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Development of Case Method-Based Learning Tools to Enhance Learning Outcomes in Engineering Physics Course

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Abstract

This study aims to develop a learning tool using the case method in an engineering physics course. The 4D (define, design, develop, disseminate) development model is used as the methodology. The development model is used to determine the feasibility and effectiveness of learning tools in improving the learning outcome. The validation sheet, questionnaire, and written test sheet were used as the data collection techniques. The validation sheet consists of construction and content validation. The questionnaire is used to collect descriptive data on the practical teaching materials test, and the written test sheet consists of a pretest and a post-test, which are used to determine learning outcomes improvement. The validation test results showed that the case-based learning tools in the engineering physics course were categorized as very valid. The practicality of case-based learning tools is evaluated through an analysis of lecturer and student responses. The results showed that the practical case-based learning tools were rated as very practical. Effectiveness can be determined from the N-gain score from the pretest and posttest. The result showed that the N-gain score was in the medium range, indicating improvement in the learning outcome. According to the results above, the development of learning tools using the case method has been declared feasible and effective for application in the engineering physics course.

Keywords: learning tools, case method, engineering physics.

INTRODUCTION

In the era of the Fourth Industrial Revolution (4.0), the development of information technology has the potential to replace human jobs. However, this situation will not affect individuals who possess the competencies and skills required in the 4.0 era. Education plays a crucial role in producing high-quality human resources, as it can cultivate individuals with strong character, attitudes, and skills (Rahmadi et al., 2022). According to Andrian and Rusman (2019), the skills required to compete in the industrial revolution are the 4Cs: critical thinking and problem-solving, creativity, communication, and collaboration.

The Ministry of Education and Culture of the Republic of Indonesia, through Decision Number 3/M/2021 on the *Indikator Kinerja Utama* (IKU) for universities in Indonesia, emphasizes collaborative, real-world learning experiences for students. This learning aims to enhance the quality of education through innovative teaching methods, enabling students to achieve optimal learning outcomes, including in attitudes, knowledge, and skills (Hodijah, Hastuti, & Zefaya, 2022).

An excellent university can provide students with the resources to develop their abilities, self-actualize, and foster independence (Andayani, Mustikowati, Setiyowati, & Firdaus, 2021). This presents a significant challenge for lecturers, who are the key parties consistently interacting with students. As facilitators, lecturers enable students to enhance their abilities, including attitudes, skills, and knowledge, through the learning process in the classroom.

Lecturers, as educators, play a crucial role in supporting the quality of education. Pedagogical competence is one of the essential competencies that lecturers must possess. This competence includes the ability to conduct effective teaching, assess the learning process and outcomes, and utilize research findings to improve the quality of learning. Therefore, lecturers must engage in the reconstruction of learning, including developing teaching tools aligned with the curriculum, such as case-based learning.

The case method and team-based learning are one of the key Performance Indicators. The case method is a learning method that uses cases in the learning process. A case is the narrative that contains information and that is interesting to analyze. There are two elements of a case: the case itself and how learning uses the case. Effective cases are usually based on real cases that have occurred in the past and present. According to Gunawan et al. (2022), the student involved in the case method serves as a decision-maker or evaluator based on available information. The case requires students to choose the theories or concepts to apply in the case analysis. Besides that, case method learning is student-centered because it involves students in intensive discussion and problem-solving (Farikah, Mulyani, Astuty, Aulya, & Cahyaningrum, 2022).

Case method learning has several advantages over other methods. Bruner (2002) mentions several advantages of the case method, namely (1) students participate actively in the learning process; (2) improve critical thinking in students through communication and literacy practice; and (3) case-based learning is a method that utilizes student experience, thus helping students develop a framework for making decisions. Yoo and Park (2014) argued that the case method can improve students' problem-solving ability.

According to Dewi and Hamid (2015), the case method can maximize students' understanding of the concept. This is characterized by increased student activity through group discussion. Kaddoura (2011) states that the case method uses a case-based approach that involves students in discussions of specific situations and real-world examples. Moreover, the case method can enhance students' creativity and foster positive attitudes, thereby improving learning outcomes (Hong & Yu, 2017). The case method applied in learning provides a practical model for students to connect content learning with practice. It helps them improve their ability to learn collaboratively, think critically, and solve problems (Dewi, Rahayu, Habidin, & Dasna, 2022). Therefore, case-based learning has been delivered in various curricula, and feedback received from students showed that case method learning significantly improves students' understanding (Bi, Zhao, Yang, & Wang, 2019; Jamari, Abdullah, Mohamed, & Zaid, 2018; Suwono, Pratiwi, Susanto, & Susiolo, 2017).

Although Case-Based Learning (CBL) has been recognized for its pedagogical advantages, it also presents notable drawbacks. A primary limitation is its restricted generalizability, as findings derived from individual cases are often context-specific and not readily applicable to other settings (Flyvbjerg, 2006). Consequently, CBL is more appropriate for hypothesis generation than theory verification. Furthermore, the approach is time- and resource-intensive, requiring the development of detailed and authentic cases, as well as killed facilitation, to ensure effective learning outcomes (Thistlethwaite et al., 2012). These requirements may constrain its scalability, particularly in large classes or resource-limited institutions.

