



## Development of interactive E-Modules on entrepreneurship based on augmented reality for students of SMKN 6 Medan

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### ABSTRACT

Entrepreneurship education in vocational high schools (SMK) is often dominated by conventional methods that make students passive and less able to connect theory with practice, especially on abstract topics such as franchising. This study aims to develop an Augmented Reality (AR)-based entrepreneurship e-Module that is interactive, contextual, and oriented toward vocational learning. Using a Research and Development (R&D) approach with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), the study involved 100 grade XI students at SMK Negeri 6 Medan. Data were collected through expert validation, questionnaires, observations, interviews, and pre- and post-tests. The validation results placed the e-Module in the highly valid category (>80%), while the N-gain test showed a significant increase in the experimental class (0.83; high category) compared to the control class (0.32; low category). The t-test also confirmed a significant difference ( $p < 0.05$ ) between the two groups. In addition, observations indicated improvements in student motivation, engagement, and understanding, as well as greater ease for teachers in delivering abstract material. These findings demonstrate that AR integration in entrepreneurship e-Modules can effectively bridge theory and practice, enhance learning quality in vocational schools, and support the achievement of SDG 4 on quality education.

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### Introduction

Entrepreneurship education in the modern era plays a very important role in shaping an independent, creative, and competitive younger generation, especially at the vocational high school (SMK) level, which is prepared to face the world of work and start their own businesses (Mahmudin, 2023; Said Ahmad et al., 2023). Entrepreneurship is not merely a theoretical subject that explains basic economic or business concepts, but rather a life skill that must be instilled early on so that students can face various challenges in the world of work and increasingly fierce business competition (Adeyemi, 2021; Alam Rizvi et al., 2023; Rahman et al., 2024). According to Mahmudin, Tono (2023), entrepreneurship education not only serves as technical knowledge, but also as a driver of proactive attitudes, independence in decision-making, and the courage to innovate amid dynamic global changes. Unfortunately, the practice of entrepreneurship education in schools, especially in vocational schools, is often still carried out

conventionally through lectures or textbook-based material delivery, so that students become less interested and tend to be passive in understanding the concepts presented (Adedeji et al., 2020; Amalia & von Korfflesch, 2021; Lotulung et al., 2018). This raises a fundamental problem, where students only understand theory superficially without being able to relate it to the real world, even though the main objective of vocational education is to provide direct, applicable experience. Furthermore, entrepreneurship not only impacts individual students but also contributes significantly to economic and social development in society, for example, by reducing unemployment, encouraging creative economic growth, and supporting the achievement of sustainable development goals (SDGs). Therefore, innovation is needed in the entrepreneurship learning model that can combine theory with practice in a more interactive, interesting, and appropriate manner in line with technological developments that are currently deeply embedded in the lives of the younger generation in the digital era (Chen et al., 2021; Lynch et al., 2021).

The main problem faced in entrepreneurship education in schools, especially in vocational schools, is that teaching methods tend to be conventional and monotonous. Teachers often rely solely on lectures, static presentations, and written teaching materials without adequate visual or hands-on approaches. As a result, students are unable to internalize the material deeply because their involvement in the learning process is not optimal. This situation is exacerbated by the abstract and complex nature of entrepreneurship material, such as understanding the franchise business model, which requires real visualization and direct simulation for students to comprehend the operational flow and challenges they will face (Bergfeld et al., 2020). If this problem is not immediately addressed, it is feared that students will only acquire theoretical knowledge without practical skills relevant to the world of work or business. In other words, there is a significant gap between what students learn in school and the real needs they will face in the field. In addition, the low level of student interest in entrepreneurship learning is also a problem in itself, as this has the potential to reduce their readiness to become entrepreneurs or even work after graduation. Therefore, an alternative learning medium is needed that not only presents the concept of entrepreneurship in text form, but is also capable of providing a more realistic, interactive learning experience that is in line with the technological developments that are familiar to the daily lives of the current digital generation (Dineva et al., 2019; Hernandez-de-Menendez et al., 2020; Saykılı, 2019).

