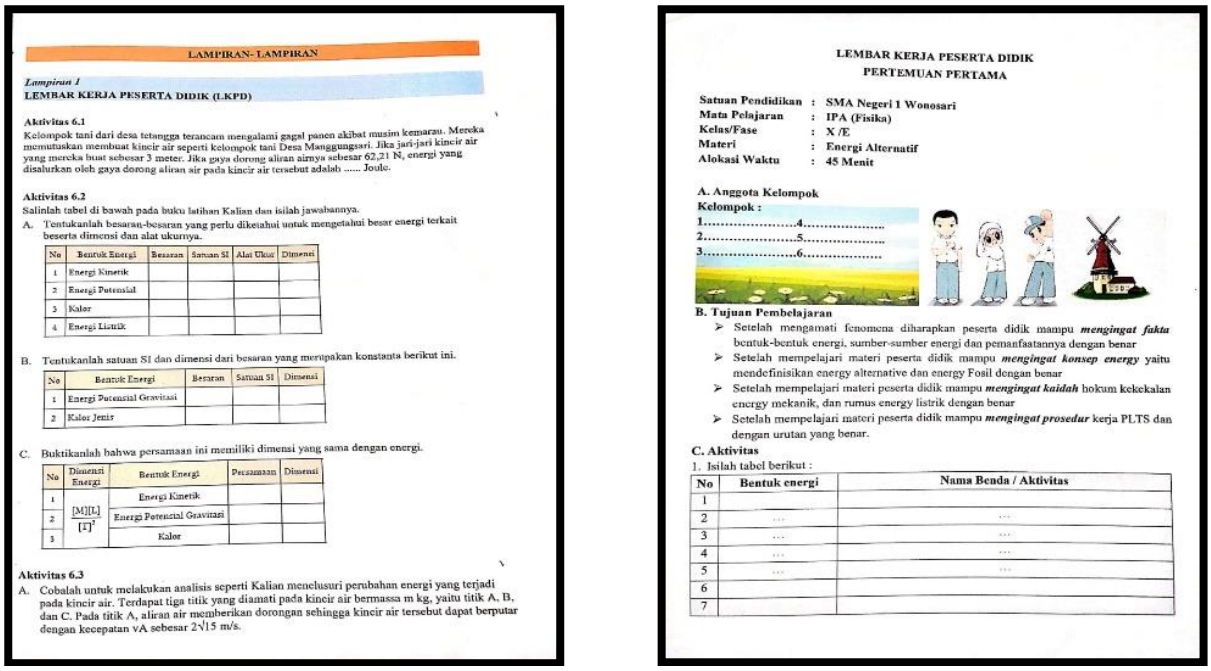
Design

The design phase aims to create a teaching module using the CDT approach. First; Criterion Test Construction. In the test preparation phase, tests are used to measure students' understanding of the material taught using the CDT approach module. The tests used in this module development are essay questions. The constructed tests include: Preparation of diagnostic tests, Preparation of formative test questions, answer keys, and scoring, and Preparation of test grids, pre-tests and post-test questions, and answer keys. The pre-test and post-test scores obtained from students are used as a measure of the module's effectiveness using the CDT approach.

Second; Module preparation and media selection. The second stage in the design phase is the preparation of the module and media selection, which is done in the following: Preparation of learning objectives, preparation of the learning objective sequence, preparation of learning activities, selection of media and preparation of Student Worksheets, and preparation of reading materials. The media selected is the use of YouTube videos available on the internet. The preparation of learning objectives, the learning objective sequence, the teaching module, Student Worksheets, reading materials, formative tests, and learning outcome tests all follow the same CDT-based objective formulation model. Designing the teaching module with the CDT approach will result in a different format compared to previous teaching modules adopted from the Merdeka Mengajar Platform. One comparison regarding the components of Student Worksheets can be seen in Figure 2.