Based on the technical-vocational education curriculum at Universitas Halu Oleo, the engineering physics course guides students in applying basic physics concepts in electronics. This lecture material covers the measurement concept, the basic concepts of mechanics, the wave and sound concepts, and the concepts of electricity and magnetism. These materials require high-level analysis and creative thinking to solve physics problems in field electronics. So, the case method is well-suited for an engineering physics course to enhance students' learning outcomes.

Developing learning tools is very important for lecturers, as it allows them to evaluate the learning process implemented. Learning tools constitute a preparatory framework developed by educators to facilitate the effective execution of the learning process. According to Sumarno and Wustqa (2014), learning tools serve as guides for teachers in implementing classroom learning, ensuring that activities are aligned with the targeted competencies. Well-designed learning tools play a crucial role in equipping students to have meaningful learning experiences. Well-designed learning tools can improve students' learning outcomes. The research conducted by Suarniati, Hidayah, and Handarini (2018) indicates that the development of PBL-based learning tools can improve students' critical thinking skills. Furthermore, Puspita and Dwikoranto (2020) demonstrate that the development of CBL-based learning tools can foster students' problem-solving abilities.

Based on the analysis of the course program documents, including the learning tools consisting of lesson plans and student assignment designs, it was found that the teaching process is still dominated by the delivery of information from the lecturer, followed by assignments, presentations, and reports from students, without directly involving students in the process. This leads to low student engagement in the learning process, a lack of problem-solving skills, limited critical thinking, and an inability to connect theory with practice, ultimately affecting students' learning outcomes. Based on the explanations above, it is necessary to develop learning tools for an engineering physics course using the case method to improve student learning outcomes. This study was carried out to develop and assess the feasibility of learning tools informed by expert input and to evaluate their effectiveness in improving student learning outcomes in the engineering physics course.

METHOD

This study is a Research and Development (R&D) study. R&D is a research method used to create specific products and test their effectiveness (Guo, Wang, & Wei, 2018; Lee, Jeong, & Yoon, 2017). Moreover, López-Meneses (2023) explains that the essence of development research is not to design or conduct theoretical studies, but to develop effective products in education. The design of this study used the 4D models according to Thiagarajan (1974). The 4D models have four stages: define, design, development, and disseminate. Figure 1 shows the 4D diagram of this study.

The define stage aims to establish and define the learning requirements, including: preliminary analysis, student analysis, assignment analysis, and the specification of the learning objective. The preliminary analysis aims to identify field-based facts regarding the use of learning tools in the engineering physics course and students' competencies, which can serve as a reference for developing the course materials. Student analysis is a critical process that involves observing students' characteristics, including traits, abilities, experiences, and motivation for learning, both individually and collectively. This analysis can provide information about the development of an effective and relevant instructional strategy. Assignment analysis involves identifying and examining the essential tasks students need to master to attain the minimum competencies set by the curriculum. The specification of learning objectives is based on the results of content and concept analyses, which aim to identify the behavioral characteristics of the research objects. These identified behaviors serve as the foundation for developing assessments and designing learning tools, which are then integrated into the course materials for the researcher's use.

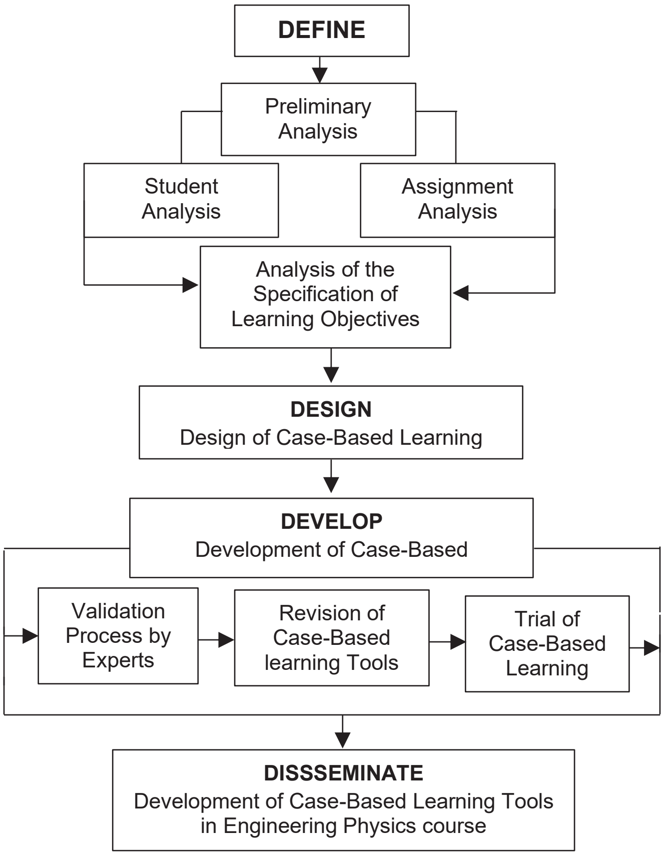


Figure 1. The 4D Development Model

The purpose of the design stage is to develop and compile learning tools using relevant resources. The initial version of the learning tools is prepared as a draft at this stage and will later be subjected to validation and trial implementation during development.

