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The Development of SETS-Based E-Modules for Industrial Chemistry According to IMO Model Course 7.04

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Abstract: *The era of Industrial Revolution 4.0 encourages universities to utilize information technology. Learning industrial chemistry courses in maritime education is still conventional, with little time allocation. Apart from that, no digital-based learning resources comply with the IMO 7.04 standard. This research aims to develop a SETS (Science, Environment, Technology, and Society) based e-module Website for the Industrial Chemistry course according to IMO 7.04 standards, as well as analyze the feasibility of the product. This research method is R&D (Research & Development) using the ADDIE model but is limited to the development stage. Quantitative data is processed into interval data using a Likert scale. The research results show that the validation of material experts is 87.89% in the very valid category, and media experts are 91.67% in the very valid category. Limited trials on students showed a positive response 90.13% in the very good category. It is hoped that the development of this e-module can improve the quality of learning in maritime education.*

Keywords: *e-module; website; SETS; industrial chemistry; IMO 7.04*

INTRODUCTION

As a maritime country, Indonesia needs qualified prospective seafarers, but maritime education still needs more attention than other sectors; in other words, maritime education institutions still need to be expanded. Maritime education has a vital role in ensuring the availability of competent human resources to support the operations and safety of the maritime industry. The International Maritime Organization (IMO), through Model Course 7.04, sets competency standards that must be met in seafarer training to understand operational safety and risk management on ships (IMO, 2014). In this context, relevant teaching materials are essential and based on international standards.

Based on IMO 7.04, industrial chemistry is a general course for prospective seafarers with little allocated study time. Besides, industrial chemistry learning at many maritime universities still uses conventional methods. This causes low student involvement in the learning process and limited access to teaching materials supporting modern learning needs (Ghanbaripour et al., 2024; Wong & Liem, 2022). On the other hand, the internet has a strong influence on various aspects of life, one of which is education. During the pandemic, the internet provided a new paradigm, namely that the learning process is offline and online (Cheung et al., 2023). Moreover, Gen Z students have the characteristics of liking technology and being good at using it in various situations. As a response to this challenge, developing digital-based teaching materials is a necessary solution, especially in utilizing Website technology to increase the flexibility and accessibility of learning (Area-Moreira et al., 2023).

Indonesia needs more human resources literacy in reading, mathematics, and science. The results of a survey conducted by the Program for International Student Assessment (PISA) released by the Organization for Economic Cooperation and Development (OECD) in 2019, Indonesia was ranked 62nd out of 70 countries, or the bottom ten countries with low literacy levels (Massimo, 2019). This situation is an indication of the accumulation of educational problems that have not been resolved. One thing that must be improved is the learning process in higher education, which utilizes technology, linking theory, and application to enhance students' scientific literacy culture. Students use laptops and smartphones as learning resources, influencing learning outcomes and thereby increasing students' scientific literacy (Hadisaputra et al., 2019).

The problem of low scientific literacy among students can be overcome by taking a SETS (science, environment, technology, society) approach to the learning process. Science learning is comprehensive and integrated by synergizing society, the environment, and technology to understand science. The SETS approach also trains students to assess the positive and negative impacts of science and technology products and their impact on the environment and society. SETS has been proven to increase the relevance of learning material to deepen students' understanding and improve critical thinking skills (Kusumaningrum et al., 2021). In maritime education, the application of SETS can help students understand the concept of industrial chemistry theoretically and see its impact on their professional environment (Kim et al., 2023; Puspitasari et al., 2024).

Interactive and web-based e-modules provide flexibility in time and place, allowing students to study independently more effectively (Venkatesan et al., 2023). In addition, e-modules can be widely accessed, and support increased student engagement through multimedia and interactive elements (Shahriar et al., 2023). Various studies have been carried out on the development of website teaching materials, and these studies show that student learning outcomes using web-based interactive teaching materials are higher than those of existing teaching materials, with materials limited to thermochemistry (Matondang et al., 2022). Research into interactive multimedia development has also been carried out using Adobe Flash software containing material about the human respiratory system. This Website is declared valid and suitable for biology learning (Sadikin et al., 2020). Integrating ICT in learning with the right strategy will help students understand the material more effectively and productively. However, both studies were limited to one subject only.