Third; Format Selection. The arrangement of teaching modules is adapted to the components in the independent curriculum, where in one set of modules consists of learning activities, Student Worksheets, formative assessments, reading materials, and learning outcome tests. The formulation of objectives is adjusted to the CDT matrix, which consists of 10 learning objectives arranged sequentially from easy to difficult levels. The learning steps are as follows: Step 1: remember facts, concepts, procedures, and principles. Step 2: use concepts, principles, and procedures. Step 3: discover concepts, principles, and procedures.

Fourth; Initial Design. The initial design is in line with the previous steps, which are the preparation of tests, the preparation of modules (Learning Objectives, Learning Objectives Flow, Teaching Modules, Student Worksheets, reading materials, learning outcome tests. It should be noted that learning outcomes are essentially unchanged or developed because learning outcomes are the official provisions of Permendikbud No. 33 of 2022, which serves as the reference or parent for all module development for educators. Learning objectives are obtained by deriving indicators from the learning outcomes provided, leading to the creation of a learning objective flow.



LAMPIRAN- LAMPIRAN

Lampiran 1
LEMBAR KERJA PESERTA DIDIK (LKPD)

Aktivitas 6.1
Kelompok tani dari desa tetangga terancam mengalami gagal panen akibat musim kemarau. Mereka memutuskan membuat kincir air seperti kelompok tani Desa Manggunggari. Jika jari-jari kincir air yang mereka buat sebesar 3 meter. Jika gaya dorong aliran airnya sebesar 62,21 N, energi yang disalurkan oleh gaya dorong aliran air pada kincir air tersebut adalah ..... Joule.

Aktivitas 6.2
Salinlah tabel di bawah pada buku latihan Kalian dan isilah jawabannya.

A. Tentukanlah besaran-besaran yang perlu dikeahui untuk mengetahui besar energi terkait beserta dimensi dan alat ukurnya.

No	Bentuk Energi	Besaran	Satuan SI	Alat Ukur	Dimensi
1	Energi Kinetik				
2	Energi Potensial				
3	Kalor				
4	Energi Listrik				

B. Tentukanlah satuan SI dan dimensi dari besaran yang merupakan konstanta berikut ini.

No	Bentuk Energi	Besaran	Satuan SI	Dimensi
1	Energi Potensial Gravitasi			
2	Kalor Jenis			

C. Buktikanlah bahwa persamaan ini memiliki dimensi yang sama dengan energi.

No	Dimensi Energi	Bentuk Energi	Persamaan	Dimensi
1	$\frac{[M][L]}{[t]^2}$	Energi Kinetik		
2		Energi Potensial Gravitasi		
3		Kalor		

Aktivitas 6.3
A. Cobalah untuk melakukan analisis seperti Kalian menelusuri perubahan energi yang terjadi pada kincir air. Terdapat tiga titik yang diamati pada kincir air bermassa m kg, yaitu titik A, B, dan C. Pada titik A, aliran air memberikan dorongan sehingga kincir air tersebut dapat berputar dengan kecepatan vA sebesar $2\sqrt{15}$ m/s.

(a)

LEMBAR KERJA PESERTA DIDIK
PERTEMUAN PERTAMA

Satuan Pendidikan : SMA Negeri 1 Wonosari
Mata Pelajaran : IPA (Fisika)
Kelas/Fase : X /E
Materi : Energi Alternatif
Alokasi Waktu : 45 Menit

A. Anggota Kelompok
Kelompok :
1.....4.....
2.....5.....
3.....6.....

B. Tujuan Pembelajaran
- Setelah mengamati fenomena diharapkan peserta didik mampu ***mengingat fakta*** bentuk-bentuk energi, sumber-sumber energi dan pemanfaatannya dengan benar
- Setelah mempelajari materi peserta didik mampu ***mengingat konsep energy*** yaitu mendefinisikan energy alternative dan energy Fosil dengan benar
- Setelah mempelajari materi peserta didik mampu ***mengingat kaidah*** hokum kekekalan energy mekanik, dan rumus energy listrik dengan benar
- Setelah mempelajari materi peserta didik mampu ***mengingat prosedur*** kerja PLTS dan dengan urutan yang benar.

