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Development of E-Module Based Teaching Materials in the Subject of Ship Main Procovery Machinery

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Abstract: The designed e-module is expected to meet these needs by presenting interactive, easily accessible, and interesting learning materials. This study aims to utilize advances in digital technology in improving the quality of vocational education and preparing students according to the needs of modern industry. The method used in this study is the Research and Development (R&D) approach by following the ADDIE model, which includes the stages of Analyze, Design, Develop, Implement, and Evaluate. The stages begin with a needs analysis to identify the specifications of the required teaching materials and the characteristics of the students. At the Design stage, the e-module is designed with an attractive structure and relevant materials. Then the initial product development is carried out, followed by evaluation by material, language, and IT experts to ensure the quality of the e-module. Implementation involves limited trials in the school environment to collect feedback and assess the effectiveness of the e-module in the learning process. The data analysis technique in this study uses a validation sheet. The results of the study indicate that the developed e-module has a high level of validity, practicality, and effectiveness in the learning process. Expert validation gave a score of 100% for material, 98% for language, and 93% for media/IT, indicating excellent quality. Field trials by teachers resulted in a score of 92%, while broader trials with learners resulted in a score of 97%, both indicating a high level of effectiveness and acceptance of the e-module. In conclusion, the development of IT-based e-modules has proven effective in improving the quality and motivation of learning, in accordance with the demands of vocational education that is adaptive and responsive to technological developments.

Keywords: Innovative e-module; Ship main propulsion engine; Vocational education

Introduction

Indonesia is one of the developing countries in an increasingly mobile and uncertain globalization (Zahoor et al., 2023). Skilled human resources are needed to bring about change. One way to create quality human resources is through education, because education is the main determinant of national progress (Subaidi et al., 2021). With quality education, it can produce potential and superior human resources and be able to compete in the future. In Law of the Republic of Indonesia Number 20 of 2003 it is written that, "Education is a conscious and planned effort in creating a learning atmosphere and learning process for students to actively develop their potential to have spiritual religious strength, self-control, personality, intelligence, noble morals, and skills needed for themselves, society, nation and state ". Thus, education can develop individuals to get a decent and prosperous life. Education in Indonesia has levels that are usually called levels of education, one of which

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is the Vocational High School level (Yoana et al., 2024). Vocational high schools (SMK) are formal education that organizes vocational education at the level of education equivalent to SMA/MA. In SMK, there are various vocational schools that have internship programs that aim to equip students with skills and be ready to enter the world of work after completing their studies (Fauzan et al., 2023).

In line with the Maritime Nusantara Vocational High School (SMK) located in West Sumatra Province with a complete address in Nagari Kuranji Hilir, Sungai Limau District, Padang Pariaman Regency. This Maritime Nusantara Vocational High School (SMK) has three vocational programs, the first is TKPI (Fishing Vessel Engineering), the second is RPL (Software Engineering), and the third is TKR (Light Vehicle Engineering). Maritime Nusantara Vocational High School is still the same as SMA/MA, it still has three stages of learning classes, class X, class XI, and class XII. The learning stages are also different, in class X (ten) at the basic introduction stage of the vocational program where the emphasis is only on the cognitive stage, in class XI (eleven) they have entered the direct introduction learning stage and laboratory practice and entered the internship program in the second semester where students have gone directly to practice in the field which is called the internship program (Dwivedi et al., 2023). The important thing before entering the internship program for students is the application of basic knowledge of the chosen vocation, where this stage is in class X (ten) prioritizing cognitive aspects and basic knowledge (Anjum, 2020).

In the TKPI (Fishing Vessel Engineering) major in class X there are subjects on the main propulsion engine of the ship: Basic construction and operation principles of machinery systems, safety and emergency procedures for operation of propulsion plant machinery including control systems, preparation, operation, fault detection and necessary measures to prevent damage to the following machinery items and control systems. The rapid development of technology and information in modern times has encouraged the replacement of traditional teaching materials with IT-based teaching materials (Yu, 2024; M. Alshehri, 2024). Modules as one of the printed teaching materials are now converted into a digital format known as e-modules (electronic modules). The Ministry of National Education defines e-modules as independent learning materials that are systematically arranged and presented in electronic format. The advantages of e-modules compared to printed modules are that they can be inserted with images, videos, and interactive questions (Puspaningtyas et al., 2024).