Research related to the interactive multimedia PBL model with the SETS vision has been implemented in experimental classes and has had a positive impact. Developing SETS vision tools is valid, practical, and effective for improving students' critical thinking abilities and social skills (Oktaviani et al., 2017). Research on innovative teaching materials based on the SETS approach has been carried out through the development of interactive physics e-modules on dynamic fluid material and observing the characteristics of students during the learning process using power points while only listening to the teacher (Syafutri & Pramudya, 2019). Scientific literacy is an indicator of success in the educational process, and one of the supporting elements is the SETS integrated learning process. SETS-integrated teaching materials can increase students' scientific literacy (Hardianti et al., 2021). Further research is recommended, namely looking at the influence of SETS on scientific literacy or developing a SETS-based learning media and student learning environment to increase scientific literacy (Nisa et al., 2021).

Based on this, the researchers concluded that the era of Industrial Revolution 4.0 requires interactive and powerful Website learning media with new research. These chemical materials comply with IMO 7.04 standards with the SETS approach method. The results of this development can become a learning resource for students to increase scientific literacy and the relevance of learning to real situations in the maritime industry.

LITERATURE REVIEW

E-learning modules (e-modules) have gained significant traction in modern education due to their flexibility, accessibility, and ability to facilitate individualized learning (Steven et al., 2019). The rise of technology in educational settings has allowed for creating interactive, multimedia-rich educational resources that can be customized to meet the needs of various learners (Lastri, 2023). E-modules are especially effective in fields that require a deep understanding of complex concepts, such as industrial chemistry, where practical applications and theoretical knowledge must be integrated.

Industrial chemistry plays a crucial role in maritime education, as it gives students an understanding of the chemical processes involved in shipbuilding, fuel systems, and ship environmental management. The International Maritime Organization (IMO) has established a set of training standards known as Model Course 7.04, which outlines the competencies required for marine engineers to understand industrial chemistry as part of the broader engineering curriculum (IMO, 2014). Incorporating e-modules that adhere to these standards can help ensure that maritime education remains consistent, up-to-date, and relevant to industry practices.

The Science, Environment, Technology, and Society (SETS) approach in education emphasizes the interconnectedness of scientific concepts with real-world applications, particularly in addressing environmental and technological challenges (Kim et al., 2023; Kusumaningrum et al., 2021; Puspitasari et al., 2024). This model fosters critical thinking, problem-solving, and the ability to apply scientific knowledge in practical settings. SETS-based learning has been found to improve students' understanding of complex scientific concepts by relating them to societal and environmental issues (Hardianti et al., 2021). This approach is highly relevant to industrial chemistry, where students must understand not only the chemical processes but also their environmental impact and technological applications.

The IMO Model Course 7.04 provides guidelines for maritime education, specifically focusing on marine engineering. It covers various aspects of marine systems, including the fundamentals of industrial chemistry, to ensure that marine engineers are equipped with the knowledge needed to manage chemical processes and materials onboard ships. These competencies are essential for ensuring the safety and efficiency of marine operations (IMO, 2014). Developing educational materials aligning with these standards is crucial for ensuring maritime education meets international benchmarks and prepares students for real-world challenges.

METHODS

This research is Research & Development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model, a systematic instructional design model often used in developing technology-based teaching materials. However, this research only covers the analysis, design, and development stages.

Analysis Stage

The analysis stage identified the needs and objectives of developing e-module websites using the Science, Environment, Technology, and Society (SETS) approach in the Industrial Chemistry course by IMO 7.04 standards. A needs analysis was carried out to identify problems in learning Industrial Chemistry in maritime education. Data collection was carried out through interviews and student surveys. Curriculum and competency analysis includes evaluation and alignment with competencies regulated in IMO 7.04 (IMO, 2014).