C. Aktivitas
1. Isilah tabel berikut :

No	Bentuk energi	Nama Benda / Aktivitas
1		
2	...	...
3	...	...
4	...	...
5	...	...
6		
7		

(b)

Figure 2. Comparison of CDT Teaching Modules with Non-CDT Teaching Modules (a) Before development, and (b) After development

The learning objectives designed for each material, such as alternative energy material, have ten formulations of learning objectives, and global warming material has ten formulations of learning objectives. The formulation of learning objectives follows the CDT learning target matrix, which is remembering facts, remembering concepts, remembering procedures, remembering principles, using concepts, using procedures, using principles, discovering concepts, discovering procedures, and discovering principles.

Development

The development phase is aimed at producing a valid and feasible Physics Phase-E teaching module. The development phase is carried out in three stages: expert validation, limited trials, and extensive trials. First, expert validation is conducted through a Forum Group Discussion (FGD), which involves an examination by expert postgraduate lecturers from UNG's Physics Education program. The results of the examination provide critiques and suggestions for draft 1 of the Physics Phase-E teaching module, which is then revised to create draft 2 of the Physics Phase-E teaching module. Draft 2 of the Physics Phase-E teaching module, using the CDT approach, is then validated by two competent expert lecturers and tested on a limited scale with 25 students from class X of phase-E at SMA Negeri 1 Wonosari.

Second, the Physics Phase-E teaching module with the CDT approach is subjected to limited testing involving 25 students from class X A of Phase-E. The purpose of this trial is to determine the students' response and their activities when using the teaching module with the CDT approach. Observations are made to obtain new findings, including strengths and weaknesses of the CDT-based module.

Third, extensive testing is carried out involving students from two classes, totaling 50 students. The extensive testing aims to assess the effectiveness of students using the developed CDT module. The results of the extensive trial will be used for further improvements to the module before it becomes the final product. Some findings from the extensive testing are as follows: The performance and content of the module are consistent with the CDT matrix, It requires students to engage in the 10-step learning objectives, with an emphasis on remembering procedures, using procedures, and discovering procedures in each session, The level of discovery, such as discovering concepts, procedures, and principles, requires students to study higher-level material, and Learning is more enjoyable because it involves activities like drawing diagrams, using procedures for experiments, and discovering procedures.

Disseminate

The final stage in the development of a 4D model of instructional materials is the dissemination phase. The dissemination phase is conducted to promote the product resulting from the development so that it is accepted by individuals, groups, or systems. Material packaging must be selective to create the right format.

According to Thiagarajan (1974), there are three main stages in the dissemination phase, namely validation testing, packaging, and diffusion and adoption.

Validation testing is conducted by implementing the developed product with the target learners, which includes the XA Phase-E class consisting of 25 students and a partial extensive trial with 50 students. The packaging stage involves printing the product as needed for distribution. The diffusion and adoption stage involve the absorption and use of the product in schools, uploading it to the Merdeka Mengajar platform as evidence of work that can be accessed by all physics teachers across Indonesia, and publishing it in national or international journals.

The quality and suitability of a product's development can be assessed through three indicators: fairness, practicality, and effectiveness in the Physics Phase-E teaching module with the CDT approach (Component Display Theory). The validity indicator can be obtained from the validation results of the Physics Phase-E teaching module with the CDT approach by expert lecturers. The practicality indicator can be obtained from the implementation of teaching and student responses. The effectiveness indicator can be obtained from student activities, which can be assessed through observation sheets during the learning process and test results.

Validity

Validation was carried out by two expert lecturers to assess the suitability of the Physics Phase-E teaching module with the CDT approach that was developed. The suitability of the teaching module was assessed based on the evaluation criteria specified in the validation form. The validation form consists of a closed questionnaire. The questionnaire for the teaching module consisted of 30 questions, the questionnaire for the Student Worksheet had 11 questions, the questionnaire for the reading materials had 10 questions, and the questionnaire for the learning outcome test had 11 questions. The analysis of the validation by two expert lecturers yielded an average score of 3.46 for the six components, indicating that the product is valid and suitable for use. Based on the validation results by expert lecturers, the Physics Phase-E teaching module with the CDT approach that has been developed is considered suitable for use and ready for limited testing. A summary of the validation results can be seen in Table 9.