Thus, e-modules are expected to increase students' interest in learning and provide a pleasant learning experience because the teaching materials are not textual (Jääskä & Aaltonen, 2022; Ratnasari & Haryanto, 2019). It is only natural that educational institutions begin to utilize IT technology in teaching and learning activities, one of which is by utilizing e-modules (Grassini, 2023). Especially in the current era, students are identical to the use of smartphones and the internet (Carbonell et al., 2018; Wang et al., 2023). E-modules can be an alternative teaching material in the digital era because they are accessed via electronic devices. That way, students can learn anytime and anywhere. This opportunity can be utilized to improve the quality of learning using IT-based teaching materials. Unfortunately, the government has not been fully able to provide e-modules for Indonesian language lessons at the upper secondary level (Jääskä & Aaltonen, 2022). The electronic teaching materials provided by the government are only E-Module packages which are converted into PDF format. Teaching materials that have begun to be forgotten now are based on E-Modules, with the development of technology, so that E-Modules are almost not used, even though they are very much needed in the learning process.

The problem that occurs is not only the lack of practical tools, teaching materials in the form of E-Modules are also non-existent, so far only using manual books or references for machine usage instructions (Cavalcanti et al., 2021). The product specifications developed in this study are in the form of teaching materials in the form of Electronic Modules (E-Modules) on the topic of Basic Principles of Construction and Operation of Machine Systems in the Main Propulsion Engine subject of Ships. This module can be accessed using a smartphone and can be used as a learning aid. This interactive e-module can be accessed via electronic devices connected to the internet network, either laptops or smartphones (Sanova et al., 2022). Interactive e-modules are arranged with basic competencies and indicators according to the Curriculum (Azhar et al., 2022). E-modules consist of materials and practice questions (Sanjaya et al., 2022). Practice questions are used to measure students' abilities after learning using e-modules. To increase students' interest in learning, researchers added images, videos, and interactive practice questions.

The purpose of this research is : to compile a product of teaching materials for procedural texts based on interactive E-modules for class X students and to test the feasibility of teaching materials for procedural texts based on interactive e-modules that have been developed. The hope is that with the existence of E-modules as a learning resource in the learning process, which can add to and expand the horizons of the presentations in the classroom, can stimulate thinking, behaving and developing further. The material

developed in the module is enriching. Students can broaden their horizons by studying additional materials presented in the module, quizzes are provided so that users do not get bored with the material and pearls of wisdom as an increase in student confidence, in addition there is also a re-discussion of some of the materials given in class. Thus, it actually motivates students' learning independence and can be a trigger for their creativity.

Method

Development Model

Development model This research was conducted in an effort to produce an electronic module for learning the Main Propulsion Engine of the Ship. The type of research used is development research or Research and Development (R&D). According to Sarpong et al. (2023), the research and development method or in English Research and Development is a type of research used to produce certain products, and test the effectiveness of the product. In order to produce certain products, research is used that is in the form of needs analysis and to test the effectiveness of the product so that it can function in the wider community, research is needed to test the effectiveness of the product. The development model used in the development of this media is the ADDIE development model which consists of five main steps, namely Analysis, Design, Development, Implementation, and Evaluation. The steps are to analyze student needs, create product designs, create products, implement products, and evaluate products (Asif et al., 2021). Based on the above understanding, it can be concluded that research and development is a process used to develop data and validate products that begins with needs analysis followed by product development, then the product is evaluated, revised and tested.

