

Development of Technopreneurship Based E-Modules on Entrepreneurial Learning

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ABSTRACT

In the digital era, the integration of technology in learning has become essential, particularly in entrepreneurship education, which must adapt to rapid technological developments. **This study aims** to develop a technopreneurship-based e-module to strengthen entrepreneurial learning in line with digital transformation. Using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation), the analysis phase included literature review and field observations to identify learning challenges and competency needs. **The design phase** involved formulating learning objectives, selecting relevant content, and defining instructional strategies aligned with technopreneurship principles. During the development phase, information and communication technology features such as multimedia, interactive content, animations, and instructional videos were incorporated to enhance student engagement. **Implementation was conducted** through classroom trials in entrepreneurship courses, followed by evaluation using tests and student questionnaires. The results show that the e-module effectively improves students' understanding of entrepreneurial concepts, problem-solving abilities, and technology-oriented entrepreneurial attitudes. Additionally, students reported higher motivation and engagement due to the interactive and modern learning format. This research demonstrates that integrating digital competencies into entrepreneurship education can provide more innovative and relevant learning experiences. **The developed** e-module offers a practical reference for educators and curriculum developers seeking to enrich instructional strategies, promote student-centered learning, and support the development of digital-based entrepreneurial skills. Overall, this study confirms that technopreneurship e-modules can effectively bridge the gap between theoretical concepts and practical skills, enhancing both learning outcomes and students' readiness for technology-driven entrepreneurial ventures.

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1. INTRODUCTION

In the rapidly growing digital era, information and communication technology has penetrated various aspects of life, including education. Entrepreneurship is one area that has been significantly influenced by technological advancement, as it plays an essential role in shaping creative, innovative, and independent individuals who are capable of facing global challenges. Using technopreneurship-based electronic modules (e-modules) has become an effective and efficient approach to support entrepreneurial learning [1, 2]. Technopreneurship, understood as the integration of technological innovation with entrepreneurial processes, has emerged as a crucial competency in the modern economy. It helps prepare a generation that can leverage technology to create new ventures and drive economic growth, while also supporting global agendas such as quality education and economic development [3–5].

E-modules function as digital learning tools used to deliver materials, assignments, and assessments. Through these modules, students can access learning content anytime and anywhere based on their needs. The development of technopreneurship-based e-modules specifically aims to merge entrepreneurial concepts with the application of digital technologies [6]. Within these modules, students are introduced to fundamental aspects of entrepreneurship such as business planning, resource management, innovation, marketing, and financial management while also learning how technology can be utilized to generate innovative business ideas and market them effectively [7].

The development process adopts an interactive and creative learning approach. Students engage in collaborative activities, case studies, simulations, and real projects that encourage active participation. The e-modules are enriched with learning videos, practical case examples, and additional references [8–10]. Through this approach, the e-modules are expected to increase students' interest and comprehension of entrepreneurship, ultimately preparing them to become technopreneurs capable of addressing challenges in the digital era. Teachers also benefit from these tools, as they can more easily monitor student progress and deliver timely feedback. The study explains the full development process, encompassing planning, design, content development, and evaluation, while involving both students and teachers to assess the effectiveness and efficiency of the modules [11, 12].

Despite these advantages, several challenges remain in developing and implementing technopreneurship based e-modules [13]. Limited access to digital devices and stable internet connections can hinder learning effectiveness. Additionally, some students and teachers may have difficulty adapting to new technologies and may require extra time or training to use the e-modules effectively. Another challenge concerns content quality; materials must be relevant, high-quality, and aligned with student needs. Entrepreneurial learning also requires interaction and discussion, highlighting the importance of features such as online forums, discussion rooms, or webinars. Evaluation and feedback also present difficulties, as teachers must design methods suitable for digital environments, such as online assignments, interactive quizzes, or project submissions, while ensuring that students receive meaningful and timely responses [14].

Although e-modules have been widely used in education, this study offers novelty through the explicit integration of technopreneurship concepts aligned with current digital transformation trends, including AI-driven business modeling, digital marketing analytics, and platform-based entrepreneurship. Unlike conventional e-learning modules that focus primarily on content delivery, technopreneurship e-modules combine technological innovation with the development of an entrepreneurial mindset [15, 16]. This approach equips learners to navigate digital ecosystems and participate in practical digital business simulations and innovation-oriented projects. Compared with other digital learning methods such as gamified learning, MOOCs, or blended learning, this model uniquely connects entrepreneurial theory with hands-on digital business practices. As a result, the modules enhance digital literacy while fostering creative problem-solving and adaptability [17].