Previous studies have highlighted the potential of digital technology in supporting the learning process, including in entrepreneurship subjects. One technology that has been widely researched and proven effective is Augmented Reality (AR). Al-Gindy, Ahmed (2020) explain that AR has the ability to integrate digital objects with the real environment, thereby creating a more immersive and interactive learning experience. Research by Riniati, Wa Ode (2024) also shows that the use of AR can significantly increase student engagement and accelerate their understanding of complex material. In the context of entrepreneurship learning, AR can be used to present realistic business simulations, allowing students to learn concepts such as management, marketing, and risk management in a more practical way. In addition, in the development of technology-based teaching materials, the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model has been widely used due to its systematic and structured nature, making it easier for teachers and researchers to produce learning media that suits the needs of students (Abuhassna et al., 2024; Zou et al., 2024). Furthermore, the Research and Development (R&D) research method also allows for continuous evaluation by considering input from experts and users, so that the resulting product is more effective and applicable (Chiesa & Frattini, 2009; Kerssens - van Drongelen & Cooke, 1997). This shows that technology-based innovations, especially AR, have great potential to be adopted in entrepreneurship learning in vocational schools, although so far research specifically developing AR-based entrepreneurship e-Modules is still limited.

Based on the problems and findings from previous studies, this study aims to develop an Augmented Reality (AR)-based e-Module as a means of entrepreneurship learning in vocational schools. Specifically, this study focuses on franchise material, which was chosen because of its practical nature and relevance to the real business world, but is quite difficult for students to understand if only presented theoretically. With the AR-based e-Module, it is hoped that students can learn the concept of franchising more interactively through visual simulations, so that they not only understand the theory but also have a practical understanding of the operations and strategies of franchise businesses. This study uses the ADDIE model as a framework for designing, developing, implementing, and evaluating e-Modules to suit

learning needs. In addition, the Research and Development (R&D) approach was chosen to ensure that the module development was carried out systematically and continuously improved based on input from users and experts. Thus, the main objective of this study is to provide concrete solutions that can improve the quality of entrepreneurship learning, increase student motivation and engagement, and make a real contribution to efforts to develop technology-based education in Indonesia, especially in vocational schools as educational institutions that prepare ready-to-work employees.

Although previous studies have highlighted the use of digital technology, including Augmented Reality, in various fields of learning, there is still a gap in the context of applying this technology to entrepreneurship subjects in vocational schools. Most AR studies focus more on science, medicine, or engineering, while the field of entrepreneurship has been relatively unexplored. In fact, the characteristics of entrepreneurship, which emphasize practical aspects, direct experience, and the ability to visualize business concepts, are highly relevant to the features offered by AR. Therefore, the novelty of this research lies in the development of an AR-based e-Module specifically designed to support entrepreneurship learning, especially on the topic of franchising, which has not been widely researched before. In addition, the use of the ADDIE model and the R&D approach in the development of e-Modules ensures that the resulting product is not only innovative in terms of technology but also systematically tested through the stages of analysis, design, development, implementation, and evaluation. The justification for this research is further strengthened by its alignment with the National Research Master Plan (RIRN) in the field of social humanities, as well as its support for the achievement of the Sustainable Development Goals (SDGs), particularly goal 4 on quality education (UNESCO, 2020). Thus, this research not only provides a theoretical contribution in the form of enriching the literature on the use of AR in entrepreneurship education, but also a practical contribution in the form of innovative solutions that are relevant, flexible, and applicable to improve the quality of learning in vocational schools.

Although a number of studies have proven the effectiveness of Augmented Reality in increasing motivation and conceptual understanding in the fields of science, health, and engineering, its application in the context of entrepreneurship education in vocational schools is still very limited. Existing studies have mostly focused on conceptual aspects or the use of digital media in general, without specifically developing AR for abstract topics such as franchising, which require visual understanding and hands-on practice. Meanwhile, data from the Central Statistics Agency (2023) shows that the level of entrepreneurial interest among vocational school graduates in Indonesia is still low, at only around 11%, while the majority prefer to work as employees. This is in line with the findings of the Ministry of Education and Culture (2022), which states that conventional methods in entrepreneurship education are only effective in improving theoretical mastery but do not sufficiently support practical skills. Thus, there is a significant gap that needs to be bridged through the development of innovative AR-based learning media to support the achievement of vocational education goals.

