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Development of problem-based learning practicum modules for the dangerous goods course

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ABSTRACT

The Dangerous Goods course is a compulsory course followed by cadets of the Diploma 3 Airport Management study program. Providing Dangerous Goods material aims to discover how to handle and pack dangerous goods under predetermined regulations, not to endanger flight safety and security. However, the cadets felt that the Dangerous Goods course was challenging due to the lack of modules and difficulty understanding the very thick Dangerous Goods book. Problem-based learning used in this study was chosen because this learning model trains the Critical Thinking skills possessed by cadets under the Dangerous Goods course material, which requires a lot of practice. This research method uses the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) research and development approach, which is a research method used to produce specific products and test the effectiveness of these products. The subjects of this study were 48 cadets of Palembang Aviation Polytechnic cadets who managed the airport. Researchers conduct research first to collect the data needed, then system development is carried out, and the system is tested and evaluated. This study showed that the results of media expert validation were obtained by 90.% with valid categories and material expert validation results by 91.% with valid categories. Based on the validity and product effectiveness results, problem-based learning e-modules on the developed Dangerous Goods material are valid and effectively used by teachers and students in the learning process.

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Introduction

The learning process is one of the main components carried out in schools. Learning is a planned effort to manipulate learning resources so that the learning process occurs in students (Junaedi, 2019). Lindgren in M.Sobry Sutikno mentioned that the learning process includes three aspects: (1) Students: Students are the most important factor because there will be no learning process without students. (2) Learning process: The learning process is what students live when they learn. (3) Learning situation: Learning is an environment where learning occurs (Sutikno, 2007). Teachers must learn various methods to create an effective learning process in carrying out the learning process. An effective learning process is teaching that can give birth to a quality learning process, namely, a learning process that involves intensive participation and appreciation of students. (Junaedi, 2019). The learning process is also an activity that has educational value. This educative value colors the interaction that occurs between educators and students. The learning process is considered an activity of educative value

because the learning activities aim to achieve specific goals formulated before teaching is carried out (Fitrianti, 2018). According to Law No. 20 of 2003, education is a conscious and planned effort to realize an active learning atmosphere so that students can develop their potential and personality better (Sari et al., 2021). Based on some of these understandings, it is concluded that education is a learning process consisting of students, learning processes, and learning situations. Educators must combine these three components to produce an effective and educative learning process so students can develop for the better.

The teaching process will go smoother if educators employ technology as a learning medium. Using technology as a teaching tool will make it easier for teachers to deliver material (Asrial et al., 2020). Media are all physical tools that can present messages and stimulate students to learn. Examples are books, movies, tapes, and film frames. One of the resource media that students can use for independent study is in the form of modules. Modules teach media that students can use to learn independently with minimal help from others. The opinion asserts that the learning process requires modules to complete the student handbook, where one of the characteristics of learning media is student motivation and curiosity. Development of learning modules aimed at student independent learning so that the modules provided assist in motivating students to learn and improve learning outcomes themselves (Perdana et al., 2017). Teachers who use technology as a learning medium can make learning more enjoyable and natural so students feel energized by what is being learned. Learning media can highlight specific facts, concepts, principles, or procedures to make them seem more concrete. So that the media can provide a more genuine experience, motivate, and increase student absorption and memory in learning (Darmaji et al., 2019). The e-module is one type of electronic instructional resource. Modules are among the educational resources that can help students learn since they have self-checking activity sheets, clear objectives, and relevant content. (Citrawathi et al., 2016). Teachers benefit from using electronic modules in their teaching. (Wulansari et al., 2018). The e-module is a teaching material that can help students learn the subject matter independently using electronic media. Electronic modules can help students learn individually / independently in class, so the teachers are only a facilitator (Koderi et al., 2017). Electronic modules were created to give students the flexibility to conduct research and enhance their academic performance. Teachers should create attractive electronic learning modules, including multiple photos and videos, to ensure that students are engaged and that learning objectives are easily met (Suyatna et al., 2018). E-Modules can display text, images, animations, and videos through computers, and e-modules can improve students' understanding of concepts and learning outcomes. An e-module is a digital learning resource organized methodically to allow students to study independently and solve difficulties (Diantari et al., 2018). Based on this opinion, it is concluded that E-modules are systematically arranged digital teaching materials presented in electronic form. E-modules can increase students' interest and motivation in learning. An E-module can improve student learning outcomes so that it is suitable to support the learning process (Nyoman et al., 2017). Interactive e-modules can significantly improve student learning outcomes (Waruwu et al., 2022). Based on the views of several previous studies, researchers did an electronic-based module in the course of the Dangerous Good because it proved more effective and valuable for cadets.