The development stage is carried out to construct the learning tools designed during the design stage. This stage consists of developing learning tools, conducting validation, and preparing a draft version ready for trial implementation. In the dissemination stage, after the researcher's revisions, the final design of the case-method-based learning tools in soft file format is produced and distributed to lecturers for use as instructional materials in lectures.

This study was conducted in the Department of Technical Vocational, Faculty of Teacher Training and Education, Universitas Halu Oleo in the odd semester of the academic year 2023/2024. The subjects of this study are students in the Department of Technical-Vocational Education enrolled in the engineering physics course.

The data collection techniques in this research include validation, questionnaires, pretests, and posttests. The validation instrument comprises detailed guidelines and a consent statement for expert validators to assess the learning tools. The outcomes of this evaluation serve as the foundation for refining the learning tools prior to their pilot implementation. This validation process aims to assess the overall feasibility and quality of the learning tools. The evaluation encompasses two primary dimensions: (1) construct validity, which includes the appropriateness of graphic design and digital media integration; and (2) content validity, which covers the relevance and accuracy of content, coherence of presentation, and clarity of language. The validation team assigned scores on the validation sheet for the learning tools, using a scale of 1 to 4 for each criterion.

$$Percentage = \frac{Score\ obtained}{Score\ maximum} \times 100\% \qquad (1)$$

Table 1. Validation and Questionnaire Criteria of Case-Based Learning Tools

No	Interval	Criteria
1.	76%-100%	Excellent
2.	51%-75%	Good
3.	26%-50%	Fair
4.	0%-25%	Poor

(Mulyono, Suardiman, & Prasoji, 2019; Rahayu, Fanaike, & Adillah, 2022)

The questionnaire used in this study was a response questionnaire for lecturers and students. This questionnaire is intended for students and lecturers to gather feedback on the developed learning tools and to assess their practicality in the learning process. In the 4D model of R&D used in this study, the questionnaire was applied at the Develop stage, specifically during the practicality testing phase after learning tools were developed and validated by experts. It consisted of several statements, each assessed on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The questionnaire assesses content, instructional design, implementation, technical quality, practicality, and effectiveness. Indicators for each aspect are presented in Table 2. The questionnaire data were analyzed to identify areas for improvement and served as the basis for revising the learning tools before dissemination. Data analysis of validation and questionnaire sheets can be determined by using equation (1) and converted into Table 1.

Table 2. Questionnaire Aspect and Indicators

Aspect	Indicators
Content	Relevance of material; completeness and depth of content.
Instructional design	Clarity of learning objectives; coherence of learning activities
Implementation	Ease of use in learning; contextual relevance
Technical quality	Visual appeal of materials; clarity of language
Practicality	Time and resource efficiency; suitability with available facilities
Effectiveness	Student engagement:

The empirical validity of the validity sheet and questionnaire was tested using Pearson's Product-Moment Correlation between each item score and the total score. Items with a correlation coefficient (r) greater than the critical value (r_{table}) at a significant level of 0.05 were considered valid. The questionnaire's reliability was measured using Cronbach’s alpha, yielding a coefficient of 0.77, which is categorized as high reliability (Taherdoost, 2016).

Pretest and posttest were administered to evaluate the effectiveness of the learning tools in improving student learning outcomes. The test comprised seven essay questions designed to assess high-order thinking skills, including the ability to understand, apply, and analyze concepts in measurement, mechanics, waves and sound, electricity, and magnetism. The construction of the test items was guided by a detailed test blueprint developed with reference to the specific Sub-Course Learning Outcomes (Sub-CLOs) to ensure alignment between the intended competencies and the assessment. The detailed descriptions of CLOs and sub-CLOs were presented in Table 6. Each item was scored on a maximum scale of 5 points, with assessment criteria covering conceptual accuracy, clarity of explanation, application of principles, and depth of analysis. The total maximum score for the test was 35. The blueprint for the pretest and posttest is shown in Table 3.

Table 3. The Blueprint for Pretest and Posttest

Item No	Topic	Sub-CLOs Code	HOTs Indicator	Cognitive Level (Bloom)	Question Type	Max. Score
1.	Quantities, Units, and Measurements	1.1	Analyze the accuracy of unit usage in a measurement and explain the reasoning.	C4 (Analyze)	Essay	5
2.	Kinematic (Motion in Straight and Circular Path)	2.1	Solve problems related to straight and circular motion based on observational data.	C4 (Analyze)	Essay	5
3.	Newton’s Law of Motion in Engineering	2.2	Apply Newton’s Laws to calculate forces in mechanical system design.	C3 (Apply)	Essay	5
4.	Work and Energy	3.1	Analyze real-life phenomena and calculate the work and energy involved	C4 (Analyze)	Essay	5
5.	Wave and Sounds	4.1, 4.2	Explain wave and sound phenomena and calculate propagation speed using the Doppler Effect.	C3 – C4 (Apply – Analyze)	Essay	5
6.	Electricity (Current, Voltage, Power)	5.1, 5.2	Analyze the relationship between current, voltage, and power in a simple circuit.	C4 (Analyze)	Essay	5
7.	Magnetism and Electronics	6.1, 7.1, 7.2	Analyze the working principle of electronic motors and explain the characteristics of electronic components.	C4 (Analyze)	Essay	5

The validity of the pretest and posttest was assessed using empirical validity, as indicated by the Pearson product-moment correlation, which showed that all test items in the instrument were valid. The instruments' reliability was assessed using Cronbach's alpha. The results showed a reliability coefficient above 0.70, indicating high reliability (Taherdoost, 2016). Therefore, the instruments were considered reliable and suitable for use in this study.