## Method

This study applies a research and development (R&D) approach with the main objective of producing a product in the form of an entrepreneurship e-Module integrated with Augmented Reality (AR) technology. The R&D approach was chosen because it supports an iterative design process, namely through stages of testing, evaluation by experts, and continuous improvement based on input from end users (Zaina & Álvaro, 2015).

The development model used is ADDIE, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation (Martatiyana et al., 2023; Rusdi et al., 2022; Widyastuti, 2019). In the analysis stage, a preliminary study was conducted through focus group discussions (FGD) and a literature review on e-Modules, AR, and entrepreneurship learning. In addition, a survey was conducted among teachers and students at SMK N 6 Medan to identify needs and problems in conventional learning.

The design stage included the design of the e-Module structure and AR-based interactive learning content. Next, the development stage was carried out by creating an e-Module prototype using AR software and integrating relevant entrepreneurship material. AR content was developed to visualize

concepts such as franchise businesses in the form of animations or simulations (Farshid et al., 2018; Jahromi & Ghazinoory, 2024).

The validation process was carried out by two parties, namely experts in the field of entrepreneurship and experts in Augmented Reality (AR) technology, to ensure that the developed content was accurate and technically feasible. Next, a limited trial phase was carried out at SMK Negeri 6 Medan, involving teachers and students as the initial users of the developed product. Their input was used to continuously refine the e-Module. The e-Module was directly implemented in classroom learning at this stage. The effectiveness of the module was evaluated through observation, interviews, and questionnaires to assess students' level of understanding and their involvement in the learning process.

All data were analyzed descriptively, qualitatively, and quantitatively to assess the effectiveness of the product. This research is at TKT 2 level, which is the concept formulation and preliminary study stage for educational technology development.

One hundred students in grade XI at SMK Negeri 6 Kota Medan were used as research subjects. The development of this E-Module used data collection instruments to measure validity, consisting of a validation sheet, instruments to measure practicality, consisting of questionnaires for teachers and students, and instruments for critical thinking skills. In this study, the following techniques were used to analyze the data:

#### 1. E-Module validity test

The validity of the E-Module was obtained based on validation from education experts, media experts, and subject matter experts. After obtaining the data, analysis was carried out using the formula (Indriani & Astuti, 2023):

$$V = \frac{\sum \text{Skor per item}}{\text{Skor Maksimum}} \times 100\%$$

After obtaining the score, it is then interpreted based on the criteria in the following table:

Table 1. E-Module Validity Criteria

Percentage	Criteria
0% < V ≤ 20%	Highly Invalid
20% < V ≤ 40%	Invalid
40% < V ≤ 60%	Less Valid
60% < V ≤ 80%	Valid
80% < V ≤ 100%	Highly Valid

#### 2. E-Module Practicality Test

The practicality of the E-Module was obtained from teacher response sheets and student response sheets. These teacher response sheets and student response sheets were intended to determine the assessments and responses of teachers and students and as a basis for determining the practicality of the AR-based interactive E-Module that was developed. After obtaining the data, an analysis was conducted using the following formula:

$$P = \frac{\sum \text{Skor respon}}{\sum \text{Skor maksimal}} \times 100\%$$

Once the score is obtained, it is then interpreted based on the criteria in the following table.