Table 9. Expert Validation Results

Physics Teaching Module Phase-E	Average Score	Score Criteria
Teaching Module	3.40	Valid
Student Worksheet	3.60	Highly Valid
Reading Materials	3.50	Valid
Learning Outcome Test	3.40	Valid
Educator Response Questionnaire	3.40	Valid
Student Response Questionnaire	3.50	Valid

Practicality

The practicality of learning can be seen from the implementation of learning that follows the steps of the physics teaching module for Phase-E with the CDT approach through the responses of educators and students, which can be measured using student response questionnaires. The results of the questionnaire were filled out by one educator who taught a related subject for four meetings during the alternative energy material. The observation results of the learning implementation by educators in the limited and extensive trials can be seen in Table 10.

Based on the data in table 10, it can be stated that learning using the CDT module is considered excellent based on the limited trial with an average score of 96.7% and the extensive trial with 88.3%, both falling within the "excellent" category.

Table 10. Percentage of Implementation of Limited and Extended Trials of Learning

Implementation	Meeting	Percentage of Implementation (%)	Criteria
Limited trial	1	100.00	Very Good
	2	93.30	Very Good
	3	93.30	Very Good
	4	100.00	Very Good
	Average	96.70	Very Good
Extensive trial	1	93.30	Very Good
	2	80.00	Very Good
	3	93.30	Very Good
	4	86.70	Very Good
	Average	88.30	Very Good

The questionnaire on student responses to learning using the physics module for Phase-E with the CDT approach was conducted over four meetings. The limited trial involved 25 students, while the extensive trial involved two classes with a total of 50 students. The scoring for each statement in the questionnaire was done using a Likert scale. The student response questionnaire consists of six indicators presented in 25 statement items, including positive and negative statements. These indicators encompass student opinions about learning using the physics module for Phase-E with the CDT approach, student feelings, student engagement, and student learning outcomes after participating in learning with the physics module for Phase-E. After the learning process, each student was given a questionnaire. The results of the student response questionnaire from the limited and extensive trials can be seen in Table 11.

Table 11. Questionnaire Response Results per Indicator in Limited Trial and Extensive Trial

Implementation	Indicators	SS	S	RR	TS	STS
Limited trial	1	15.20	72.80	12.00	0	0
	2	25.30	66.70	8.00	0	0
	3	25.30	52.00	22.70	0	0
	4	30.70	56.00	16.00	0	0
	5	24.00	53.30	22.70	0	0
	6	50.00	46.00	7.50	0	0
Extensive trial	1	39.20	48.80	12.00	0	0
	2	33.00	54.00	13.00	0	0
	3	34.00	44.67	21.33	0	0
	4	46.70	42.00	11.33	0	0
	5	43.33	49.33	7.33	0	0
	6	46.80	38.40	14.80	0	0

Information SS is Strongly Agree, S is Agree, RR is Uncertain, TS is Disagree, and STS is Strongly Disagree.

Based on the data above, it is evident that learning using the Physics module for Phase-E with the CDT approach, which has been developed, meets the requirements for use. The average response of the students reaches 83.16%. The conclusion from the limited trial table shows that there are six indicators responded to by the students, with the highest scores in the "Agree" (S) column. The conclusion from the extensive trial table indicates that the "Strongly Agree" (SS) and "Agree" (S) columns have equally high scores. In conclusion, both tables show that the student response questionnaire is suitable for use as it receives a positive response. Therefore, it can be stated that the Physics teaching module for Phase-E meets the criteria for practicality.

Effectiveness

Assessment of student activities was conducted by observers during the learning process for four sessions by filling out student observation sheets. There are 10 indicators for student activities to make it easier for the observer to assess the students' activities shown in Table 12.