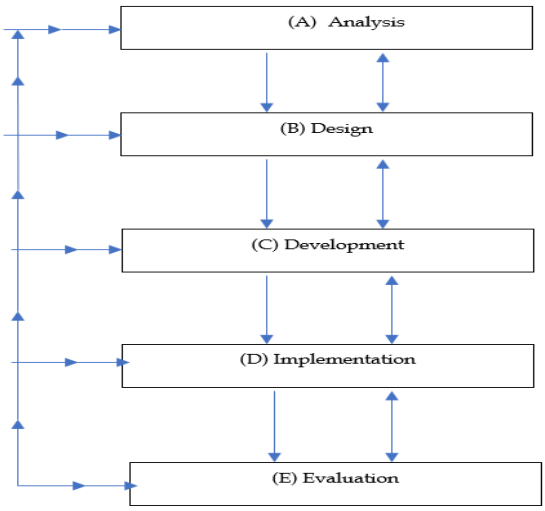


Figure 1. Stages of the ADDIE development model

Development Procedure

The development procedure is divided into 5 steps, namely: analysis, design, development, implementation, and evaluation with the ADDIE model. The steps above are not standard steps that must be followed but can be used as a reference for research, therefore the development in this study refers to the steps of development research.

Product Trial

In this product trial, a validation test will be carried out. In this trial, which is to find out errors and deficiencies in the development of the E-module that has been made.

Trial Subject

The research subject in this study is the E-Module for the main propulsion engine lesson for class X SMK ships used in schools based on the Independent Learning Curriculum, the product trial was carried out at the Pariaman Middle Fisheries Business School, then a development researchs was carried out on the material, namely creating a learning material product in the form of an E-Module containing learning material related to the subject of learning.

Type of Data

The type of data in this development research is qualitative data, data collection techniques through qualitative are carried out using natural conditions (natural settings), primary data sources and data collection techniques are more on participant observation, in-depth interviews and documentation. Data is obtained in several ways, including distributing questionnaires, observations and class tests.

Instruments and Data Collection

This research instrument uses a validation sheet, where the validation sheet is a measure that shows the level of validity of an instrument. Validation sheets are a number of questions addressed to experts to obtain corrections, criticisms and suggestions.

Data Analysis Techniques

The data analysis technique in this development research uses validation sheets. The expert team validation sheet is used to find out the validator's opinion on the designed media

Result and Discussion

Model Development

The development of teaching materials in this study focuses on the creation of e-modules intended for the subject of Ship Main Propulsion Engines, especially for

grade X students in Vocational High Schools (SMK). This e-module is designed to support educators and students in improving the quality of the learning process, with the main objective to maximize the achievement of expected learning outcomes. To achieve this goal, the study adopted the Research and Development (R&D) development model, specifically the ADDIE model which is an acronym for Analyze, Design, Develop, Implement, and Evaluate.

This model was chosen because of its ability to provide a systematic and structured framework for the development of teaching materials, allowing researchers and developers to effectively identify needs, design solutions, develop prototypes, implement them in learning settings, and evaluate the effectiveness of the resulting teaching materials. This process is carried out iteratively, ensuring that each step is informed by feedback and evaluation results, resulting in teaching materials that are not only relevant and in accordance with learning needs but also effective in supporting the achievement of learning objectives :

Preliminary Research Stage
Needs Analysis

There are several needs analyses that are the basis for the research and development of e-modules conducted by the author, namely: The subject of Ship Main Propulsion Engines is a special discipline that requires an in-depth understanding of theory and practice in the context of vocational education, especially for grade X students in Vocational High Schools (SMK). To achieve effective learning objectives in this subject, the use of creative and innovative media is required; Students at a young age are very close to the world of IT and social media. Thus, electronic learning can be more easily provided and understood by students; Determine the location of e-module research that is in accordance with the problems found; Determine the material for the Ship's Main Propulsion Engine to be developed into an e-learning module; Students have a cellphone/Android with an Android 5.0 (Lollipop) operating system or higher. For iPhone and iPad phones with an iOS 13.0 operating system or higher with a minimum available memory space of 150MB.

The network connection at school and the student's residential environment meets the criteria for using Canva with TLS version 1.2 or higher; Some students also have laptops that can be used to access e-modules on Canva with a minimum of 1GB RAM for Windows 10, CPU at least 1GHz and 2GB for Mac, 64-bit Intel CPU with 1GB free space. At this stage, several potentials were found that could be utilized to maximize teaching and learning activities. The knowledge and ownership of students regarding HP/Android became the potential developed in this study to achieve the predetermined objectives.