The data analysis technique used to assess the feasibility of learning tools is determined by practical value. Practical value is obtained from analyzing questionnaires completed by lecturers and students. The learning tools are considered practical if the responses are judged to be good according to practical standards. Practical analysis is conducted using percentage values (%) as seen in Equation (2):

$$\text{Practically value} = \frac{\text{Total score obtained}}{\text{maximum total score}} \times 100\% \quad (2)$$

The interpretation of the calculation data in this study can be seen in Table 4.

Table 4. Interpretation of Practical Criteria

No	Interval	Criteria
1.	P ≥ 85%	Very practical
2.	70% ≤ P< 85%	Practical
3.	50% ≤ P< 70%	Less practical
4.	P < 50%	Impractical

(Muttakin, Dewi & Sari, 2024; Sari & Rakhmawati, 2025)

Effectiveness testing is carried out by analyzing the pretest and posttest. The effectiveness of learning tools can be measured by comparing student learning outcomes before and after their implementation. The increase in learning outcomes is expressed as standard gain. The N-Gain standard can be expressed by Equation (3).

$$N - Gain = \frac{\bar{X}_{Posttest} - \bar{X}_{Pretest}}{Maximum\ Score - \bar{X}_{Pretest}} \quad (3)$$

According to Nismalasari, Santianin, and Rohmadi (2016) and Sundayana (2014), the N gain standard is shown in Table 5.

Table 5. N-Gain Standard Criteria

No	Gain Standard Value	Category
1.	(g) ≥ 0.7	High
2.	0.7 >(g) ≥ 0.3	Medium
3.	(g) < 0.3	Low

RESULT AND DISCUSSION

The results of this study are explained in terms of the development procedure. The stages of this study are in accordance with the stages of development research based on the 4D development, namely:

Define Stage

The define stage aims to determine and define learning requirements as follows:

a. Preliminary Analysis Results

A preliminary analysis was conducted to identify the fundamental problem in development case-method-based learning tools. At this stage, facts and alternative solutions are gathered, making it easier to determine the initial steps in the development process. This stage is crucial because it helps identify mismatches between existing learning tools and students' learning needs or characteristics. In addition, it provides insight into the obstacles both lecturers and students face in implementing case-based learning, including a lack of contextual cases, unclear learning objectives, and insufficient student engagement. By understanding these issues early on, the development process can be directed toward producing learning tools that are more effective, relevant, and aligned with the principles of the case method approach (Putri, Roza, & Maimunah, 2020).

b. Student Analysis Results

Based on initial observations, not all students were able to understand the materials delivered by the lecturer, as each student has a different learning style. When instructional methods do not align with students' preferred learning styles, comprehension becomes limited, and learning becomes less effective. This mismatch between teaching strategies and learning preferences contributes to decreased engagement and low motivation during the learning process (Peacock, 2001; Rinekso, 2020). To address this issue, it is important to implement varied and flexible teaching approaches that accommodate diverse learning needs. Integrating multimedia resources, collaborative activities, and case-based learning can create a more inclusive, student-centered learning environment. Such an approach not only enhances understanding but also fosters active participation and sustained motivation throughout the course (Sartania et al., 2022; Zhang et al., 2023).

c. Assignment Analysis Result

Based on the results of task analysis, it was found that many students were unable to complete their assignments effectively, indicating the need for a more structured and engaging assignment presentation that refers not only to the clarity of instructions but also to the contextualization of tasks that align with students' prior knowledge and learning outcomes. By designing assignments that are relevant, meaningful, and appropriately challenging, students are more likely to feel motivated and capable of completing them successfully. Additionally, incorporating real-world problems or case-based scenarios can enhance students' interest and encourage deeper engagement with the learning materials (Krause, Waters, & Stuart, 2016).

d. Results of the Analysis of the Specification of Learning Objectives

The results of the analysis of the learning objective specification and the learning achievement indicator for the engineering physics course are shown in Table 6.