Design Stage

The design stage is carried out by designing the framework and display structureof the e-module Website according to the results of the previous analysis. This design includes designing learning objectives, designing content and materials, designing Website navigation flows, and selecting learning media. The media presented in this Website e-module includes videos, illustrations, simulations, animations, and quizzes. This media was chosen based on its effectiveness in supporting digital-based learning, which is expected to help increase student motivation and understanding (Li et al., 2024).

Development Stage

The development stage focuses on creating a Website e-module based on the formulated design. The stages include developing SETS-based e-module content, developing multimedia elements, validation testing (material experts and media experts), revisions based on input from material experts and media experts, and limited testing on students majoring in Engineering. Materials such as animation, illustrations, videos, and images are packaged to realize the product being developed.

Data Collection Techniques

Data collection techniques in research were carried out using two methods, namely interviews and questionnaires. Interviews were conducted with lecturers and experts (material and media) to obtain data related to learning needs and material validation. Questionnaires were given to material experts, media experts, and students. This is to obtain validation data and student responses.

Data Analysis Techniques

The data obtained was analyzed descriptively, quantitatively, and qualitatively. Data from the questionnaire was analyzed using descriptive statistics to determine student perceptions, while test results were analyzed to see improvements in learning outcomes. Feedback from validators and interview results are analyzed qualitatively to correct deficiencies in the module (Sugiyono, 2019). The Website e-module quality assessment is still in the form of letters SB, B, C, K, and SK. The average score from each instrument in the form of quantitative data is converted into data in qualitative criteria according to the conversion of the actual score into a standard five-scale value using the formula in Table 1.

Table 1. Interpretation of validation results from material and media experts, and student responses

Score Interval	Quality Category		
	Material Experts	Media Experts	Student Responses
81-100	Very Valid	Very Valid	Very Good
61-80	Valid	Valid	Good
41-60	Neutral	Neutral	Sufficient
21-40	Invalid	Invalid	Poor
0-20	Very Invalid	Very invalid	Not Good

The total value of the Website e-module is obtained by calculating the average score of all assessment criteria, which is used to assess the quality of the product that has been developed. Next, the data obtained is calculated to determine the ideal percentage using the formula:

$$P = \frac{f}{N}\, x\ 100\% \qquad (1)$$

with,
P = percentage of final ideal,
f = average value, and
N = maximum average score.

The research focused on a web-based e-module that uses the SETS approach according to the IMO 7.04 standard. The research subjects were material experts, media experts, and 42 students in the Department of Engineering at Politeknik Maritim Negeri Indonesia (Polimarin).

RESULT AND DISCUSSION

Analysis

At the analysis stage, user needs and learning objectives to be achieved through e-modules are identified. In the Industrial Chemistry course context, curriculum, and competency analysis include evaluation and alignment with the competencies regulated in IMO 7.04 (IMO, 2014). A needs analysis was conducted to identify limitations in industrial chemistry learning and their correlation with maritime education standards. Some problems are still the lack of interactive and easily accessible industrial chemistry teaching materials, materials not by IMO 7.04, the minimal allocation for industrial chemistry lectures (limited space and time), difficulty understanding abstract chemical concepts, and low student scientific literacy. This causes students not to be able to study effectively and efficiently.

The characteristics of students as e-module users are also analyzed, including their ability to use technology, learning preferences, and the challenges they face in digital learning. This analysis is essential for designing modules that are right on target and easily accessible to students (Sutherland et al., 2024). Apart from that, the analysis also includes identifying available resources, technology to be used, and potential obstacles that may be faced in developing this e-module. Data collection at this stage is carried out through observation, interviews, and surveys of students.