School Selection

Through preliminary research in the form of interviews with teachers, it was discovered that the problem of learning the Main Propulsion Engine of Ships was that students needed more interesting teaching materials to increase their enthusiasm and motivation to learn. Based on initial observations, most students were not optimal in participating in learning, this was evident from the minimal activity in each learning process. Several students said that the learning carried out was too monotonous and the media displayed was also less interesting, causing students to need more creative and innovative teaching materials so that follow the learning more optimally.

Selection of Materials

The material selected in the development of this e-module is the Main Propulsion Engine material. Because based on interviews with teachers who stated that there was a lack of adequate teaching materials.

Planning Stage

At the planning stage, research planning for the development of the e-module was carried out with the following stages: Collecting materials sourced from the latest Main Propulsion Engine of the Ministry of Education and Culture and several Journals related to the material presented; Making a draft of the material presented in the e-module according to the material taught in the even semester; Designing the Main Propulsion Engine e-module design according to the characteristics of class X students; Preparing additional materials needed for the development of the e-module such as images, videos and audio; Validation questionnaire by five validators based on three aspects, namely the material aspect, the language aspect and the media/IT aspect.

Initial Product Development Stage
Cover

On the cover of the e-module there is a title, logo, picture of a ship, name of the author and the target of the e-module, namely class X students. The cover created describes the contents of the e-module presented.

Foreword

The foreword of the e-module is a description of the importance of the learning e-module produced in the teaching and learning activities of the Main Propulsion Engine of Ships.

Figure 2. Cover of the ship's main propulsion engine e-module

Figure 3. Preface to the ship main propulsion engine e-module

General information

Figure 4. Instructions for using the module

Figure 5. General information of e-module

Core Components

Figure 6. Core components of the e-module

Glossary, contains the meaning of terms, difficult words, foreign words, and is arranged in alphabetical order and is attractively designed

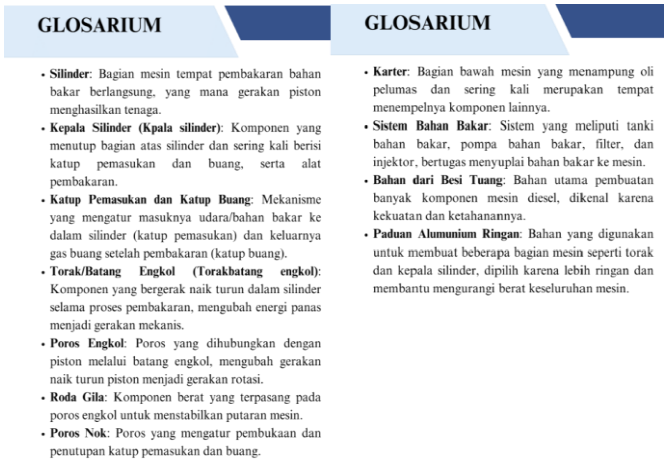


Figure 7. E-module glossary

Introduction

The introduction is the opening of the e-module which contains competency standards, descriptions, instructions for using the e-module and the final objective.

Learning

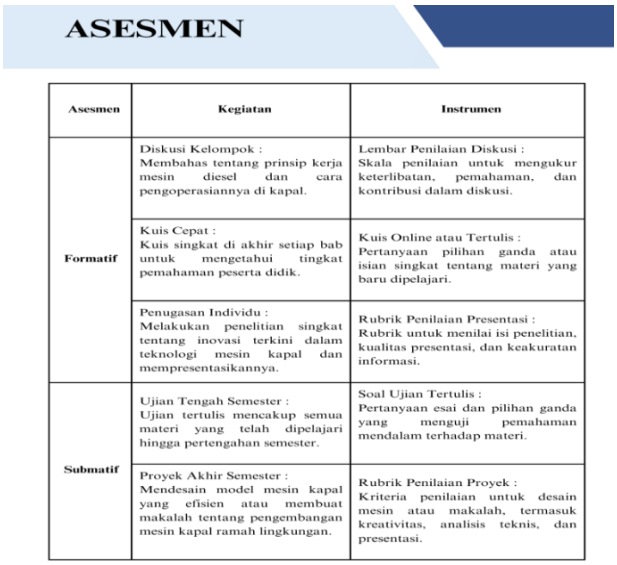
In the learning section there are two main topics, namely Ship Propulsion Engine

The Working Principle of Ship Propulsion Engines and Auxiliaries

Video 1. Jenis-jenis kapal

Figure 8. E-module material

After the presentation of the material, there are questions in the form of quizzes, which make it easier for students to work on the questions.