This research has a high urgency considering the importance of entrepreneurship in facing challenges in the digital era [18–20]. Technology is a key driver of change and innovation in a rapidly changing world; therefore, preparing students with entrepreneurial skills supported by information and communication technology becomes essential. The development of technopreneurship-based e-modules offers a learning approach that aligns with the characteristics of today's digital generation by enabling independent and flexible learning while integrating technology to enrich the learning experience [21]. This urgency is also reinforced by the global agenda set out in the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) which emphasizes equitable, technology-enhanced learning, and SDG 8 (Decent Work and Economic Growth) which highlights the need to cultivate innovation and entrepreneurship as drivers of sustainable economic development. By integrating technopreneurship into digital learning, this research supports curriculum development

that is more modern, relevant, and aligned with global demands [22].

2. LITERATURE REVIEW

The development of information technology has brought significant transformation to the field of education. Technology has become an effective tool to support teaching and learning, including in the domain of entrepreneurship. In this context, the development of technopreneurship-based e-modules is highly relevant for enhancing the quality of entrepreneurship education [23]. Previous studies have shown that e-learning media can serve as an effective solution to support learning processes. The rapid advancement of information and communication technology has influenced various sectors, including education, increasing the demand for technology-integrated learning mechanisms [24]. As technological innovation continues to progress, education systems are required to adapt by utilizing digital platforms and tools to meet modern learning needs [20, 25, 26]. Technology has also played a crucial role in sustaining entrepreneurial activities during crises such as the COVID-19 pandemic, where digital literacy and technology-based learning strategies became essential. Despite this progress, traditional teaching methods are still widely used in entrepreneurship education, indicating a need for more transformative and interactive approaches [27].

Techno-entrepreneurship-based e-modules offer an innovative solution to strengthen entrepreneurship learning. These modules can be designed by integrating digital tools, interactive features, and technology-driven learning strategies within economic and entrepreneurial contexts [28]. Numerous studies have emphasized the importance of higher education programs in preparing students to become future entrepreneurs. To cultivate entrepreneurial character and skills, learning activities must be innovative, technology-oriented, and aligned with real-world business dynamics [29]. Research has demonstrated that well-designed educational programs can enhance students' entrepreneurial mindset through various academic and extracurricular activities. Entrepreneurship is often associated with courage, initiative, and the ability to turn opportunities into meaningful value. Therefore, providing students with innovative learning resources is essential for fostering these qualities [30].

One effective learning resource is a technopreneurship-based e-module. Such modules are developed to make entrepreneurship learning more engaging, interactive, and effective [31]. Studies have shown that e-modules designed with digital authoring tools can significantly enhance students' understanding of entrepreneurship concepts. To position the contribution of this research, a conceptual framework is presented to illustrate the process and structure of technopreneurship-based e-module development [32].