At the analysis stage, data was obtained that chemistry lecturers and students majoring in Engineering at the Indonesian State Maritime Polytechnic needed industrial chemistry learning media that could be accessed anytime and anywhere, agreed that chemical material must be adapted to the competencies of prospective seafaring students (IMO 7.04), and looked forward to teaching materials which have complete features (images, videos, animations, and simulations).

Design

The design stage, designing the e-module Website, takes around three months, including collecting materials, videos, images, animations, and simulations from various relevant sources, creating storyboards, and designing the Website's appearance. The e-module structure is designed using the SETS (Science, Environment, Technology, and Society) approach at the design stage. This design aims to integrate industrial chemistry concepts with social and environmental contexts. Each unit has interactive elements such as videos, quizzes, and online discussions to increase student engagement. User interface design was also considered to ensure intuitive navigation and accessibility for all users.

The learning objectives are designed based on the competencies set by IMO 7.04. The design of Industrial Chemistry content and materials is prepared using the SETS approach, which links chemical concepts with environmental, technological, and societal issues. This approach aims to improve understanding of concepts and critical thinking skills (Kusumaningrum et al., 2021). The Website design is developed with an intuitive and user-friendly interface. This includes designing a navigation flow so students can easily access e-module content. Research shows simple but interactive interface designs can increase user engagement (Shahriar et al., 2023). The choice of learning media in e-modules includes videos, simulations, animations, and quizzes. This media was chosen based on its effectiveness in supporting digital-based learning. It is hoped to help increase student motivation and understanding (Venkatesan et al., 2023). The purpose of the design stage is to make it easier to develop learning media.

Table 2. Industrial chemistry material according to IMO 7.04 in e-module

Industrial Chemistry Material	
Chapter	Subchapter
Fundamentals (Basic of Chemistry)	Atoms, molecules, matter, elements, compounds, mixtures, chemical reactions, oxide compounds, chemical equation conventions, and solutions
Acidity/Alkalinity	Atomic composition, acid-base theory, hydrogen ions, hydroxyl ions, pH value, and acid-base strength
Corrosion	Definition of corrosion, corrosion mechanisms, corrosion components, types of corrosion, corrosion factors, seawater and corrosion, boiler water, corrosion control, and passive layers
Water testing and treatment	Relevance IMO, ballast water, wastewater, boiler water, drinking water, boilers, corrosion and ship scale systems, pH and minimum corrosive, chemical additives, seawater conditioning methods, standard units of measurement, water hardness, as well as water testing and treatment
Introduction to fuels and lubricants	Concept of fuel, ship fuel, ship lubricants, fuel and lubricant urgency, flash point, viscosity, flash point, and viscosity urgency, fuel temperature regulation, fuel and lubricant test, water content test in fuel, as well as fire prevention

Students should explore SETS elements as an integral part of learning. Students can develop a more comprehensive understanding of how innovation affects the social and ethical environment by studying the relationship between science, engineering, technology, and society. This assignment encourages students to think critically and creatively, exploring society's challenges and opportunities in facing technological advances. Through this exploration, they are ready to face the world of work and contribute positively to sustainable social change. The following are several SETS element activities integrated into the Website e-module.

Table 3. SETS activities in website e-module

Material	SETS Elements
Chemical Reaction	Science: Students conduct simple experiments to observe reactions, such as the reaction between baking soda and vinegar (acid-base reaction) and combustion reactions. Environment: Discuss how chemical reactions in burning fossil fuels affect air quality and climate change. Technology: Demonstrate using simulation software to model chemical reactions and discuss new chemical synthesis technologies, such as catalysts. Society: Students create an awareness campaign about the safe use of household products, explaining the chemical reactions and their impact on health and the environment.
Periodic System of Elements (SPU)	Science: Presentation on specific groups of elements (for example, metals, non-metals, and metalloids), explaining their properties and applications. Environment: The role of elements in the environment, such as the importance of macro and micro elements for life and the impact of heavy metal pollution. Technology: The use of elements in technology, such as semiconductors, batteries, and new materials. Society: Public awareness about the importance of understanding elements for safety and health.
Acids and Bases	Science: Conduct experiments to test various solutions using pH indicators and discuss the characteristics obtained. Environment: The impact of acids and bases on the environment, such as acid rain and pollution. Technology: PH meters are used in laboratories and industry, and pH control technology is used in industrial processes. Society: Awareness campaign about the use of acids and bases in household products
Ship Corrosion	Science: Students carry out simple experiments to observe corrosion Environment: The impact of corrosion on the marine environment, such as the release of heavy metals due to ship corrosion. Technology: Demonstrating various corrosion prevention methods and discussing the latest technology in protecting ships from corrosion,