Teachers can employ a variety of learning models in the teaching and learning process. Aspini's research shows that with the addition of learning media, the Problem-based learning card will increase students' HOTS ability from 63.89% to 79.20%, which is classified as good (Aspini, 2020). Based on Waruwu's research, which makes learning media e-modules based on problem-based learning, it was also found that there was an increase in learning outcomes when testing the effectiveness of products using the N-gain test, an average score of 0.59 showed an increase in cognitive learning outcomes with moderate criteria (Waruwu et al., 2022). So, based on research, it is proven that creative and innovative learning models can improve student competence. Learning models can maximize student comfort in learning and improve students' thinking skills (Aspini, 2020). According to Lubis, critical thinking competencies, problem-solving skills, communication and technology, and contextual learning are indispensable in the 21st century (Lubis, 2018). The safe transport of dangerous goods is of paramount importance to the government and enterprises in any country. The type and quantity of dangerous goods transported via air continue to increase due to new technologies and hazardous materials. Dangerous goods include explosives, flammables, oxidizing substances, toxins, radioactive materials, and corrosive materials. If these hazardous substances are not correctly handled, risks such as leakage, fire, or explosions may lead to air accidents or incidents, threatening air transport safety. These consequences may cause personal injury, property damage, and environmental pollution. The impact scope of accidents and incidents involving dangerous goods is broader, and the consequences are even worse than other modes of transportation. The transport safety of dangerous goods is essential to aviation safety. Shipping dangerous goods is one of the most complex airline tasks, requiring careful safety measures and transportation technologies. Therefore, studies concerning the safety management of dangerous goods air transportation are necessary. (Zhao et al., 2018). Dangerous Goods is one of the courses related to handling dangerous goods so that they are safe when transported in an aircraft. Today's problems in the aviation industry are that human resources (HR) at airports do not understand the safety management system (SMS), primarily related to the COVID-19 pandemic. Airport

management has human resources in the operational field who handle passengers and cargo. Not all of them understand well about handling documents and cargo following the principles of SMS and handling dangerous goods. They also understand handling them well in the era of the new standard and the next normal. (Rizaldy et al., 2021). Based on this, Palembang Aviation Polytechnic, as one of the Institutions of aviation human resources, especially in flight operators, students are directed to interpret and solve problems regarding problems that may occur that endanger flight safety when handling dangerous. Problem-based learning is a learning model that challenges students to think critically in solving existing problems. According to Serevina, PBL is a learning method that provides problems to cadets, and cadets must solve these problems (Serevina et al., 2018). The characteristics of PBL learning are focusing on interdisciplinary, authentic inquiry, producing real work, usually in the form of reports, and collaboration (Shofiyah & Wulandari, 2018). Sumardjoko & Musyiam's PBL research can improve student learning outcomes with a score of 75%. This study's findings support that PBL can help students become more adept critical thinkers, enhancing their learning outcomes (Sumardjoko et al., 2018).

The research aims to describe and validate problem-based learning E-modules in batch II Airport Management Study Program cadets. This study will combine the PBL model with E-module teaching materials. Based on the research that has been done, this study has differences from other studies. The materials used in developing instructional materials and the research topic differ. The selection of E-modules with the PBL model is adjusted to the facilities each subject, namely cadets, has owned. The steps correspond to the syntax of the PBL learning model. According to Trianto, the PBL learning model consists of five steps: (1) orienting students to problems; (2) setting up the classroom for learning; (3) directing both individual and group investigations; (4) creating and presenting work; and (5) assessing and analyzing the process of solving problems (Prasetyanti et al., 2016). This step is combined with E-module teaching materials as a learning resource. Using E-modules with PBL learning models is expected to improve the learning outcomes of Dangerous Goods. The combination of models and teaching materials will be an alternative for lecturers to innovate creative and innovative learning.