Table 12. Percentage of Student Activities Limited Trial and Extensive Trial

Implementation	Meeting	Percentage of Student Activities (%)	Criteria
Limited trial	1	83.20	Very Good
	2	84.40	Very Good
	3	85.20	Very Good
	4	88.40	Very Good
	Average	85.30	Very Good
Extensive trial	1	83.20	Very Good
	2	83.80	Very Good
	3	84.20	Very Good
	4	87.20	Very Good
	Average	84.60	Very Good

In this case, the observation sheet was given to the students, with one class in the limited trial consisting of 25 students and two classes in the extensive trial consisting of 50 students. Based on the observations, the percentage of student activity assessments in the limited trial and extensive trial.

Learning outcomes in the cognitive domain were assessed using an assessment sheet in the form of an essay test for two groups, namely the limited class trial and the extensive class trial. The test was given before learning (pre-test) and after learning (post-test). The test was prepared based on the question indicators that were adapted to the learning indicators, consisting of 10 items. The improvement in the cognitive domain was measured based on N-Gain analysis. Based on the tests that were given, the overall average N-Gain scores for the pre-test and post-test in the limited class trial and extensive class trial are shown in Table 13.

Table 13. Average Pre-test, Post-test, Difference, and N-Gain Scores for Limited and Extensive Class Trials

Implementation	Respondent	Pre test	Post test	Difference (%)	N-Gain	Criteria
Limited trial	25	34.76	83.58	48.82	0.74	High
Extensive trial	50	33.72	81.21	47.49	0.72	High

The learning outcomes in the cognitive domain for each cognitive aspect, in accordance with the CDT learning target matrix, during the limited and extensive trial, can be seen in Table 14.

Table 14. Cognitive Domain Learning Outcomes in Limited and Extensive Trials

Cognitive Aspect	Score of Learning Outcomes Percentage (%)	
	Limited trial	Extensive trial
IF	87.20	90.40
IK	85.00	88.00
IR	82.60	86.60
IP	87.20	92.00
GK	88.00	91.00
GP	83.30	83.00
GR	80.00	88.70
TK	85.00	90.00
TR	80.70	80.00
TP	82.30	90.00

The conclusion obtained from the table is that in the cognitive domains of IF, IK, IP, GK, and GP, students find it relatively easy, both in the limited and extensive trials. On the other hand, IR, GR, and TR belong to cognitive domains that are considered difficult. Upon reflection with students who scored low in IR, GR, and TR, it was found that the difficulties they faced in the cognitive domains of IR, GR, and TR were due to the challenge of remembering formulas, applying formulas, and, most notably, discovering physics formulas that had not been taught at the previous educational level. Other factors contributing to this challenge were both internal and external, including a lack of mastery of basic formulas, unit conversions, and the interpretation of physics formulas. As for the external factor, the limited coverage of physics topics in Phase D, which was a result of science teachers not being specialized in physics, played a role.

The results of students' completeness in both the limited and extensive trials are shown in Table 15.

Table 15. Student Learning Achievement Completeness in the Limited and Extended Trials

Implementation	Number of Students	Number of Students Passed	Number of Students Failed	Classical Completeness (%)
Limited trial	25	22	3	88.00
Extensive trial	50	41	9	82.00

Based on Table 16, it can be seen that in both the limited trial and the extensive trial, all students achieved the minimum completeness score. The advantages of the CDT approach module product include: Each meeting is equipped with Participant Worksheets and reading materials arranged in one package, while other teaching modules attach Participant Worksheets and reading materials at the end of the module, Reading materials include concept maps in each meeting, and the content matches the CDT learning target matrix, Every chapter of the material requires remembering procedures, using procedures, and finding procedures, whereas other modules only use one of them, and Learning using the Physics Phase-E teaching module with the CDT approach has a significant impact, as demonstrated by the improvement in student learning outcomes and increased motivation, as shown in the analysis of student activities and learning outcomes.