Table 2. e-module practicality criteria

Percentage	Criteria
0% < P ≤ 20%	Very impractical
20% < P ≤ 40%	Impractical
40% < P ≤ 60%	Less practical
60% < P ≤ 80%	Practical
80% < P ≤ 100%	Very practical

### 3. E-Module Effectiveness Test

The ability to think critically is measured by indicators such as providing simple explanations (Elementary clarification); building basic skills (Basic Support); making conclusions (Inference), and using strategies and tactics (Strategies and tactics) (Ennis, 1985). To determine the extent of improvement, it is calculated using the normalized gain formula (Bao, 2006).

$$g = \frac{\text{skor postest} - \text{skor pretest}}{\text{skor maks} - \text{skor pretest}}$$

The N-gain calculation results were then interpreted based on the following table (Triyono et al., 2024)

Table 3. N-gain calculation results

N-gain value	Category
$g > 0,7$	High
$0,3 < g \leq 0,7$	Medium
$g \leq 0,3$	Low

## Results and Discussions

### 1. Analysis Stage

The analysis stage is an essential initial phase in the process of designing an Augmented Reality (AR)-based entrepreneurship e-Module. This step aims to explore learning needs from the perspective of teachers and students, while identifying various obstacles encountered in conventional learning methods. Based on data from interviews and questionnaires conducted among vocational school teachers and students, it was found that the majority of students had difficulty understanding entrepreneurship material, especially abstract topics such as franchise systems, distribution chains, and production process stages. Approximately 85% of respondents stated that learning approaches that rely solely on text or lecture methods are not effective in helping them visually understand the abstract concepts presented.

In addition, teachers also mentioned that there are limitations in the use of visual media that can facilitate more contextual and interactive learning. They stated the need for learning media that not only delivers material more effectively but also increases student motivation to learn. Based on the results of this analysis, a digital e-module based on Augmented Reality (AR) was developed, designed to present visual objects in three dimensions (3D) as a learning aid. This module is designed not only to convey text-based information but also to provide an immersive learning experience through the visualization of real objects that can be rotated, enlarged, and observed from various angles. This approach is in line with the principle of concrete visualization in constructivist learning theory, which emphasizes the importance of students' active involvement in building understanding through direct experience.

### 2. Design Stage

In the design stage, the AR-based e-Module design was developed comprehensively, starting from the content structure, navigation, user flow, to AR technology integration. The system begins with a landing page that serves as the main page and login page for users, both administrators and students, to access features according to their roles. After logging in, users are directed to the main display, which is divided into two types: the Admin Display and the Student Display, each of which has different functions and roles but are integrated with each other.

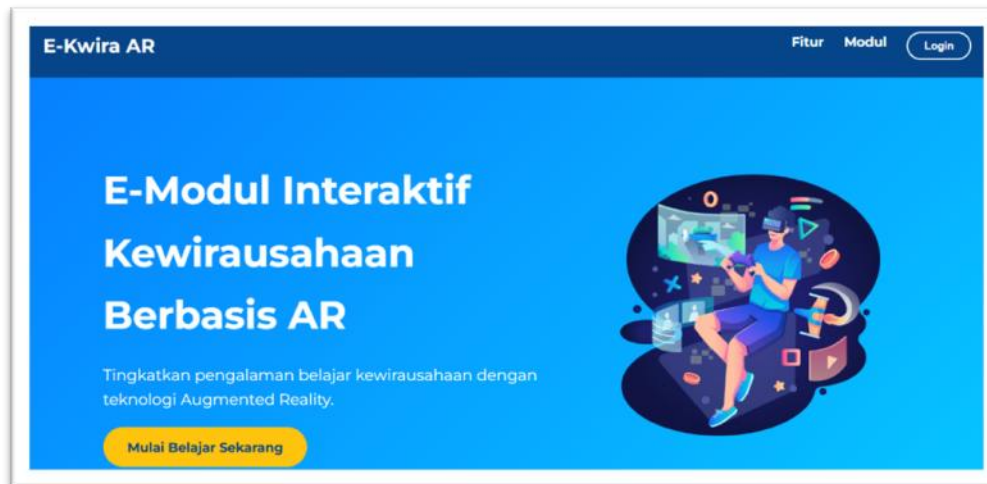


Figure 1. E-Kwira AR main page

The Admin view is used to manage learning content and student data. Some of the important features in this view include: Dashboard to view user activity statistics, Manage Students to perform CRUD on student data, Manage Topics and Modules which allows admins to organize material structure based on specific topics, and Manage Quizzes and AR, which is used to add evaluation questions and 3D object files (.glb) as AR-based teaching materials.