Method

This development research will be carried out from April to October 2023. The subjects in this study were one subject content expert, one learning design expert, one learning media expert, three people for individual trials, and six people for small group trials. This development research procedure refers to the ADDIE model, which consists of five steps. The stages of the ADDIE model are: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation) (Arofah & Cahyadi, 2019). The ADDIE model was chosen because every step is systematic and straightforward to comprehend, making it easy to use. Data collection in this study was using observation, interviews, and questionnaires. Stating the observation method is a way of assessment by making direct observations systematically. The purpose of this observation method is to collect actual data. The interview method collects data through systematic questions and answers, and the results are carefully recorded. The questionnaire method collects data by providing a list of questions to respondents that are answered in writing. This method measures the feasibility of E-module products from experts (subject experts and learning media experts). The learning Media Expertof this research is Herlina Febiyanti, S.T., M.M., one of the senior lecturers in Palembang Aviation Polytechnics; the subject experts in this research is Shabrina Ramadhani, A.Md one of the teaching staff that has Dangerous Goods certification The instruments used to collect research data are observation sheets, interview sheets, and questionnaire sheets. Observation sheets determine the learning facilities owned by schools and cadets and see the learning process in class. The grid of observation sheets is in Table 1.

Table 1. Observation Sheet Grid

Question
What are the learning media used by lecturers to support the learning process?
How cadets motivate in the learning process
Do cadets face any obstacles in participating in learning activities in class?
How many cadets are active in the learning process?
How many cadets feel bored when participating in classroom learning?

Instruments in the form of interview sheets are used to find media information and models used in the learning process, facilities owned by cadets in the learning process, obstacles faced by lecturers in teaching, and learning outcomes of student cadets. The interview sheet grid is in Table 2.

Table 2. Interview Sheet

	Statement	Source
1	Do you experience problems in the learning process??	DG Lecturer
2	Is a media module needed to support learning activities?	DG Lecturer
3	Can the media you use make it easier for you to learn about it?	DG Lecturer
4	Is there an internet connection at school?	Cadet
5	Does the student have a computer/laptop?	Cadet
6	Do students get other learning resources besides textbooks?	Cadet

Instruments in questionnaire sheets are used to collect data on E-module product assessment results from experts (subject experts, learning design experts, and learning media experts). The expert grid of subject content, learning media, and individual and small group trials is described in Tables 3.

Table 3. Subject Content Expert Grid & Learning Media Instrument Grid

	Aspects	Indicator		Item Number	Number of Items
1	Curriculum	1.	Learning Indicators	1,2,3	3
		2.	Learning Objectives		
		3.	Learning Achievements		
2	Method	1.	Suitability of the content of the material	4,5,6	3
		2.	Systematics of the material		
		3.	The degree of ease and depth of the material		
3	Language	1.	Clarity of Information	7,8	2
		2.	Language use		
4	Evaluation	1.	The difficulty level of the question	9,10	2
		2.	Clarity of question formulation		

	Aspects	Indicator		Item Number	Number of Items
1	Text Design	1.	Accuracy of type, font size, and punctuation	1,2,3,4	4
		2.	Accuracy of word selection		
		3.	Text and background color accuracy		
2	Image Design	1.	Suitability of images and materials	5,6,7	3
		2.	Image caption availability		
		3.	Image layout precision		
3	Module Organizing	1.	Easy-to-use modules	8,9,10	3
		2.	Consistency of navigation		
		3.	Clarity of instructions for use		

Then, the instrument is assessed by experts who have expertise in the variables studied. After expert review, the contents' validity was obtained using Gregoy's formula. For experts who have conducted instrument assessment by clarifying instrument items, the assessment results will be tabulated in matrix form, then the validity of the contents will be calculated (Wijayanti et al., 2020).