	including the latest materials and techniques. Society: Make a presentation or poster about the importance of corrosion prevention and maintenance of vessel
Boiler Water Testing and Treatment	Science: Students test water quality using simple tools like pH meters and TDS measuring devices. Environment: The impact of wastewater discharge from the boiler system on the environment and the importance of water treatment to reduce pollution. Technology: Demonstrate the use of modern technology in water treatment, including software that monitors water quality in real-time. Society: Students created an awareness campaign about the importance of water testing and treatment and steps that the community can take to maintain water quality in the environment.
Fuels and Lubricants	Science: Students conduct experiments to observe fuel properties (e.g., flash point and viscosity) Environment: The impact of fossil fuel use on climate change and air pollution Technology: Technology in the processing and using fuels and lubricants, including innovations in biofuels and environmentally friendly lubricants. Society: Students can make presentations or posters about the benefits of using environmentally friendly biofuels and lubricants.

Development

The development stage consists of e-module development, material expert validation, media expert validation, and student response testing. The first stage is developing an e-module Website using the Google Sites platform. This platform was chosen because it is economical, easy to use, integrated with other Google products, and responsive. Next, select the desired template and systematically arrange content such as text, images, videos, quizzes, and pages. The material designed in the previous stage was developed into a complete SETS-based e-module. Module content is integrated into a Website platform with interactive features to support distance and face-to-face learning processes (Shahriar et al., 2023). Students can independently access the material and test their understanding through quizzes included in each chapter. Fast and precise feedback through digital media can increase learning motivation and help students focus more on correcting their mistakes (Gan et al., 2021). The menu features in the e-module consist of home, materials, SETS, simulation, evaluation (quiz), RPS, profile, and references. The developed e-module Website can be accessed via the link https://bit.ly/kimindustri.

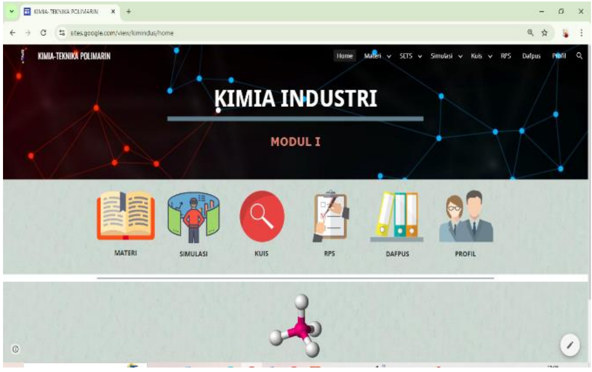

Figure 1. Main page of e-module website

This e-module is added with research-based interactive software like PHET (Physics Education Technology) Simulations, which teaches science and mathematics concepts, including chemistry. PhET (Physics Education Technology) simulations have various advantages such as being interactive and engaging, concept visualization, easy to access and free, multiple topics, flexible, and discovery-based. Multimedia elements, such as videos and interactive simulations, are developed to enrich the student learning experience. Using multimedia in e-modules has proven effective in increasing understanding of abstract and complex concepts (Çeken & Taşkın, 2022). PhET simulation in this e-module is related to atomic material, Rutherford experiments, molecules, chemical equations, pH values, and acids and bases. This e-module is also equipped with WebQC.org, a Website that provides tools for molecular structure analysis, chemical property prediction, and chemical equations. Through this, users can draw molecules and get information such as physical properties, spectrum data, and other related information.