Asesmen	Kegiatan	Instrumen
Formatif	Diskusi Kelompok : Membahas tentang prinsip kerja mesin diesel dan cara pengoperasiannya di kapal.	Lembar Penilaian Diskusi : Skala penilaian untuk mengukur keterlibatan, pemahaman, dan kontribusi dalam diskusi.
	Kuis Cepat : Kuis singkat di akhir setiap bab untuk mengetahui tingkat pemahaman peserta didik.	Kuis Online atau Tertulis : Pertanyaan pilihan ganda atau isian singkat tentang materi yang baru dipelajari.
	Penugasan Individu : Melakukan penelitian singkat tentang inovasi terkini dalam teknologi mesin kapal dan mempresentasikannya.	Rubrik Penilaian Presentasi : Rubrik untuk menilai isi penelitian, kualitas presentasi, dan keakuratan informasi.
Submatif	Ujian Tengah Semester : Ujian tertulis mencakup semua materi yang telah dipelajari hingga pertengahan semester.	Soal Ujian Tertulis : Pertanyaan esai dan pilihan ganda yang menguji pemahaman mendalam terhadap materi.
	Proyek Akhir Semester : Mendesain model mesin kapal yang efisien atau membuat makalah tentang pengembangan mesin kapal ramah lingkungan.	Rubrik Penilaian Proyek : Kriteria penilaian untuk desain mesin atau makalah, termasuk kreativitas, analisis teknis, dan presentasi.

Figure 9. Material evaluation

Product E-Module Subject Main Propulsion Engine Ship

Final product development of E-Module Subject Main Propulsion Engine Ship. Here is the product barcode and link:

Figure 10. Barkot code

Limited field testingpPhase
Limited testing by experts
Material expert test data

Material experts who test the development e-module are competent people in the field of Ship Main Propulsion Engines. In this stage, the experts provide assessments, comments and suggestions through questionnaires sheets. The results of the e-module validation from the material aspect are as follows:

Table 1. Results of Material Validation on E-Module Development

Statement	Mark
Suitability of E-module with the purpose of learning the main propulsion engine of the ship	4
Suitability of E-module learning Pencak silat for Class X students with the characteristics of students	4
Suitability of E-module learning the main propulsion engine of the ship for Class X students as a learning resource	4
Ability of E-module learning the main propulsion engine of the ship for Class X students in increasing student motivation	4
Ability of E-module learning the main propulsion engine of the ship for Class X students to create a sense of pleasure for students in learning	4
The ability of the E-module for learning the main propulsion engine of the ship for Class X students as a tool to help understand and remember information/lessons	4

Statement	Mark
The ability of the E-module for learning the main propulsion engine of the ship for Class X students in arousing students' interest in practicing what has been learned outside of class hours	4
The clarity of the design of the E-module for learning the main propulsion engine of the ship for Class X students in making it easier for students to understand the material	4
The ability of the Main Propulsion Engine Ship Learning E-module for Class X Students to produce immediate feedback	4
The quality of the effective Main Propulsion Engine Ship Learning E-module for Class X Students	4
The ability of the Main Propulsion Engine Ship Learning E-module for Class X Students to deliver learning materials because Class X students are still imitative	4
The efficiency of the Main Propulsion Engine Ship Learning E-module for Class X students related to costs	4
The efficiency of the Main Propulsion Engine Ship Learning E-module for Class X Students related to time	4
The effectiveness of the Main Propulsion Engine Ship Learning E-module accompanied by Physical Fitness Training Activities for Class X Students related to facilities and infrastructure	4
The security of the Pencak Silat learning E-module for Class X students for students as users.	4

The learning developed is very worthy to be tested in terms of material. Comments and suggestions obtained from the validator indicate that this module can be used for research. Further analysis of the data can be done through the formula that will be explained below.

$$P = \frac{F}{N} X\ 100\% \quad (1)$$

The number of questionnaire items assessed reached 15 items, with a maximum score per questionnaire item of 4. Therefore, the maximum score that can be obtained from the entire questionnaire is 60:

P= 50 x 100 = 100%
60

After getting the percentage data, it can be seen in the assessment scale table that a score of 100% is categorized as "very feasible". This is because the score is in the percentage range of 86-100%, which according to the descriptive analysis criteria, is considered very feasible.