The data analysis methods used in this development research are qualitative descriptive analysis methods and quantitative descriptive methods. The qualitative descriptive analysis method is a method of processing systematic data in the form of sentences to obtain general conclusions (Arofah & Cahyadi, 2019). Data from the research studies of subject matter experts, learning media experts, individual test subjects, and small group trial subjects are processed using this method. Information in the form of input, criticism, and suggestions in the questionnaire is utilized to adjust the E-module products. The quantitative descriptive analysis method systematically processes data in numbers to obtain general conclusions (Arofah & Cahyadi, 2019). In decision-making regarding the development of E-modules with PBL models, reference is when achievement level 90%-100% is excellent quality and no revision required, 75%-89% is good quality and needs revision slightly, 65%-

74% is enough qualification and needs more revision, 55%-65% is less qualification and need a lot of revision, and when 0-54% is very lacking qualification and must repeated to make the product.

Table 4. Individual and Small Group Instrument Grid

	Aspects	Indicator		Item Number	Number of Items
1	Learning Media	1.	Ease of use	1,2,3,4	4
		2.	Highlights		
		3.	The accuracy of learning media		
2	Material	1.	Accuracy of the content of the material	5,6,7	3
		2.	Language		
		3.	Evaluation		
3	Benefit	1.	Interest	8,9,10	3
		2.	Learning Motivation		

Results and Discussions

The results of this study will discuss two main things: describing the design of PBL-based E-modules and the validity of PBL-based E-modules. Design PBL-based E-modules using the ADDIE development model. PBL-based E-module development begins with the analysis phase. The results obtained through **analysis** activities are (1) analysis of learning activities, which found some students have not been able to learn independently due to the lack of interactive media in the learning process; (2) reviewing educational facilities, which found that facilities such as laptops and internet networks are not used optimally. Adequate learning facilities can be used by students in learning, such as independent study. The second stage is design. At the **design** stage, (1) making flowcharts and storyboards E-modules. The flowchart was created to find out the workflow of the E-module developed. (2) design an E-module framework; to make the E-module's outline and the organization of its content must be described. The E-module hoist will guide the developed E-module's compilation process. (3) set the display design of the E-module. This design determination aims to make the E-module attractive and easy to read. (4) Prepare assessment instruments. Instruments are developed to determine the validity of the products developed. (5) Prepare a learning implementation plan (RPP). RPP is prepared to direct learning activities using E-module teaching materials with the PBL learning model. The third stage is development. During the **development** phase, the tasks completed are (1) E-module content development. This activity is carried out by collecting teaching materials on Handling Dangerous Goods. (2) development of E-modules. After the material is developed into a complete teaching material, Continue creating E-modules accessible through a laptop or computer. The **implementation** phase is the fourth. One of the activities during the implementation stage is having learning media experts and experts in handling dangerous goods conduct product validation tests. (2) There are two types of product trials: small group trials with 12 cadets and individual trials with three cadets. Product trials are conducted to evaluate the viability and appeal of the developed E-modules. The last phase is evaluation. At the **evaluation** stage, the data collected during implementation is evaluated. Formative evaluation aimed at assessing the E-module product developed includes the validity of experts, individual trials, and small groups. Based on these stages, the PBL-based E-module has been successfully developed by applying the ADDIE model. The validity test of PBL-based E-modules aims to test the feasibility level of PBL-based E-modules. The instrument used is a questionnaire prepared to determine the validity of E-module products. Instruments are tested for item validity by competent judges—the results of the validation of instruments tested.

Judges' results of the validity of the subject content instrument get a value of 1, so they get very high criteria. The results of the validity of learning design instruments get a value of 1, so they get very high criteria. The results of the validity of learning media get very high qualifications, and the results of student validity also get very high qualifications. After testing the instrument's validity, proceed with an assessment from experts (subject content experts and learning media experts. Tests conducted by Dangerous Goods subject content experts used questionnaire data collection methods. The calculation results are converted using the achievement level scale of 5; the achievement percentage is 90.3% to get excellent qualifications.

Testing was conducted by learning media experts using questionnaire data collection methods. The calculation results are converted through the achievement level of a scale of 5; the achievement percentage is 91.3% to get excellent qualifications.