Table 6. The Specification of Learning Objectives for Physics Engineering Course and the Correlation with the PLOs

NUM (CLOs)	Course Learning Outcomes (CLOs)	Sub-Course Learning Outcomes (Sub-CLOs)	PLOs Supported
1.	Able to understand the concept of quantities, units, and measurements	1.1. Able to explain the concept of quantities, units, and measurements.	• PLO-1, PLO-2
2.	Able to analyze the concept of motion	2.1. Able to analyze the motion of an object in a straight and circular path 2.2. Able to apply the concept of Newton's law of motion in the field of engineering	• PLO-2, PLO-3
3.	Able to analyze the concept of work and energy	3.1 Able to analyze the concept of work and energy in a live event.	• PLO-1, PLO-2, PLO-4
4.	Able to analyze the concept of wave and sound	4.1 Able to explain the concept of a wave and its units 4.2 Able to determine vibration, wave, and sound, and determine the speed of propagation by applying the Doppler Effect.	• PLO-2, PLO-3
5.	Able to analyze the concept of electricity	5.1 Able to analyze the concept of current 5.2 Able to analyze the concept of voltage and the relation between voltage and the power of electricity	• PLO-1, PLO-2, PLO-4
6.	Able to analyze the concept of magnetism	6.1 Able to analyze the concept of magnetic field around electric currents with the application of Oesterd's law, Biot-Savart law, and Ampere's law	• PLO-2, PLO-3
7.	Able to apply the use of electrical materials, diodes, and transistors in live events.	7.1 Able to analyze the work principle of an electric motor 7.2 Able to recognize the characteristics of electric materials, diodes, and transistors.	• PLO-2, PLO-3

Table 6 provides a structured mapping between the course learning outcomes (CLOs), their corresponding sub-CLOs, and the Program Learning Outcomes (PLOs) they support. Each CLO is further specified into measurable sub-CLOs to guide the instructional process and assessment. The alignment with PLOs ensures vertical coherence between the course-level outcomes and the broader program objective. This mapping is essential for maintaining curriculum integrity and for supporting the implementation of an outcome-based education framework (Al-Eyd et al., 2018; Mendoza et al., 2022).

Design Stage

At the design stage, the research instrument or product is developed based on the results of the previous analysis (Arifin, 2022; Rasid, 2022; Fajar, 2017). The output of this stage is the learning tools format design, created in Microsoft Excel. The learning tools format design includes a cover sheet, a learning design sheet, an indicator and rubric sheet, a course learning outcome (CLOs) measurement sheet, and the taxonomy bloom sheet. The flowchart for the learning tools format design is illustrated in Figure 2.

Each of these components serves a specific function. The cover sheet provides identity and document metadata such as the course title and developer name. The learning design sheet outlines the structure and stages of the learning process, including learning objectives, activities, methods, and media used. The indicator and rubric sheet describe observable indicators aligned with CLOs and include performance rubrics to assess students' achievement levels. The CLO's measurement sheet maps learning outcomes with assessment strategies and instruments used. Lastly, the Bloom taxonomy sheet ensures that the formulation of learning outcomes and assessments aligns with appropriate levels of cognitive processes, supporting the development of higher-order thinking skills. Together, these components ensure that the learning tools are systematically designed, measurable, and aligned with course goals.

The learning tools format design developed in Microsoft Excel serves as a framework for creating actual teaching materials. This format serves as the basis for developing concrete learning products, such as the semester learning plan, digital learning modules, and student worksheets, which are produced and validated during the development stage.

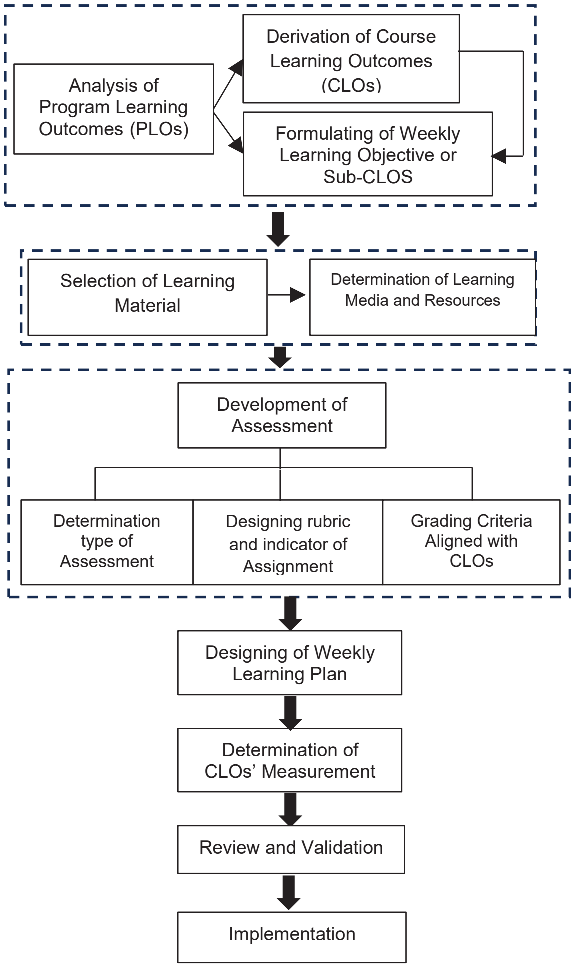


Figure 2. Flowchart of Learning Tools Format Design

Develop Stage

The development stage is validating research instruments or products that have been developed (Ndoa, 2022; Arif, 2021). At this stage, the effectiveness and feasibility of the learning tools have been designed (Handayani et al., 2024). The development stage in this study includes two steps: expert validation and product testing. An expert validation step is performed by an expert who assesses the validity of the research product (Sari, 2024; Masuwai, 2024; Zhang & Aryadoust, 2022). The product developed in this study is a set of case-method-based learning tools for the engineering physics course, including a semester-long lesson plan, a digital learning module, and a student worksheet (LKM).