The SETS element on the Website can be seen through the various interactive elements available, such as PhET simulation and WebQC.org, which are examples of educational technology allowing users to carry out virtual experiments with scientific concepts. Additionally, videos and images enrich the content, making the information more exciting and easy to understand. Apart from technology, elements of science are also present through articles and in-depth explanations of scientific theories and the latest discoveries. On the other hand, environmental issues are explored through information about sustainability and ecological challenges, raising users' awareness of the importance of maintaining the balance of nature. No less important, the societal aspect is raised through discussions about the impact of technology and science on social life and the ethical challenges that arise. By integrating all these elements, the Website provides comprehensive information and is also expected to encourage users to think critically and contribute positively to social and environmental change.

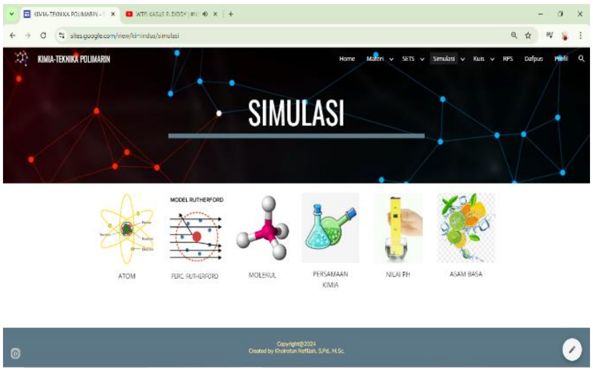

Figure 2. Simulation menu page (PhET simulation)

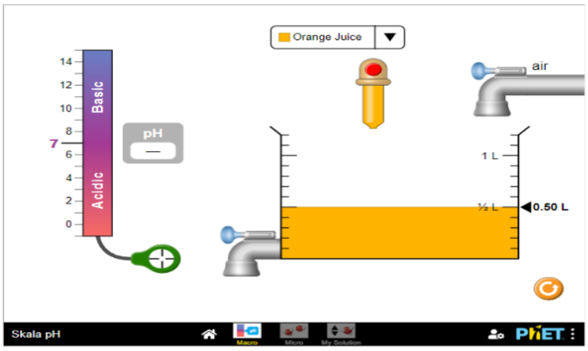

Figure 3. PhET simulation on acid-base materials

The e-module that has been developed is then validated by material and media experts. The material experts involved are Industrial Chemistry lecturers and maritime professionals tasked with evaluating the accuracy of the content and its suitability to competency standards. Meanwhile, media experts assessed the design and interactivity of the module from a technical perspective (Steven et al., 2019). Two chemistry lecturers from different state universities carried out the material expert validation stage. The aspects measured in the material validation process are the material suitability aspect, the SETS approach aspect, the concept depth aspect, the material clarity aspect, the linguistic aspect, and the implementation aspect.

Table 4. Material expert validation results

	Aspects	Number of Indicators	Percentage of Ideal (%)	Category
A	Material suitability	5	86	Very Valid
B	SETS Approach	2	90	Very Valid
C	Depth of concept	3	83.33	Very Valid
D	Clarity of material	5	86	Very Valid
E	Language	5	92	Very Valid
F	Implementation	4	90	Very Valid
	Overall Score	24	87.89	Very Valid

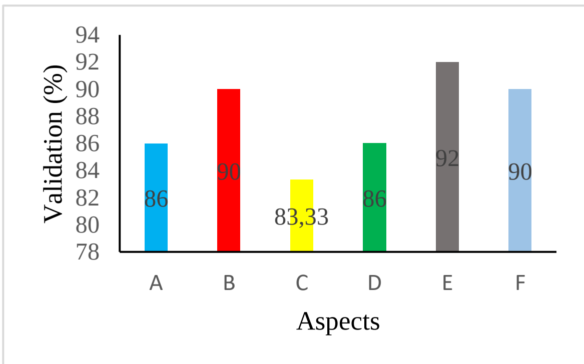

Figure 4. Percentage of material expert validation

The average percentage result for all aspects of material validation is 87.89% by category Very Valid. This indicates that the material in the e-module complies with IMO 7.04 standards and the needs of prospective seafarers. In addition, the suitability of chemical concepts is also in accordance with those put forward by chemists.