Table 5. Calculation results by Subject Content Experts

Number	Question	Result
1	Curriculum	**87,0%**
2	Method	**90.67%**
3	Language	**91,67%**
4	Evaluation	**92,0%**
	Average	**90,30%**

Table 6. Calculation results by Learning media experts

Number	Question	Result
1	Text Design	92,0%
2	Image Design	90,50%
3	Organization of Modules	91,50%
	Average	91,30%

Individual and small group trials using questionnaire data collection methods. The calculation results are converted through the achievement level of a scale of 5; the achievement percentage is 94%, so getting the qualification is very good.

Number	Question	Result
1	Learning Media	90%
2	Content of the material	95%
3	Benefit	93%
	Average	94%

Based on these results, it can be implied that the PBL-based module is feasible for use and does not need to be revised. Input provided by the subject, learning design, and learning media experts is considered in refining the development of PBL-based E-modules. The revision of the product is presented in Table 5.

Table 5. Product Improvement by Subject Content Experts

Number	Comments and Suggestions	Revision
1	You should add a separate sub-chapter related to the Step Steps for packaging dangerous goods on the E-Module Sheet.	Added a separate sub-chapter related to Steps for packaging dangerous goods
2	There are no examples of consequences caused by negligent packaging of dangerous goods.	Added examples of consequences caused by negligent packaging of dangerous goods

Based on the input provided by subject content experts, improvements were made to improve the E-module product. The results of the development of PBL-based E-Modules are presented in Figures 1, 2, and 3. The cover of this module contains the title, author name, and user, and the image contains nine types of classes in Dangerous Goods (Table 1). Figure 2 contains essential competencies that cadets should Accomplish and owned by cadets at every meeting. The material description page contains material cadets can read; this information on reading books on dangerous goods makes it easier to understand. The question Page was created to measure cadets' understanding of the material read on the previous page.

Figure 1. Cover Modules

Figure 2. Basic Competencies Pages and Learning Objectives

Figure 3. Material Description Page

Figure 4. Question Page

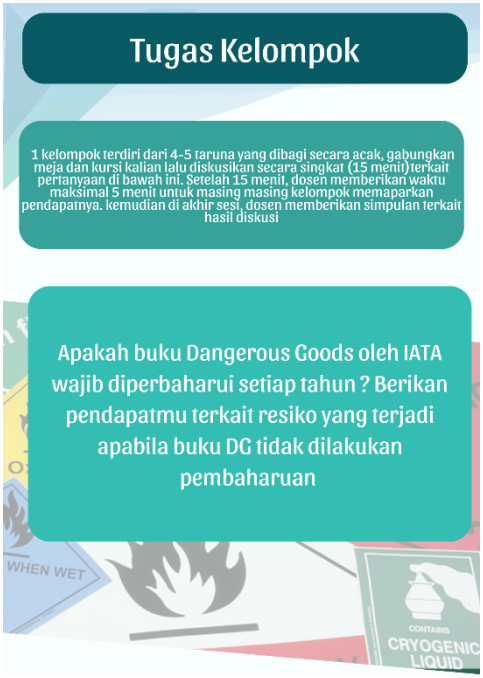

Figure 5. Discussion Page

The discussion page contains short group assignments helpful in developing their thinking about how problems and solutions develop on the material at each meeting.

Based on the results of the validity test that has been carried out, PBL-based E-modules show outstanding qualifications from experts, so they are suitable for use in the learning process. This is because the development of PBL-based E-modules has been carried out systematically. The process of developing PBL-based E-modules based on the ADDIE model is what causes the effectiveness of PBL-based E-modules, starting at the stages of analysis, design, and development to small group trials and product improvements to support the success of PBL-based E-module development, so that it is suitable for use in the learning process Based on the results of the assessment provided by subject experts handling Dangerous Goods on PBL-based E-module products get The qualifications are excellent. On the questionnaire, eight out of ten questionnaire items scored very well, and two items scored well. Excellent qualifications can be achieved due to several things, namely: (1) The E-module's identity, indicators, and learning objectives are clear; (2) The material content, depth, and systematic suitability of the information presented in the E-module are all present; (3) In terms of language, information can be communicated, language use and text readability are appropriate, and (4) Evaluation questions are formulated, and the degree of difficulty is appropriate. It is also evidenced by research conducted by Fadillah, which states that clarity in preparing teaching materials and material systematics will be more readily understood by students