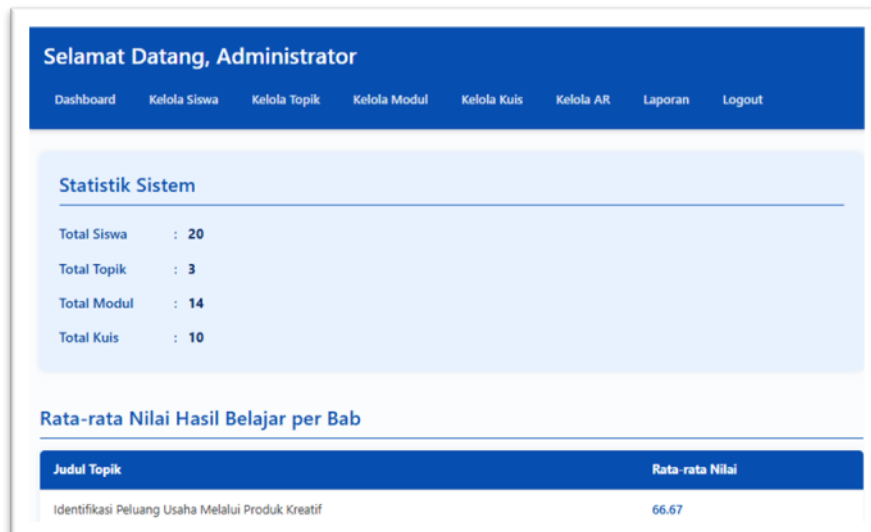


Figure 2. Admin page display

Another outstanding feature is the Evaluation Report, which allows administrators to view the quiz results of each student, both individually and for the entire class, as well as print reports for learning analysis purposes.

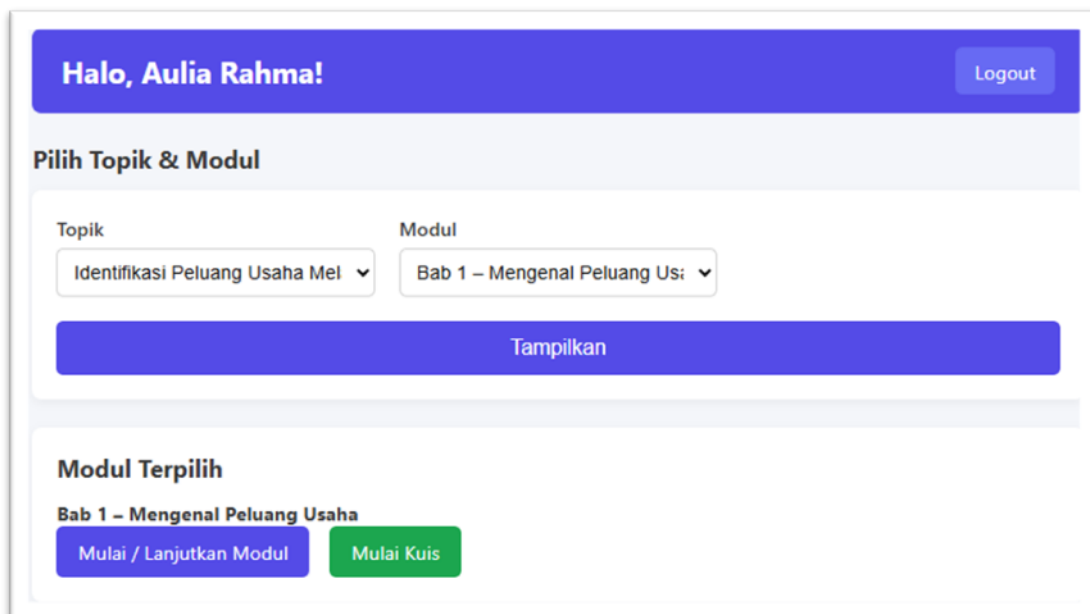


The screenshot shows a web interface titled "Nilai Siswa". It displays student information: Nama: Aulia Rahma and Kelas: X Tata Busana 1. Below this is a table titled "Daftar Nilai:" with two columns: "Modul" and "Nilai". The table contains one row with the module "Mengenal Peluang Usaha" and a score of "80". At the bottom left, there is a green button labeled "Cetak PDF".