The advantages and success of the Physics Phase-E teaching module with the CDT approach are supported by previous research, such as Husain and Katili (2022). Their research showed that the material expert validation score was very appropriate at 95%, the practicality test by educators was very practical at 90.2%,

and the small group trial received a 97% student response, while the large-scale trial received a 97.6% student response. In conclusion, this research is considered practical for use in basic graphic design subject instruction.

One of the advantages of the Physics Phase-E teaching module with the CDT approach is its structured cognitive sequence, starting from easy, moderate, and difficult levels. This CDT sequence helps create a well-structured framework for both performance and content thinking. Additionally, the cognitive level of "finding" in CDT requires a deep understanding of the material and broader insights. Empirical findings (Laliyo, 2012) suggest that presenting topics using a framework (diagram), defining learning objectives, and providing examples in the CDT Merrill model for each meeting help students recognize, understand, relate, sequence, and remember the concepts they are learning, making it easier for them to acquire new knowledge.

One of the characteristics of CDT is its ability to achieve a high level of precision in reaching learning objectives. By accumulating mastery of a carefully designed set of learning objectives, students are guided to think sequentially, critically, and systematically. Furthermore, through the learning program developed using CDT, students are assisted in choosing and employing appropriate methods (Hidayanto, 2016).

The weaknesses of the teaching module with the CDT approach are as follows: The learning process requires more time and stricter time management. This is because, in the second meeting when using concepts, formulas, and procedures, more time is needed. The process of independently discovering concepts, formulas, and procedures requires intensive guidance. Not all students have a deep understanding of higher-level concepts, such as the reflection of light, light radiation, mechanical energy, and so on. Therefore, it is necessary to expand the material's scope to a higher level. The process of students discovering procedures takes longer, mainly because, after monitoring the project, some discoveries may fail in the experiment. This requires repeating and replacing several equipment and materials components, which takes even more time. Additionally, it requires collaboration between groups. Challenges encountered during the project task include the distance between students' residences and transportation limitations.

Conclusion

The teaching module for Physics Phase-E with the Component Display Theory (CDT) approach has demonstrated strong validity, practicality, and effectiveness in various aspects. Validity stated about the teaching module, student worksheets, reading materials, and learning outcome assessments received an average validity score of 3.5. This indicates that the teaching module is valid for use, ensuring it aligns with its intended educational goals. Practicality stated about the module proved practical during testing. In the limited trial, it received a score of 96.7%, and in the extensive trial, it received a score of 88.3%. Additionally, student response analysis indicated that the module met practicality standards. Effectiveness stated about the module's effectiveness is evident through the high level of student engagement during the learning process. In the limited group trial, student engagement was 85.3%, and in the extensive group trial, it was 84.63%. Moreover, the assessment results showed a high level of achievement, with an 88% success rate and a substantial N-Gain difference of 0.74 in the limited trial and 0.75 in the extensive trial. These results suggest that the teaching module for Physics Phase-E, using the CDT approach, is highly effective for learning. This comprehensive evaluation demonstrates the module's overall success in terms of validity, practicality, and effectiveness, making it a valuable tool for physics education.

Acknowledgments

Thank you to the principal, teachers, and students at SMA Negeri 1 Wonosari for their assistance and participation so that this research was carried out correctly.

Author Contributions

Pujijana Purnawati: Conceptualization, methodology, writing—original draft preparation, writing—review and editing; Masri Kudrat Umar: Methodology, writing—review and editing, validation; Tirtawaty Abdjul: Formal analysis, data curation, validation.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

Archambault, D., Munzner, T., & Auber, D. (2008). GrouseFlocks: Steerable exploration of graph hierarchy space. *IEEE transactions on visualization and computer graphics*, *14*(4), 900-913. https://doi.org/10.1109/TVCG.2008.34

Butler, M. M., Fraser, D. M., & Murphy, R. J. (2008). What are the essential competencies required of a midwife at the point of registration?. *Midwifery*, *24*(3), 260-269. https://doi.org/10.1016/j.midw.2006.10.010

Arikunto, S. (2009). *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.