in absorbing information(Fadillah dan Jamilah et al., 2016). In addition, the clarity and linkage of learning media with learning indicators and objectives will make it easier for students to learn so that learning objectives will be achieved (Krissandi & Rusmawan, 2015). Based on the statement above, the clarity and readability of the material contained in the E-module and the indicators and learning objectives contained therein will make it easier for students to learn so that learning objectives can be achieved. This is evidenced by research conducted by Lukum, which states that good learning planning will facilitate the learning process and can run optimally, and the existence of learning evaluation will help students understand learning (Lukum, 2015). Nurwidayanti stated that the completeness of learning media and learning instructions can affect student learning outcomes for better output (Nurwidayanti & Mukminan, 2018). Based on the statement above, good learning planning and completeness of learning media will make it easier for students to learn so that learning objectives can be achieved optimally.

They get excellent qualifications based on the assessment results given by learning media experts on PBL-based E-module products. Eight of the ten items on the questionnaire scored very well, and two scored well. Excellent qualifications can be achieved due to several things, namely: (1) accuracy and readability of the text, (2) suitability of the images presented in the E-module with the learning material, (3) availability of learning videos in the E-modules, and (4) E-modules are easy to use. The suitability and legibility of the proper text will be received quickly by Sudarma's sense of sight so that the message can be conveyed to students properly. In addition, the availability of exciting learning media, such as learning videos, will increase student motivation in learning to improve learning outcomes (Novita et al., 2019). Based on the statement above, the suitability and readability of the text in the E-module and the use of learning videos can increase motivation and facilitate students' absorption of information.

PBL-based e-modules can assist students in learning independently. The advantage of the E-module over the print module is that it is interactive, makes it easy to navigate, can display video, images, and audio, and is equipped with formative tests that provide feedback quickly (Sugihartini & Jayanta, 2017). The advantages of the PBL model are increasing understanding, independence, higher-order thinking skills, motivation, and skills in building teamwork. (Sofyan et al., 2016). Research conducted by Sadiminn states that E-modules effectively facilitate learners' learning. In addition, E-modules also help in understanding the material (Hardyanto et al., 2017). The results of research conducted by Irwansyah also show that e-modules can improve critical thinking skills and student motivation compared to conventional learning, so they are suitable for use in learning (Irwansyah et al., 2017). Based on this research, it can be concluded that E-modules can be applied in the learning process because they can improve student learning outcomes.

Excellent qualifications were obtained based on the assessment results of individual and small-group trials. Excellent qualifications can be achieved due to several things, namely: (1) ease of use of E-modules, (2) attractive display of E-modules, and (4) material presented in E-modules using communicative language. It is in line with research conducted by Diantari, which states that the ease of use of E-modules will provide convenience for students to access teaching materials independently (Diantari et al., 2018). The display of engaging learning media can motivate students to learn, and communicative language can make it easier for students to understand learning material. Based on the statement above, it can be concluded that ease of use, attractive appearance, and communicative language will comfort students in learning and significantly increase student motivation and learning outcomes (Sukriah Siregar et al., 2022). Learning with PBL-based E-modules can have a positive effect on student learning outcomes. Combining teaching materials and learning models can create innovative learning to motivate students to learn.

Conclusions

In the results of this study, two conclusions were obtained that the creation of PBL-based modules is necessary in the Dangerous Goods course to support and facilitate learning activities. Another conclusion obtained is that the quality of modules in the PBL-based Dangerous Goods course is as follows. (a) Based on the aspect of validity, an average score above 90% was obtained, which was included in the excellent category (b) Judging from the practicality aspect, it was found that the results of student responses to the module were also good with an average of 94% which was included in the excellent category. It can be concluded that the modules developed are practical. That is, modules are easy to use in learning activities.

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