Language Expert Test Data

Table 2. Language Validation Results for E-Module Development

Statement	Mark
Ease of understanding the language used	4
Compliance with correct Indonesian language rules	3
Effectiveness of sentences	4
Ease of understanding discussion and questions	4
Writing is easy to understand	4
Compliance with student development	4
Compliance with student emotional development	4
Accuracy of punctuation use	4
Consistency of punctuation use	4
Use of clear and straightforward language	4

The language expert who tested the e-module development consisted of one person who was competent in the field of language, namely the Indonesian Language Lecturer. This stage was carried out to test the quality of the product in terms of language. In this stage, the experts provided assessments, comments and suggestions through questionnaires/validation sheets. The results of the e-module validation from the language aspect are shown in table 2.

Table 3. Results of Media/IT Validation for E-module Development

Statement	Mark
Simple e-module design	4
Easy to use e-module	3
Use of clear and straightforward language	4
Video display quality	4
Easy to understand writing	4
Systematic presentation of e-module	4
Efficiency of e-module use	3
Lighting in the video is appropriate	4
User convenience of learning e-module	4
Attractiveness of learning e-module	4
Completeness of information presented	4
Information presented is easy to understand	3
Narrator's voice intonation	4
Video fluency	4
Video duration	4

Based on the valid test results of the four aspects mentioned, the conclusion can be seen in the following image:

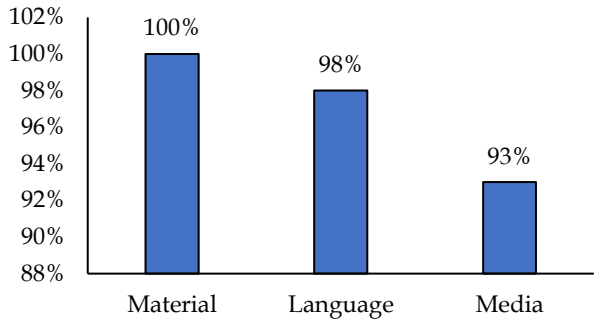


Figure 11. Histogram of e-module validation test results

Limited Trial by Teachers and Students

The initial field test of the e-module was carried out by three teachers at SMK Maritim Nusantara, West Sumatra. The limited field test was conducted by Teachers Mr. Novi Erizal. AMd, ATT.III and Mr. Harisjon, S, Pi, M.Si. The data obtained from the limited field test was 92% with a very good category using descriptive analysis.

Design Improvement Stage of Limited Field Test Results

Comments and suggestions obtained from the limited field test with several experts were then improved according to the suggestions.

Wider Field Trial Stage

After the limited field test, the next step was a wider field trial with 47 class X students of SMK Maritim Nusantara, West Sumatra. The data obtained from the wider field test was 97% with a very good category using descriptive analysis.

Discussion

Researchs conducted on the development of e-module-based teaching materials for the Main Propulsion Engine subject at SMK Maritim Nusantara showed very positive results. The developed e-module showed a high level of feasibility with an almost perfect score in the evaluation, including 100% material validity, 98% language clarity, and 93% media effectiveness. Field trials involving teachers and students also provided very good feedback, with effectiveness scores of 92% and 97% respectively. The validity of the e-module you developed is reflected in the level of content suitability with the needs of the curriculum and maritime industry which reached 100%. This shows that the material presented not only supports academic learning objectives but is also relevant to the practical needs of the industry (Zamiri & Esmaeili, 2024; Haleem et al., 2022). This high validity is obtained through a design and development process involving experts from the field of maritime education and technicians from the industry, ensuring that the e-module contains up-to-date and applicable information.