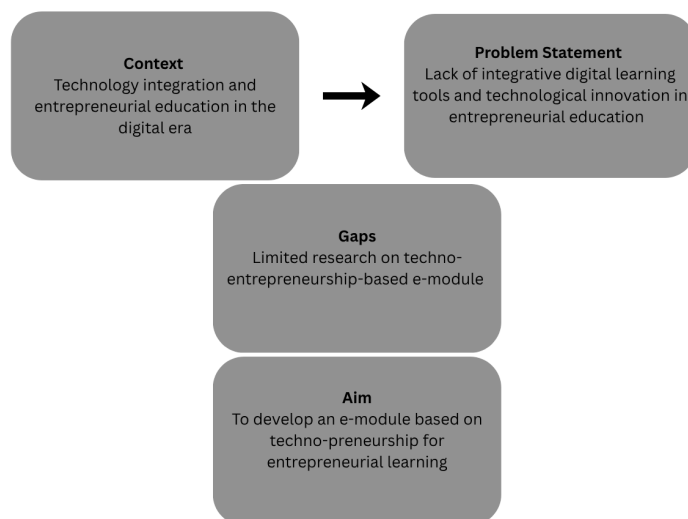


Figure 1. Conceptual Framework Proposed by Authors

Figure 1 illustrates the logical flow of the foundation of the study, starting in the larger context of increasing technology integration within entrepreneurial education in the digital era. This emerging landscape highlights a crucial problem, namely the lack of integrative digital learning tools and limited technological innovation within entrepreneurship learning environments. As shown in the diagram, this problem leads to a clear research gap, specifically the scarcity of studies focusing on technopreneurship-based e-modules that combine technological competence with entrepreneurial skill-building [33–35]. Addressing this gap, the study establishes its primary aim, which is to develop an e-module grounded in technopreneurship principles to enhance the effectiveness, relevance, and innovation of entrepreneurial learning [36].

3. RESEARCH METHOD

3.1. Research Design and Procedures

The research employed the ADDIE Model consisting of Analysis, Design, Development, Implementation, and Evaluation as the primary methodological framework due to its systematic, iterative, and adaptive nature in developing technology-based instructional products such as technopreneurship e-modules. This model provides a structured approach beginning with a comprehensive needs assessment to ensure that each design and development component is grounded in relevant evidence, which is essential for producing effective and applicable instructional media [34, 37, 38]. In addition, the ADDIE framework incorporates both formative and summative evaluation cycles, enabling continuous product refinement based on feedback from experts and end users prior to large scale implementation. It also emphasizes the importance of establishing clear relationships among learning objectives, instructional strategies, and evaluation mechanisms, making it suitable for development research that requires measurable outcomes and coherence between theory and instructional practice. The model has been widely applied in school contexts to enhance the quality of teaching [39].

Operationally, the application of the ADDIE model in developing the technopreneurship e-module involved five detailed stages. The analysis stage included curriculum needs assessment, identification of learner characteristics such as digital literacy and prior competencies, examination of infrastructural constraints, and determination of required techno-preneurial competencies. The design stage involved formulating measurable learning objectives, organizing content structure, selecting instructional strategies such as problem-based learning and digital simulations, and creating an evaluation blueprint. During the development stage, the focus was on producing multimodal content including text, video tutorials, business simulations, and interactive quizzes, designing module navigation, and validating both content and media through expert reviews [40]. The implementation stage consisted of pilot testing the e-module with selected students, facilitating learning activities, observing interactions, and collecting pretest-posttest data along with student response questionnaires. The evaluation stage comprised formative analysis based on expert validation and pilot testing results for necessary revisions, followed by summative assessments such as N-Gain analysis, response satisfaction levels, and feasibility scores to determine the module's overall effectiveness [41].

Both qualitative and quantitative methods were used for data analysis. Qualitative data were obtained from interviews, observations, and reflection notes, then analyzed through coding, theme grouping, and interpretation of meaning. Comparative analysis of pretest and posttest data was conducted using appropriate statistical techniques to measure improvements after using the e-module. Student responses were analyzed descriptively, using mean scores and percentages to assess satisfaction levels. Feedback from students and teachers regarding the strengths and weaknesses of the e-module was analyzed thematically, offering essential insights for further refinement and optimization of the developed product [42, 43].

3.2. Data Analysis Techniques

The data analysis used in this development research is a descriptive analysis, which aims to present research findings systematically based on the data collected in order to determine the feasibility and quality of the developed e-module. The primary data in this study consists of qualitative input obtained from expert validators who reviewed both the material and media components of the e-module. This qualitative data is examined through a descriptive approach by interpreting expert comments, identifying strengths and weaknesses, and categorizing suggestions for improvement. The descriptive analysis enables the researchers to gain a clearer understanding of how well the e-module aligns with pedagogical, technological, and content standards. After gathering all comments, the data is reanalyzed, summarized, and utilized as essential reference material to revise and refine the e-module so that it better meets instructional requirements and learner needs [44]. In addition to qualitative feedback, numerical validation scores provided by experts are analyzed using

descriptive percentages to quantify the level of feasibility. This method helps transform subjective expert evaluation into measurable indicators of quality. The validity of the Technopreneurship-Based E-Module, assessed by both material and media experts, is calculated using descriptive percentage analysis through the following formula.

$$P = \frac{\sum n_i}{\sum n} \times 100\%$$

Remarks.