Figure 3. Example of Case Method-Based Learning Module on Work and Energy

The developed case-method-based learning tool was implemented in the Engineering course on the topic of Work and Energy. The theoretical foundation for this topic is Physics for Scientists and Engineers With Modern Physics by Serway and Jewett (2018), particularly Chapter 7: Work and Kinetic Energy, and the subchapter The Work-Energy Theorem and Conservation of Mechanical Energy. Figure 3 shows a section of the digital learning module that presents a real-life case study on the design of a skateboard ramp. In the introduction stage, students were introduced to a real engineering case study on the design of a skateboard ramp that must meet both safety and performance standards. The lecturer began by showing a short video of a skateboarder's motion on ramps with varying slopes, followed by a guided discussion to spark curiosity. Students were asked to identify factors affecting the skateboarder's speed and energy transformation during motion. This stage aimed to connect students' prior knowledge with real-world contexts and to introduce the learning objectives, namely understanding the concepts of work, kinetic energy, potential energy, and the principle of energy conservation (Serway & Jewett, 2018; Sudirman, Marwoto, & Nugroho, 2024).

In the main learning activity, students worked collaboratively in small groups using the PhET Interactive Simulation Energy Skate Park. They manipulated variables such as the skateboarder's mass, ramp height, and surface type to observe how changes in these variables affect potential, kinetic, and total mechanical energy. These activities are recorded in the Student Worksheet (LKM 05), as shown in Figure 4, which guides students through a series of structured steps: identifying variables, formulating hypotheses, and analyzing the relationship between theory and simulation results. This process reflects the essence of case-based learning, in which students construct understanding through exploration, experimentation, and evidence-based reasoning (Yoo & Park, 2014; Hong & Yu, 2017).

After completing the simulation, each group discusses its findings and formulates recommendations for an optimal ramp design. The results are then presented in a class discussion session where peers and lecturers provide feedback and critical comments. The lecturer evaluates the clarity of arguments, the correctness of calculations, and the student's ability to relate theoretical principles to practical applications. Through this exchange of ideas, students learn to justify their reasoning scientifically and collaboratively refine their understanding.

The reflection phase serves as an essential component of this learning design. Students complete an individual reflection sheet, available in LKM 05, in which they explain what they have learned, the difficulties encountered, and how their understanding of the concepts of work and energy has evolved. This reflective process encourages metacognitive awareness and helps students evaluate their learning strategies (Silitubun & Dewi, 2025). The integration of simulation-based exploration and reflective thinking also aligns with research by Sartania et al., who found that combining case-based discussion and digital simulations improves motivation, engagement, and comprehension of scientific phenomena.


LEMBAR KERJA MAHASISWA
(LKM 05)
Modul 4: Usaha dan Energi

Figure 4. Example of Student Worksheet (LKM 05) on Work and Energy

Overall, the case method implementation in the Work and Energy topic fosters not only conceptual understanding but also critical thinking, collaboration, and communication skills. Students become more active in linking theoretical knowledge with practical design problems and are encouraged to view physics as a dynamic and applicable science. The case-based approach, therefore, provides a meaningful learning experience that integrates conceptual mastery with authentic problem-solving in engineering physics.

After the case-based learning tools were developed and applied in the instructional design, the next step was to ensure their validity and feasibility through expert evaluation. 3 experts validated the learning tools. There are two aspects of validation in this study: construct validation and content validation. The validation construct consists of the feasibility of preparation and media. At the same time, validation content includes the feasibility of RPS content, language, and timing. The validity analysis of learning tools, based on two aspects, is shown in Table 7.

As seen in Table 7, the average score of the validation results is 3,49 with a percentage of 87,25%, and it belongs to the very valid category (Sulastri, Badruzsaufari, Dharmono, Aufa, & Saputra, 2022). The results of the assessment, suggestions, and the validator's input are then periodically revised by the researcher to produce a draft of the learning tools, which are ready for testing with research subjects. This indicates that the developed learning tools have met the requirements of content feasibility and construct validity, which are essential for ensuring the product can be used effectively in the learning process. The high validity score also reflects that the learning tools are aligned with the expected learning outcomes and can support the achievement of competencies targeted in the course. Moreover, the iterative revision process based on expert feedback demonstrates the application of formative evaluation in development research, where continuous improvement is made before implementation. Such steps are important to minimize potential weaknesses when the tools are applied in real classroom settings and to increase their potential effectiveness in improving student learning outcomes.

Table 7. Validation of Learning Tools

No	Aspect	X	Percentage (%)	Category
1.	Construct	3.56	89	Very valid
2.	Content	3.4	85	Very valid
3.	Average of all aspects	3.49	87.25	Very valid

The product testing step is used to determine the outcomes of implementing learning tools in the classroom, such as measuring student learning outcomes (Sari, Ambiyar, Mukhayar, & Wulansari, 2024). In this study, the product testing step includes: effectiveness and practical test. The cover page of the engineering physics course plan is shown in Figure 5.