This suitability is important so that the learning material can be used as a strong foundation in facing real challenges in the world of work. The practicality of the e-module can be seen from the ease of access and flexibility of use. E-modules as a digital platform allow learners to access learning materials from anywhere and at any time, which is very useful in the context of modern education that often requires distance and independent learning. In addition, the digital format of e-modules allows the integration of various types of media such as videos, animations, and interactive simulations, which not only facilitate the understanding of complex concepts but are also interesting for learners, especially those who are more accustomed to using digital technology in their daily lives. The effectiveness of e-modules is proven through positive feedback from field trials involving teachers and learners, as well as high scores obtained from learning evaluations (Utaminingsih et al., 2022). Learners who use e-modules show a significant increase in understanding the material, as shown by the evaluation score reaching 97% in the very good category. This indicates that the e-module has succeeded in delivering the material in an effective way, facilitating deeper learning and inspiring learners to interact with the material actively.

E-modules are designed with a constructivist learning approach that supports learners to build their own knowledge through exploration and interaction, which are key factors in improving understanding and retention of information (Bawa, 2016; Zawacki-Richter et al., 2019). The results of the study indicate that the development of e-modules for the Main Propulsion Engines of Ships subject not only meets academic and industrial standards with high validity, but also offers practical and effective learning solutions. E-modules as modern digital learning tools provide many advantages, including adaptability to various learning styles, wide accessibility, and the ability to deliver complex materials in a more engaging and interactive way. This shows the great potential of using technology in supporting vocational education, especially in preparing learners for the needs of a dynamic and ever-growing industry. In the context of supporting theory, the results of this analysis are summarized in the principles of constructivist learning theory.

This theory, introduced by educators such as (Könings et al., 2021; Phala & Chamrat, 2019), emphasizes the importance of learners as active participants in their own learning process. E-modules developed in accordance with this constructivist approach allow learners to construct their own knowledge through interaction with interactive and dynamic materials. This creates a learning environment that facilitates inquiry and discovery, strengthens learners' understanding, and inspires them to apply new knowledge in practice. In an effort to develop an e-module for the Main Propulsion Engine subject of Ships at SMK Maritim Nusantara, this study has shown very satisfactory results, with a high level of validity and effectiveness in learning. As a way to deepen this analysis, it is important to compare these findings with previous studies that have been conducted in a similar context. Research by Fauzi et al. (2020), on the development of web-based learning media for the Basic Computer Network subject at SMK Negeri 1 Lembah Melintang uses the Research and Development (R&D) method with the 4D model.

The results showed high validity and a significant increase in students' pretest and posttest scores, indicating that a systematic learning media development approach can greatly affect students' learning outcomes. The developed e-module also achieved high validity and was responded very well by teachers and students, confirming that a systematic method in developing learning materials is key to learning effectiveness. Ananda et al. (2023), developed an E-Module for engineering drawing for grade X at SMK which had a high level of validity and practicality. This study also found that the E-Module was effective in improving students' knowledge and skills. This is similar to the findings in this study, where the e-module of the Ship's Main Propulsion Engine is not only theoretically valid but also very practical and effective as a learning tool. Rahim et al. (2024), developed a project-based module in the Advanced Welding Engineering course which showed a significant increase in student learning outcomes.

The module was declared very practical based on the responses of lecturers and students (Rahayu & Sukardi, 2021). This shows that project-based learning can be very effective in technical and vocational contexts, as found in the development of e-modules, where active involvement of students in the learning process results in deeper and more applicable understanding. Guo et al. (2020), also highlighted the effectiveness of project-based learning in developing a learning module for project management in building engineering education. This module was declared valid, practical, and effective in improving student knowledge and skills. The similarity with your research lies in the use of an active and student-centered learning approach, which emphasizes the importance of challenging learning methodologies and involving students directly in the learning process. This comparison shows that there is a general trend in vocational education that focuses on developing learning materials that are not only theoretical but also highly applicable and interactive.