P : Percentage

100 : Constant number

$\sum n_i$: Number of Scores Obtained

$\sum n$: Maximum Number of Scores

3.3. Data analysis of E-Module validation results

The module review questionnaire by validators is analyzed qualitatively to provide an overview of the input given regarding content, material, presentation, language, and graphics. Validation questionnaires by validators are analyzed in a quantitative descriptive manner. The percentage of validation results by validators is obtained based on the calculation of scores according to the Likert scale as follows.

Table 1. Likert Scale Assessment Criteria Validation Questionnaire

Criterion	Grade/score
Excellent	4
Keep	3
Bad	2
Very Not Good	1

Table 1 presents the Likert Scale Assessment Criteria used in the validation questionnaire to evaluate the feasibility of the developed e-module. The scale consists of four response categories, each representing a different level of quality, ranging from Excellent with a score of 4, Keep with a score of 3, Bad with a score of 2, to Very Not Good with the lowest score of 1. This scoring system allows validators to quantitatively assess various aspects of the e-module, such as content accuracy, presentation quality, clarity, and usability, ensuring that each component is measured consistently. The assigned numerical values also enable the calculation of descriptive percentages, which are essential for determining the overall validity and feasibility of the e-module in a structured and measurable manner.

The questionnaire results are analyzed using the number of data collection scores divided by the massive score multiplied by hundreds.

$$\text{Percentage} = \frac{\text{Correct Answer}}{\text{Number of Items}} \times 100$$

From the analysis results, conclusions will be obtained about the feasibility of Technopreneurship-Based E-Modules using the Likert Scale with criteria that can be seen in the following table.

Table 2. Expert Validation Interpretation Criteria

Valuation	Interpretation Criteria
0% - 20%	Very Poor
21% - 40%	Poor
41% - 60%	Moderate
61% - 80%	Feasible
81% - 100%	Highly Feasible

Table 2 presents the interpretation criteria used to determine the feasibility level of the e-module based on expert validation percentages. Scores ranging from 0% to 20% indicate that the product is classified as very unworthy, while 21% to 40% reflects a not worth it category. A percentage of 41% to 60% places the product in the pretty decent category, showing moderate feasibility. Higher scores between 61% and 80% signify that the

e-module is proper and acceptable for use, whereas the highest range of 81% to 100% categorizes the product as very decent, indicating strong feasibility and high quality according to expert judgment. It can be concluded that the Technopreneurship-Based E-Module is considered feasible/very feasible if it gets a $\geq 61\%$. Student response questionnaires are analyzed in a quantitative descriptive manner. The percentage is obtained based on the calculation of the Likert Scale in the table below.

Table 3. Student Response Likert Scale Assessment Criteria

Criterion	Grade/score
Excellent	4
Keep	3
Bad	2
Very Not Good	1

Table 3 presents the Likert Scale Assessment Criteria used to measure student responses toward the developed e-module. The scale consists of four categories: Excellent with a score of 4, Keep with a score of 3, Bad with a score of 2, and Very Not Good with the lowest score of 1. These criteria enable researchers to convert students' qualitative perceptions into quantitative data, making it easier to evaluate satisfaction, usability, and overall acceptance of the e-module.

The questionnaire results are analyzed employing the number of scores from the data collection divided by the maximum score divided by one hundred.

$$\text{Percentage} = \frac{\text{Number of Correct Answer}}{\text{Number of Items}} \times 100$$

The analysis above shows conclusions about the feasibility of Technopreneurship-Based E-Modules using the Likert Scale with opinion criteria in the table below.

Table 4. Student Response Interpretation Criteria

Valuation	Interpretation Criteria
0% - 20%	Very Poor
21% - 40%	Poor
41% - 60%	Fair
61% - 80%	Good
81% - 100%	Excellent

Table 4 outlines the criteria used to interpret student response percentages toward the e-module. A score between 0% and 20% is categorized as very unkind, indicating extremely poor acceptance, while 21% to 40% is classified as bad. Scores in the 41% to 60% range are interpreted as good enough, showing moderate acceptance. Higher percentages between 61% and 80% fall under the good category, reflecting positive student responses. Lastly, scores from 81% to 100% are considered excellent, indicating very strong student approval of the e-module.