BPMP. (2023). *Gelar Sosialisasi Pendaftaran IKM Mandiri Tahun 2023. Gorontalo*: bpmpgorontalo.kemdikbud.go.id

Cahyanto, B., & Afifulloh, M. (2020). Electronic Module (E-Module) Berbasis Component Display Theory (CDT) Untuk Matakuliah Pembelajaran Terpadu. *Jurnal Inovasi dan Teknologi Pembelajaran*, *7*(1), 49-56.

Camelia, S., Mawardi, M., & Suryani, O. (2023). Pengembangan Bahan Ajar untuk Menunjang Pembelajaran Kurikulum Merdeka pada Materi Konsep dan Dampak Pemanasan Global Fase E SMA/MA. *Jurnal Pendidikan MIPA*, *13*(2), 530-537. https://doi.org/10.37630/jpm.v13i2.1091

Hake, R. R. (1999). Analyzing change/gain score. [Online] Tersedia: http://www. physics. indiana. edu/nsdi. *AnalyzingChange-Gain. pdf.[Diakses 16 Desember 2019*.

Hamdi, S., Triatna, C., & Nurdin, N. (2022). Kurikulum merdeka dalam perspektif pedagogik. *SAP (Susunan Artikel Pendidikan)*, *7*(1), 10-17. http://dx.doi.org/10.30998/sap.v7i1.13015

Heryani, T. P., Suwarma, I. R., & Chandra, D. T. (2023). Development of STEM-Based Physics Module with Self-Regulated Learning to Train Students Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4245-4252. https://doi.org/10.29303/jppipa.v9i6.3578

Hidayanto, D. N. (2016). Pengembangan pembelajaran IPS SD berdasarkan preskripsi Component Display Theory (CDT). *Jurnal Ilmu Pendidikan*, *6*(2).

Husain, H., & Katili, M. R. (2022). Pengembangan Bahan Ajar Digital Desain Grafis Berbasis CDT Merrill untuk Siswa Kelas X Multimedia SMK Negeri 1. *Educational Technology Journal*, *2*(1), 56-65. https://doi.org/10.26740/etj.v2n1.p56-65

Illahi, F. A., Darvina, Y., Desnita, D., & Gusnedi, G. (2023). Validity Of LKPD Based Project Based Learning on Global Warming Material for Phase-E Students At SMAN 1 Banuhampu. *Jurnal Pendidikan Tambusai*, *7*(3), 24080-24091. https://doi.org/10.31004/jptam.v7i3.10393

Kahar, M. S., Arsyad, R. B., Fathurrahman, M., & Mursalin, M. (2023). Component Display Theory (CDT) Learning Model Design in Basic Physics Lectures. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 9629-9635. https://doi.org/10.29303/jppipa.v9i11.5427

Kemendikbudristek. (2022). *Platform Merdeka Mengajar*. Jakarta: kemendikbudristek

Kricsfalusy, V., George, C., & Reed, M. G. (2018). Integrating problem-and project-based learning opportunities: Assessing outcomes of a field course in environment and sustainability. *Environmental education research*, *24*(4), 593-610. https://doi.org/10.1080/13504622.2016.1269874

Laliyo, L. A. (2015). Pemetaan Struktur Pengetahuan Sebagai Ukuran Penguasaan Konsep Laju Reaksi Siswa SMA di Kota Gorontalo. *Fundamental (DP2M)*, *2*(956).

Laliyo, L. A. R. (2012). Pengaruh strategi pembelajaran dan gaya kognitif spasial terhadap hasil belajar ikatan kimia siswa kelas XI SMA Negeri di Gorontalo. *Jurnal pendidikan dan Pembelajaran (JPP)*, *19*(1), 14-27.