The use of technology in learning, especially the development of e-modules, has been proven effective in improving the quality of technical and vocational learning. The importance of this and previous studies shows that innovative approaches to learning, especially through the use of e-modules and learning technology, have a significant impact on the effectiveness of vocational education (Wijayanto et al., 2023). This proves that innovations in learning methods, especially those that utilize technological advances, can bring significant changes in the quality and outcomes of learning, and better prepare students for the challenges of the modern maritime industry. The implementation of this e-module designed to meet the needs of 21st century education has proven successful, as reflected in the results of the field test and very positive feedback (Meyer & Norman, 2020). The e-module developed for the Main Propulsion Engine subject has become a real manifestation of the application of constructivist learning theory in the real context of vocational education. By prioritizing interactive student learning experiences, this material allows students to play an active role, explore, and ultimately understand the concepts learned, not only as theory but also as practical applications that are relevant to the maritime world of work.

Furthermore, the successful implementation of this e-module also demonstrates how educational technology can be used to facilitate independent learning methods, where students have full control over their learning process (El-Sabagh, 2021). This is a significant step forward in changing the traditional learning paradigm to a more modern and learner-centric one, where students are empowered to not only be passive recipients of information, but also creators of their own knowledge. Factors that contributed to the successful development and implementation of this e-module include careful planning, student-focused content development, and the use of technology that supports interactive learning. The evaluation is not only based on academic standards, but also on the level of student engagement and the relevance of the material to the actual needs of the maritime industry (Pandita & Kiran, 2023). Therefore, this e-module not only serves as an effective teaching aid but also as a foundation for students to prepare for their future in the maritime industry.

The experience of SMK Maritim Nusantara provides valuable insights for other vocational schools that may be looking for ways to modernize their curriculum and make the subject matter more interesting and challenging. E-modules as an educational innovation promise a breakthrough that can overcome many of the challenges of conventional learning, especially in preparing students for the competitive global era. Given the ever-changing dynamics of learning, this e-module also provides opportunities for continuous revision and adjustment to ensure that the material presented remains relevant to the latest developments in maritime technology and industry needs. This creates a continuous learning cycle, where feedback from students and teachers is continuously incorporated to enrich and update the e-module content. In the context of Indonesian education, this achievement marks significant progress in efforts to improve the quality of vocational learning (Yang et al., 2023).

Following the success of this e-module, there is great potential for replication and adaptation of similar

approaches in other vocational fields, which will ultimately strengthen the vocational education infrastructure in Indonesia and produce graduates who are not only work-ready but also innovative and adaptive to changing times. The development of the Ship's Main Propulsion Engine e-module has paved the way for substantial improvements in vocational education (Van Biert et al., 2016). The learning process supported by e-modules has proven to be effective, demonstrating that technology integration in education is key to achieving optimal learning outcomes (Marlena et al., 2022). By applying constructivist learning principles and using feedback received to make continuous improvements, vocational education in Indonesia can continue to evolve and adapt to the changing needs of the workforce. In conclusion, the development of e-modules for the Main Propulsion Engines subject not only reflects a shift in methodology in vocational education but also reinforces a more inclusive and dynamic vision of education.

The successful implementation of this project demonstrates the limitless potential of innovative approaches in education, which can transform the way learners learn and interact with subject matter (Markula & Aksela, 2022). By continuing to push the boundaries of educational innovation, we can expect a future generation that is better prepared to face the challenges of the global maritime industry and beyond that, become thought leaders in technology and sustainability.

Conclusion

The development of an e-module for the Main Propulsion Engine subject at SMK Maritim Nusantara, West Sumatra, was carried out by utilizing the potential use of HP/Android by students as an interactive and interesting learning media. The material selected in the development of the e-module is the Main Propulsion Engine material, which is adjusted to the needs and characteristics of class X students. The development process includes collecting materials from current sources, compiling a draft of e-module material that is in accordance with the curriculum, designing an attractive e-module, and preparing additional materials such as images, videos, and audio. The scores obtained were 100% in the material aspect, 98% in the language aspect, and 93% in the media aspect, indicating that the e-module has very good content quality, almost perfect language clarity, and media use that is close to ideal standards. The initial field test conducted by the teacher scored 92% in the very good category, indicating that the e-module is practical in teaching. A wider field trial involving 47 grade X students scored 97% in the very good category, indicating the effectiveness of the e-module in interactive and interesting learning for students. The suitability of the e-module to the needs of 21st century learning and the principles of constructivist learning indicate that this e-module is very effective and practical in the process of learning the main propulsion engine of the ship.

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