Modul	Nilai
Mengenal Peluang Usaha	80

Figure 3. Display of student evaluation results

On the other hand, the Student View is designed to be simpler and more intuitive. After logging in, students will select a Learning Topic, then access the Learning Module for that topic. Each module contains a combination of text, images, and AR files that can be visualized through their devices, such as smartphones or tablets. After completing the module, students will take an Evaluation Quiz, the results of which are immediately displayed as feedback. This approach makes the learning process more personalized, adaptive, and concept-oriented, rather than just memorization.



The screenshot shows a student dashboard. At the top, a blue header bar contains the greeting "Halo, Aulia Rahma!" and a "Logout" button. Below the header is a section titled "Pilih Topik & Modul". It features two dropdown menus: "Topik" with the selected value "Identifikasi Peluang Usaha Mel" and "Modul" with the selected value "Bab 1 – Mengenal Peluang Us:". A large blue "Tampilkan" button is positioned below these menus. Underneath, a section titled "Modul Terpilih" displays "Bab 1 – Mengenal Peluang Usaha" and two buttons: "Mulai / Lanjutkan Modul" (blue) and "Mulai Kuis" (green).

Figure 4. Student page display

### 3. Development Stages

The development stage is the process of actualizing the previously designed plans. At this stage, the development team begins building the application using technology that supports AR integration. 3D object files are created in .glb format so that they can be accessed and visualized properly through a browser or mobile device. Digital learning modules are then integrated into the application management system, followed by the preparation of multiple-choice quizzes relevant to each chapter. The module content is adapted to the vocational school entrepreneurship curriculum and organized with consideration for digital pedagogy principles such as multimodal presentation, interactivity, and direct feedback.

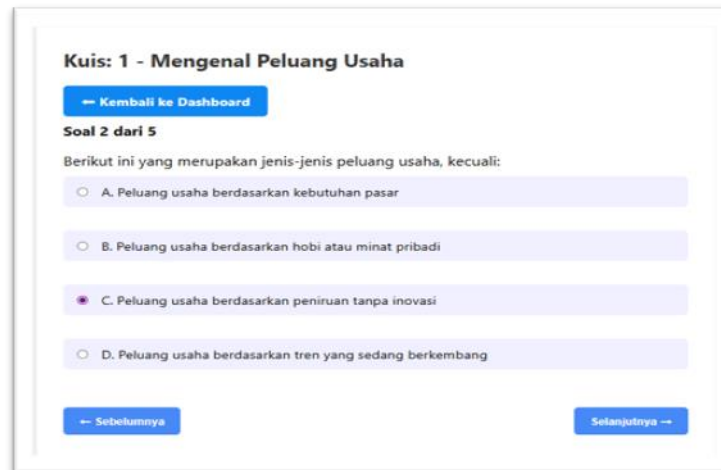


Figure 5. Quiz display

After the application prototype was completed, it was validated by experts, consisting of content validators (entrepreneurship material), media experts (appearance and usability), and education experts (pedagogical suitability). The validation process showed that the e-Module was highly valid, with an average score above 80%. Several revision suggestions, such as simplifying the menu navigation and adjusting several technical terms, were then implemented. A limited trial (alpha test) was conducted on a small group of students and teachers to assess the practicality and functionality of the system, which then resulted in minor improvements such as the addition of a help button and tooltips to facilitate the use of the application.