Marlina, L., Dariyani, N., Sriyanti, I., Sudirman, S., & Meilinda, M. (2022). Development of Differentiated Physics Teaching Modules Based on Kurikulum Merdeka. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2286-2292. https://doi.org/10.29303/jppipa.v8i5.2061

Marsh, J. A., Sloan McCombs, J., & Martorell, F. (2010). How instructional coaches support data-driven decision making: Policy implementation and effects in Florida middle schools. *Educational policy*, *24*(6), 872-907. https://doi.org/10.1177/0895904809341467

Moko, S. N. A., Pikoli, M., & Ahmad, J. (2023). Development of Science Teaching Materials Based on Component Display Theory (CDT) Model to Improve the Creative Thinking Ability of Elementary School Grade V Students. *Open Access Repository*, *10*(1), 32-38. https://doi.org/10.17605/OSF.IO/Q5UTY

Nazifah, N., & Asrizal, A. (2022). Development of STEM Integrated Physics E-Modules to Improve 21st Century Skills of Students. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1783-1789. https://doi.org/10.29303/jppipa.v8i4.1820

Nematillaevna, J. M. (2021). Methods for the formation of competencies in the technology of teaching students basic didactic units among mathematics teachers. *European Scholar Journal*, *2*(6), 184-188. https://www.scholarzest.com

Nugraha, T. S. (2022). Kurikulum merdeka untuk pemulihan krisis pembelajaran. *Inovasi Kurikulum*, *19*(2), 251-262.

Putri, A. J., Sukmono, T., & Wicaksana, E. J. (2023). The Influence of Problem Based Learning (PBL) Model Based on STEM Approach on Critical Thinking Ability Phase-E in Biology Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7056-7063. https://doi.org/10.29303/jppipa.v9i9.4568

Rahmadayanti, D., & Hartoyo, A. (2022). Potret kurikulum merdeka, wujud merdeka belajar di sekolah dasar. *Jurnal Basicedu*, *6*(4), 7174-7187. https://doi.org/10.31004/basicedu.v6i4.3431

Rees L. D. G., Gerber, E. M., Carlson, S. E., & Easterday, M. W. (2019). Opportunities for educational innovations in authentic project-based learning: understanding instructor perceived challenges to

design for adoption. *Educational technology research and development*, *67*, 953-982. https://doi.org/10.1007/s11423-019-09673-4

Siregar, L. F., Sumanik, N. B., & Christianto, H. (2022). Analysis of Teacher's Ability in Setting Learning Objectives, Flow of Learning Objectives, And Modules in The Merdeka Curriculum. In *SHS Web of Conferences* (Vol. 149, p. 01005). EDP Sciences. https://doi.org/10.1051/shsconf/202214901005

Sudiarman, S., Soegimin, W. W., & Susantini, E. (2015). Pengembangan perangkat pembelajaran fisika berbasis inkuri terbimbing untuk melatihkan keterampilan proses sains dan meningkatkan hasil belajar pada topik suhu dan perubahannya. *JPPS (Jurnal penelitian pendidikan sains)*, *4*(2), 658-671. https://doi.org/10.26740/jpps.v4n2.p658-671

Sugiyono. (2009). *Metode Penelitian Bisnis (Pendekatan Kuantitatif, Kualitatif, Dan R&D)*. Bandung: Alfabeta.

Sukardi. (2013). *Metodologi Penelitian Pendidikan: Kompetensi dan Praktiknya*. Jakarta: PT Bumi Aksara.

Swawikanti, K. (2022). *Kupas Tuntas Kurikulum Merdeka, Begini Konsep & Implementasinya.* Jakarta Selatan: Ruang Guru.

Thiagarajan, S., at el. (1974). *Instructional Development For Training Teachers Of Exceptional Children*. National Center For Improvement Educational System. Https://Doi.Org/10.1016/0022-4405(76)90066-2

Wantu, H. M., Djafri, N., Lamatenggo, N., & Umar, M. K. (2022). Model Pembelajaran Component Display Theory-Self Confidence (Cdt's) Dalam Pembelajaran Pendidikan Agama Islam. *Irfani (e-Journal)*, *18*(2), 165-176. https://doi.org/10.30603/ir.v18i2.3060