3.4. Test the Effectiveness of E-modules

This study uses the N-Gain test to provide an overview of improving student learning outcomes before and after using E-modules in learning. The gain normality test formula is as follows.

$$\text{Normalized Gain (g)} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Posttest Score}}$$

Information:

Post test Score: Final test score

Pretest Score: Initial test score

Maximum Score: The maximum (ideal) score of the initial test and the final test

g: Normalized Gain (N-gain) of both models

The following table presents the interpretation criteria of the traditional value of Gain (g).

Table 5. Interpretation of Standard Value of Gain (g)

Value of g	Criterion
$g \geq 0,7$	High (Very Effective)
$0,7 > g \geq 0,3$	Medium (Effective)
$g < 0,3$	Low (Ineffective)

Table 5 presents the interpretation of the standard value of Gain (g), which is used to determine the effectiveness of learning improvements based on pretest and posttest results. A gain score of $g \geq 0.7$ is categorized as High (Very Effective), indicating a strong improvement in student learning outcomes. Scores within the range of $0.7 > g \geq 0.3$ fall into the Medium (Effective) category, showing a moderate but meaningful level of learning improvement. Meanwhile, scores of $g < 0.3$ are classified as Low (Ineffective), suggesting that the learning intervention did not produce significant improvement. This interpretation helps researchers evaluate how effective the developed e-module is in enhancing student learning performance.

4. RESULTS AND DISCUSSION

4.1. Expert Validation

Before the field trial, the product development process of the Technopreneurship-Based E-Module had undergone several validation stages, namely the validation of material and media experts. The validation conducted by these experts aimed to obtain feedback input related to the e-module product developed so that it is suitable for use. The step taken in this validation is to submit the e-module product and instruments that experts will use to test the feasibility of the product. Instrument validation is necessary to determine the correctness of important product development aspects. The experts conduct a feasibility assessment to know the developed product's quality. The validation data that has been obtained is then corrected so that the product is feasible and ready to use.

4.2. Media Expert Validation

The assessment by media experts aims to determine the quality of Technopreneurship-Based E-Modules seen from the media side. Media experts rate according to the grid of media design. In the preparation of e-modules, compilers must master design skills so that the appearance of e-modules will arouse student motivation to read and learn them.

Media experts carried out the assessment. The following data from the assessment of E-Module is Based on Technopreneurship media experts.

Table 6. Media Expert Assessment Results Data

No	Indicator	Average Score	Category
1	Display Aspect	93%	Very Worth It
2	Aspects of Use	88%	Very Worth It
Average score		91%	Very Worth It

Source: Data Processed 2024

Based on the Table 6, it can be explained that the results of the assessment of Technopreneurship-Based E-Modules by media experts, namely (1) the average display aspect of the score of 93% is included in the "very feasible" category, (2) the usage aspect gets an average of 88% is included in the "very feasible" category. So it can be concluded that the development of Technopreneurship-Based E-Module products is very feasible to be used in field trials with revisions according to the advice given by media experts. The average score obtained from about 1 to 4 assessments is 91%, which means that the overall assessment of media experts exceeds the minimum score that has been determined.

Suggestions given by media experts include module titles that must be improved and added classes following the research to be carried out, in the aspect of utilization must be adjusted to the instrument.

Below the results of media experts' assessment of E-modules in each aspect can be seen in the following graph.

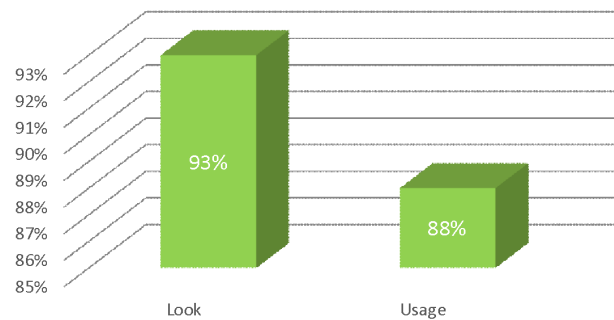


Figure 2. Evaluation by Media Experts

Figure 2 illustrates the results of media expert evaluations on two key aspects of the developed e-module, namely Look and Usage. The visual presentation shows that the Look aspect obtained a score of 93%, while the Usage aspect achieved 88%, both indicating strong positive assessments of the module's design quality and usability. These results align with the data presented in Table 6, where the overall evaluation from media experts places the e-module in the "Very Decent" category with an average score of 91%. This demonstrates that the e-module meets the required quality standards and is considered suitable for use, although minor revisions may further enhance its effectiveness.