Student learning outcomes determine the effectiveness of case method-based learning tools before and after their use. In this study, student learning outcomes were assessed using a pretest and a posttest. As seen in Table 8, analysis of the pretest and posttest showed improvement, with an N-Gain value of 0.56 in the medium category (Parno, 2024; Eambaipreuk, 2023). It can be concluded that case method-based learning tools are effective to implement in engineering courses (Ndoa, Anastasia, & Jumadi, 2022). This finding implies that the application of case-method-based learning tools has a positive impact on student learning and development, particularly by fostering critical thinking, analytical skills, and the ability to apply concepts in practical contexts (Flyvbjerg et al., 2006). The medium N-Gain category also suggests that although there is a meaningful improvement, further refinement in instructional design, learning materials, and student-centered activities is still necessary to achieve higher levels of effectiveness. Moreover, the positive results of product testing demonstrate that the developed tools are not only effective but also have the potential to enhance student engagement and motivation, as students are encouraged to actively participate in the learning process through contextual and problem-oriented cases (Silitubun, Mustaji, & Dewi, 2025).

The practical test is based on responses from students and lecturers. In this study, students' and lecturers' responses cover several aspects: learning aspect, material aspect, learning design aspect, implementation aspect, technical quality aspect, practical aspect, and effectiveness aspect.

Based on Table 9 and Table 10, the practical case method-based learning tools are effective, with a range of P ≥ 85%. It concludes that case-method-based learning tools are a very practical category (Saputri, 2023; Sulastri, 2022; Akbar, 2013). This finding indicates that the developed learning tools are easy to apply in classroom settings, from both lecturers' (implementers') and students' (users') perspectives. According to Akbar (2013), practicality is reflected when a product can be used without significant obstacles and in accordance with its intended function. Similarly, Sulastri et al. (2022) emphasize that practical learning tools are those considered simple, efficient, and effective in supporting the achievement of learning outcomes. The high percentage score in this study demonstrates that students find the tools accessible and engaging, while lecturers view them as efficient and supportive of the teaching process. In line with Saputri et al. (2023), practicality also ensures that learning tools are not only theoretically sound but also feasible to implement in diverse classroom contexts. Therefore, the very practical category achieved reinforces the case that case method-based learning tools can be effectively integrated into engineering education to foster more interactive, student-centered learning.

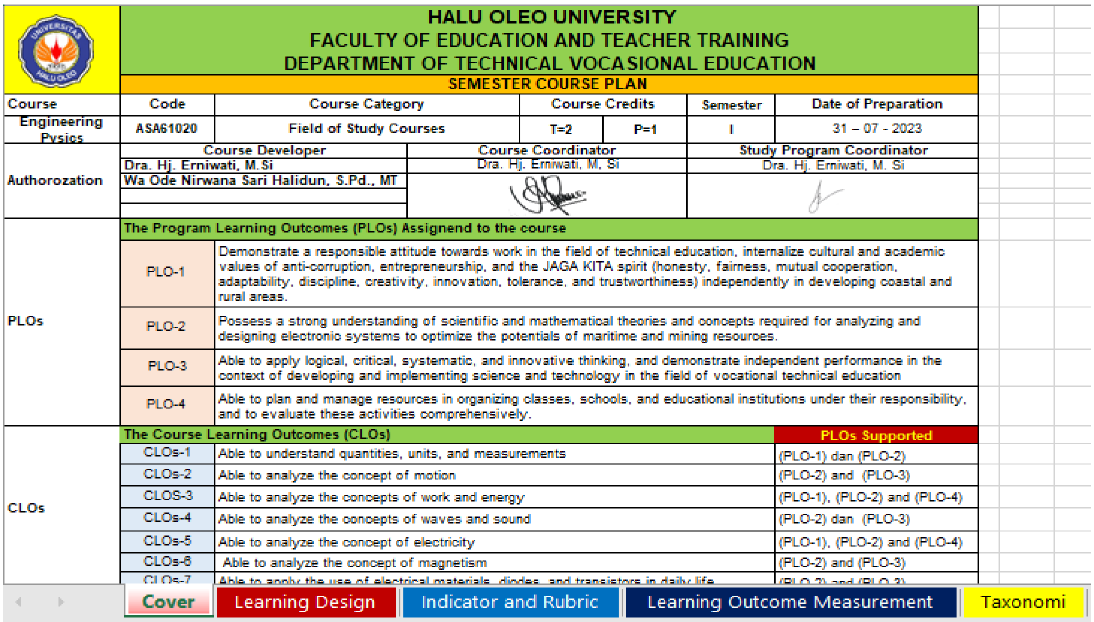
Table 8. Analysis of Pretest and Posttest

Student	Average of Pretest	Average of Posttest	N-Gain	Category
1-31	18.84	64.48	0.56	Medium

Disseminate Stage

The disseminate stage is the last stage of this study. At this stage, case-based learning tools have been tested by students and revised by the researcher (Sari, 2024; Saputri, 2023; Arifin, 2022). The revision process is carried out based on shortcomings when the learning tools have been implemented in the classroom. Furthermore, case method-based learning tools in engineering courses can be disseminated to lecturers for use as teaching materials in the learning process.