The next stage is media validation, which will assess the quality of the website e-module. There are four aspects of assessment: media effects, learning design aspects, visual communication aspects, and implementation aspects. The results of the media validation assessment show that the assessment percentage is 91.67% by category Very Valid. This indicates that the e-module website's performance is suitable for students to use as a learning medium for industrial chemistry courses.

Table 5. Media expert validation results

	Aspects	Number of Indicators	Percentage of Ideal (%)	Category
A	Media effect	11	89.09	Very Valid
B	Learning Design	7	94.28	Very Valid
C	Visual Communication	9	83.33	Very Valid
D	Implementation	3	100	Very Valid
	Overall Score	30	91.67	Very Valid

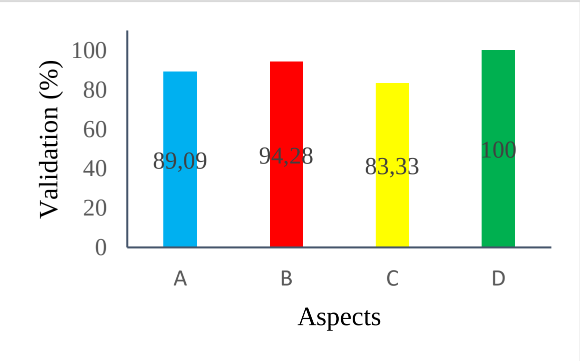

Figure 5. Percentage of media expert validation

Validation by material and media experts shows that this e-module meets the feasibility criteria in terms of content and technical design. Material experts gave a positive assessment of the suitability of the material with the curriculum and IMO standards. In contrast, media experts assessed that the module interface design was interactive enough and easy for students to use. This validation reinforces the importance of a systematic approach in developing technology-based teaching materials, where validation by experts is necessary to ensure product quality (Sugiyono, 2019).

Based on the validation results, revisions were made to correct deficiencies in the e-module in terms of material and media. This revision aims to improve product quality before further trials. Several improvements, such as the appearance of the website logo, material revisions, and the appearance of quizzes, were made. Apart from that, e-modules were also added with several learning tools for industrial chemistry courses.

The revised e-module was tested on a small group of students. This trial aims to determine student responses to the e-module and identify aspects that need to be improved. Using trials in small groups follows best practices in digital learning media development to obtain accurate initial feedback. The student response test is limited to 42 students in the Department of Marine Engineering in Politeknik Maritim Negeri Indonesia. The results of the student response test produced a percentage value for all aspects of 90.13% with categories Very Good. This percentage can be broken down into 4 main aspects: the product suitability aspect of 88.41%, the appearance aspect of 89.28%, the effectiveness aspect of 91.19%, and the satisfaction aspect of 91.67%.

Table 6. Student response results

	Aspects	Number of Indicators	Percentage of Ideal (%)	Category
A	Product Suitability	3	88.41	Very Good
B	Appearance	8	89.28	Very Good
C	Effectiveness	4	91.19	Very Good
D	Satisfaction	2	91.67	Very Good
	Overall Score	17	90.13	Very Good