#### 4. Implementation Stages

Implementation was carried out by applying AR-based e-Modules to vocational school students in a guided classroom environment. Students were divided into two groups, namely the experimental class that used AR e-Modules and the control class that used conventional modules. Both groups underwent a pre-test to measure their initial ability to understand the concept of entrepreneurship. After the learning process, both groups underwent a post-test as a final measurement. The pre-test and post-test results were then subjected to an N-gain test and statistical test. The normalized gain test was used to determine whether or not there was an increase in the students' critical thinking skills. The N-gain test results showed a score of 0.83 in the experimental class and a score of 0.32 in the control class. These results show an increase in critical thinking skills in the high category in the experimental class and in the low category in the control class. To determine whether there was a significant difference between the two sample conditions tested, an independent sample t-test was used. The data was homogeneous and regularly distributed, thus meeting the testing requirements. The following table shows the test results.

Class	t-test	Sig.
Experiment	7,074	0,000

Based on the table above, it can be seen that  $\text{sig } 0.000 < 0.05$ , thus it can be concluded that students who learn using augmented reality-based E-Modules understand the concept of entrepreneurship better than students who learn with regular modules. In terms of understanding the learning material, the experimental class students have a higher average score than the control group.

In addition, during the learning process, teachers observed that students became more active, enthusiastic, and interested in the learning material because they could see entrepreneurial objects in 3D, such as shop displays, processed products, or business model diagrams. The learning process became more meaningful because students not only heard or read explanations but also experienced them visually and interactively. Teachers also found it easier to explain abstract material with the help of AR visualizations. These observations reinforce the finding that AR integration can improve students' conceptual understanding and learning engagement..

#### 5. Evaluation Stages

The evaluation stage is carried out continuously at every stage of development and implementation. Formative evaluation is carried out during the validation process by experts and internal trials, while summative evaluation is carried out by measuring effectiveness using pre-test and post-test instruments. Data analysis shows that AR-based e-Module products meet three main criteria, namely validity (validation score > 80%), practicality (smooth use in class), and effectiveness (significant increase in understanding). In addition, feedback from students shows that more than 90% feel that this application helps them understand difficult material, and 87% feel more motivated to learn entrepreneurship.

The evaluation report feature integrated into the Admin display also plays an important role in this evaluation process. Teachers can monitor student progress in real-time, both individually and for the entire class. If students with low scores or who have not completed the module are identified, teachers can immediately take appropriate follow-up action. Thus, the learning process becomes more responsive and adaptive to student needs. This comprehensive evaluation ensures that the AR e-Module product developed is not only suitable for use but also capable of improving the quality of learning in a real and sustainable manner...

#### Conclusions

This study successfully developed an entrepreneurship e-module based on Augmented Reality (AR) technology using a Research and Development (R&D) approach through the ADDIE model. The results show that this e-module is effective in improving the quality of entrepreneurship learning, particularly on the topic of franchising, by providing an interactive, visual, and contextual learning experience. Validation by experts confirmed the feasibility of the module in terms of both content and technology, while its implementation at SMKN 6 Medan demonstrated increased student understanding, motivation, and engagement. The integration of AR effectively bridged the gap between theoretical and applied concepts, while also supporting teachers in delivering material that is difficult to explain through conventional methods. The novelty of this research lies in the development of an AR-based e-module specifically designed for entrepreneurship learning, particularly franchising, which has rarely been explored in previous studies. This strengthens its scientific contribution by filling a significant gap in the literature, while also providing a practical innovation that is relevant to vocational education. In addition, the findings contribute to the advancement of technology-based learning media and support national and global agendas in improving the quality of vocational education in line with SDG 4 on quality education. Although this research has made a significant contribution, several recommendations should be considered for further development. First, implementation should be expanded to more vocational schools with diverse student characteristics to obtain broader evidence of effectiveness. Second, integrating additional features such as gamification, AR-based assessment systems, and collaboration with industry players can enhance relevance and sustainability. Third, teacher training programs are essential to ensure technical and pedagogical readiness in optimizing AR use. Finally, future research should evaluate the long-term impact of AR-based e-modules on the development of entrepreneurial character—including independence, creativity, innovation, and risk-taking—so that the contribution extends beyond conceptual understanding to holistic entrepreneurial competencies.

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