The dissemination stage is essential because it ensures that developed learning tools do not remain at the research level but can be adopted, adapted, and implemented widely by other educators. Previous studies emphasized that dissemination is part of the academic responsibility to spread research outcomes to a broader audience (Association of American Universities, Association of Research Libraries, Coalition for Networking Information, 2009). In engineering education, the success of dissemination is strongly influenced by factors such as relative advantage, compatibility with existing practices, simplicity of use, and institutional support (Hazen, Wu, & Sankar, 2012). Moreover, dissemination should be conducted actively and systematically, involving careful planning, coordination, and feedback mechanisms to ensure continuous improvement of the developed learning tools in a real classroom context (Tabak, Reis, Wilson, & Brownson, 2015).



HALU OLEO UNIVERSITY
FACULTY OF EDUCATION AND TEACHER TRAINING
DEPARTMENT OF TECHNICAL VOCASIONAL EDUCATION
SEMESTER COURSE PLAN

Course	Code	Course Category	Course Credits		Semester	Date of Preparation
Engineering Pysics	ASA61020	Field of Study Courses	T=2	P=1	I	31 – 07 - 2023

Authorozation	Course Developer	Course Coordinator	Study Program Coordinator
	Dra. Hj. Erniwati, M.Si	Dra. Hj. Erniwati, M. Si	Dra. Hj. Erniwati, M. Si
	Wa Ode Nirwana Sari Halidun, S.Pd., MT		

The Program Learning Outcomes (PLOs) Assignend to the course

PLOs		
	PLO-1	Demonstrate a responsible attitude towards work in the field of technical education, internalize cultural and academic values of anti-corruption, entrepreneurship, and the JAGA KITA spirit (honesty, fairness, mutual cooperation, adaptability, discipline, creativity, innovation, tolerance, and trustworthiness) independently in developing coastal and rural areas.
	PLO-2	Possess a strong understanding of scientific and mathematical theories and concepts required for analyzing and designing electronic systems to optimize the potentials of maritime and mining resources.
	PLO-3	Able to apply logical, critical, systematic, and innovative thinking, and demonstrate independent performance in the context of developing and implementing science and technology in the field of vocational technical education
	PLO-4	Able to plan and manage resources in organizing classes, schools, and educational institutions under their responsibility, and to evaluate these activities comprehensively.

CLOs	The Course Learning Outcomes (CLOs)		PLOs Supported
	CLOs-1	Able to understand quantities, units, and measurements	(PLO-1) dan (PLO-2)
	CLOs-2	Able to analyze the concept of motion	(PLO-2) and (PLO-3)
	CLOS-3	Able to analyze the concepts of work and energy	(PLO-1), (PLO-2) and (PLO-4)
	CLOs-4	Able to analyze the concepts of waves and sound	(PLO-2) dan (PLO-3)
	CLOs-5	Able to analyze the concept of electricity	(PLO-1), (PLO-2) and (PLO-4)
	CLOs-6	Able to analyze the concept of magnetism	(PLO-2) and (PLO-3)
	CLOs-7	Able to apply the use of electrical materials, diodes, and transistors in daily life	(PLO-2) and (PLO-3)

Cover | Learning Design | Indicator and Rubric | Learning Outcome Measurement | Taxonomi

Figure 5. The Front Page of the Engineering Course Plan

Table 9. Result of Student Responses

Item	Aspect of Practical Assessment	Total Score	Max Score	P (%)	Category
1-2	Material	77	80	96.25	Very practical
3-7	Design learning	180	200	90	Very practical
8-10	Implementation	111	120	92.5	Very practical
11-14	Technical quality	150	160	93.75	Very practical
15-16	Practical	72	80	90	Very practical
Practical Average of All Aspects		590	640	92.3	Very practical

Table 10. Result of Lecturer Responses

Item	Aspect of Practical Assessment	Total Score	Max Score	P (%)	Category
1-7	Learning	24	28	85.71	Very practical
8-12	Design learning	18	20	90	Very practical
13-15	Implementation	12	12	100	Very practical
16-20	Technical quality	18	20	90	Very practical
21-12	Practical	7	8	90	Very practical
23-25	Effectiveness	12	16	75	Practical
Practical Average of All Aspects		91	104	87.5	Very practical

CONCLUSION

Based on the results above, case-based learning tools in the engineering physics course are feasible. This is seen in the average construct and content validation, which is 3.46, indicating a very valid category, and in the practical value of the learning tools, obtained from students' and lecturers' responses, which is 97.2% and 87.5%, indicating a very practical category. Meanwhile, the increase in learning outcomes after using case-method-based learning tools is in the medium category, with an N-Gain value of 0,56. It indicates that case method-based learning tools are effective to implement in an engineering physics course.

Based on these findings, further research is recommended to investigate the application of case-method-based learning tools in other engineering courses and at other educational levels. Future studies may also examine how this approach influences students' higher-order thinking skills, collaboration, and long-term retention of the concept.

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