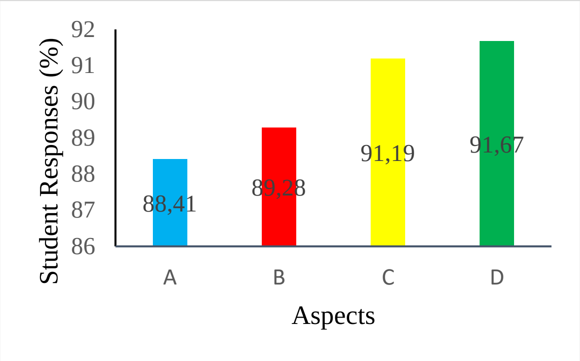

Figure 6. Percentage of student response test

The first aspect is the product suitability aspect, resulting in 88.41% by category Very Good. The assessment of the product suitability aspect consists of 3 indicators. The first indicator, the material in the e-module, is taught by the curriculum (IMO 7.04). The second indicator, the e-module, presents information relevant to the Industrial Chemistry course. The third indicator, e-modules are considered relevant to contemporary issues related to chemistry and the maritime environment, helping to increase user awareness and understanding of these issues. Each of the 3 indicators shows a good percentage of results, in sequence, namely 90; 88.57; 86.67%.

The second aspect is the display, resulting in a percentage of 89.28% with categories Very Good. This aspect consists of 8 indicators. The first indicator, the appearance of the e-module can attract students' attention to learning through a combination of attractive and relevant visuals to the industrial chemistry learning context. The second indicator is the e-module website interface design, which is attractive and easy to use. The third indicator, navigation in the e-module is intuitive and not confusing. The fourth indicator, the presentation of material, pictures, videos, and simulations can attract students' interest in learning compared to textbooks/package books. The fifth indicator is that the form of media is easy to carry everywhere (accessible anytime and anywhere). The sixth indicator, the availability of PhET Simulation and webQC which increases understanding of chemical material. The seventh indicator, the availability of quizzes to measure user understanding. The eighth indicator, the e-module can be accessed well on various devices.

The third aspect is effectiveness, resulting in a percentage of 91.19% with the category Very Good. This aspect consists of 4 indicators. The first indicator is that the SETS-based website e-module has succeeded in effectively conveying chemical and maritime environmental concepts to users and can enrich the user's knowledge. The second indicator, text, images, videos, and simulations in the e-module are easy to understand, ensuring that users can well receive the messages. The third indicator, SETS (Science, Environment, Technology, Society) based website e-modules can help users to learn independently according to my learning speed. The fourth indicator is that users can discover every environmental problem with scientific explanations with the help of e-module website media.

The fourth aspect is satisfaction, resulting in a percentage of 91.67% with the category Very Good. This aspect consists of two indicators. The first indicator, users are satisfied with the experience of using SETS-based website e-modules according to IMO 7.04. The second indicator is that users will recommend this e-module to others. The results of this aspect indicate that the website e-module received a positive response from students.

The results of limited trials show that the e-module website greatly facilitates learning access and increases student involvement in the learning process. As a digital learning medium, interactive websites supported by multimedia elements such as videos, animations, and chemical simulations can provide a more interesting and effective learning experience than conventional teaching materials. Previous research (Lusiana & Maryanti, 2020; Mahrani et al., 2022) shows that digital website media can increase students' interest in learning and make complex material easier to understand.

Even though this e-module has shown a positive response, this research is limited to the e-module development stage, so it cannot measure its effectiveness comprehensively. Therefore, it is necessary to proceed to the implementation stage to find out to what extent this e-module can be implemented and positively impact the student learning process.

CONCLUSION

This research concludes that the SETS-based e-module Website for industrial chemistry courses according to IMO 7.04 standards has been successfully developed using the Research and Development method and the ADDIE model. Validation from material and media experts showed a percentage result of 87.89% and 91.67% with the category Very Valid. The response test on 42 students showed positive results with a percentage of 90.13% in the category Very Good. This indicates that e-modules can be a learning resource for students and are relevant to maritime education needs. The implementation stage through large-scale trials is needed to determine the effectiveness of the learning Website e-module, such as the effect on students' scientific understanding and literacy.

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