4.3. Aspects of Material Expert Assessment

Material experts carry out material validation in the development of e-module products. Material validation needs to be done to test the quality of the material from the primary components, content, learning, assignments/exercises and evaluation. Data on the assessment results according to material experts can be found in the table below.

Table 7. Material Expert Assessment Results Data

No	Indicator	Average Score	Category
1	Introductory Aspect	94%	Very Worth It
2	Content Aspect	90%	Very Worth It
3	Learning Aspects	94%	Very Worth It
4	Summary Aspect	91%	Very Worth It
5	Task/Rehearsal Aspect	91%	Very Worth It
Average Score		92%	Very Worth It

Source: Data Processed 2024

Based on the Table 7, it can be explained that the results of the assessment of e Technopreneurship-Based E-Module by material experts, namely (1) the preliminary aspect gets an average score of 94% included in the "very feasible" category, (2) the content aspect gets an average score of 90% included in the "very feasible" category, (3) the learning aspect gets an average score of 94% is included in the "very feasible" category, (4) the summary aspect gets an average score of 91% included in the category "Very Decent", (5) The task/exercise aspect gets an average score of 91% is included in the "Very Decent" category. So it can be concluded that the development of Technopreneurship-Based E-Module products is very feasible to be used in field trials with revisions per material experts' advice. The average score derived from supervisory beds 1 to 4 is 92%, which means that the overall assessment of material experts exceeds the minimum score determined. Analysis of data obtained from material experts in Table 7 shows that the overall quality of the developed e-modules falls into the "Very Decent" category. This can be seen from the average percentage value of all aspects assessed by material experts, which is 92%.

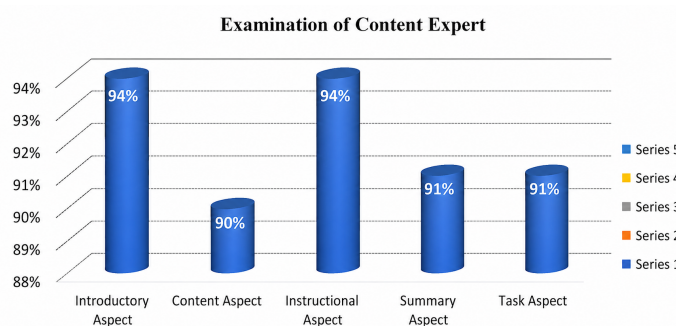


Figure 3. Assessment by subject matter experts

Figure 3 shows the results of the content expert evaluation across five key aspects of the developed e-module. The Introductory Aspect and Instructional Aspect both received the highest score of 94%, indicating that the module's introduction and instructional structure are considered very strong. The Content Aspect obtained 90%, reflecting a high level of relevance and clarity in the material presented. Meanwhile, both the Summary Aspect and Task Aspect received 91%, demonstrating that the module's summaries and assigned tasks are well-designed and supportive of student learning. Overall, the data in Figure 3 illustrates that the e-module meets high content quality standards across all evaluated components.

4.4. Product Trials

Product trials were carried out by students of SMK 2 Sekong Kabupaten East Lombok. This trial will be conducted in 2023. The trial was conducted to determine the effectiveness of using e-modules before and after learning by improving the learning outcomes of learners using user response scales (students) and learning outcomes (pretest-posttest).

4.5. Student response to product trials

The implementation of this trial was carried out on 20 students. Before using the e-module, students are given pretest questions first; after that, students use the e-module product, and then after that, students are given posttest questions. After completing the posttest questions, students will be given a response questionnaire. Here are the results of obtaining student responses.

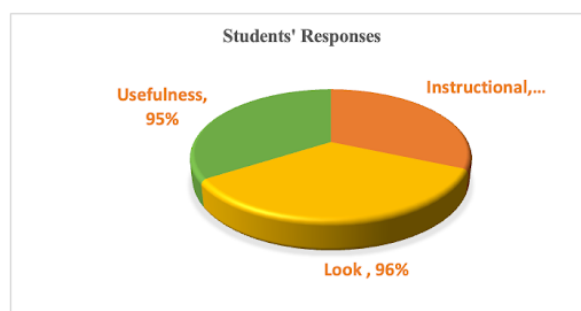


Figure 4. Results of the Student Response Questionnaire

From Figure 4, the overall student questionnaire assessment results received an average score of 84% in the "Very Decent" category. Judging from the overall aspect, the highest average must be the aspect of Benefits getting an average value of 95% with the category "very decent". Display aspect with an average of 96% in the "very decent" category. Learning aspects with an average of 88% in the "very feasible" category. The results of students' responses to the development of technopreneurship-based entrepreneurship E-Modules at SMK Negeri 2 Selong were implemented. Judging from the results of the distribution of questionnaires, many students strongly agree and are interested in using the Technopreneurship-based entrepreneurship E-Module in the learning process. The analysis results of student responses to the Technopreneurship-based entrepreneurship E-Module can be seen in the graph below.

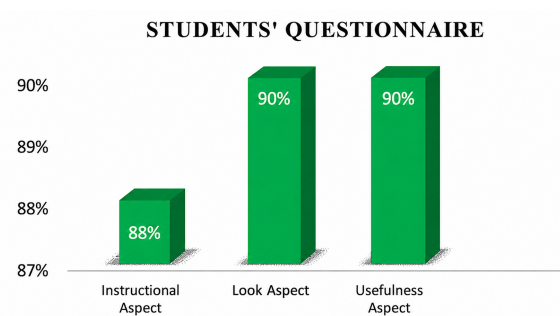


Figure 5. Student Validation Results

Figure 5 presents the results of the students' questionnaire evaluating three aspects of the developed e-module. The Instructional Aspect received a score of 88%, indicating that students found the instructional structure clear and supportive of their learning. Both the Look Aspect and Usefulness Aspect obtained scores of 90%, showing that students considered the visual design appealing and the module highly beneficial for understanding the learning material. Overall, the data in Figure 5 demonstrates strong positive student acceptance of the e-module in terms of design, usefulness, and instructional quality.

4.6. Student Learning Outcomes

Student learning outcomes were measured using pretest and posttest assessments. The pretest scores ranged from 27 to 80 with an average of 58.4, which was below the Minimum Completeness Criteria (MCC) of 75. After six learning sessions using the technopreneurship-based e-module, posttest scores increased to a range of 73–93 with an average of 86.4, indicating that students successfully met the MCC and showed significant improvement in their learning performance.

Data regarding pretest-posttest results can be seen in the following appendix. The following is a summary of the pretest-posttest result data.

Table 8. N-Gain Test

Description	Before	After	N-Gain
Minimum Value	27	73	44,2
Maximum Value	80	93	7,6
Average rating	58,4	86,4	24,1

Table 8 presents the results of the N-Gain test, which compares student learning outcomes before and after using the e-module. The minimum score increased from 27 to 73, resulting in an N-Gain of 44,2, while the maximum score rose from 80 to 93, with an N-Gain of 7,6. The average score also improved significantly from 58,4 to 86,4, producing an N-Gain of 24,1. These results indicate substantial improvement in student performance and demonstrate the effectiveness of the developed technopreneurship-based e-module in enhancing learning outcomes.

A comparison of the improvement in student learning outcomes can be seen in the following figure.

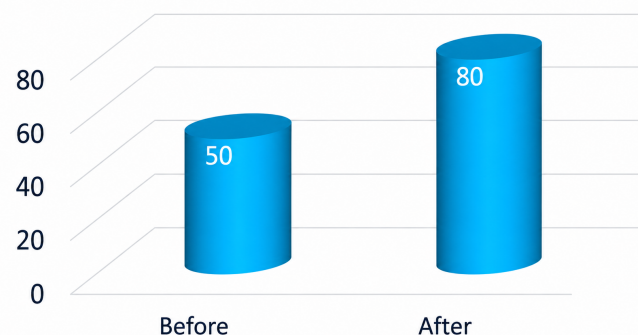


Figure 6. Improving Student Outcomes Before and After E-Modules

In the Figure 6, it is clear that there is a change in the increase in student learning outcomes in cognitive aspects with an average gain value of 24.1%, which is included in the high category. It can be concluded that students' learning outcomes have increased in cognitive aspects. Therefore, based on the test results obtained, it is explained that the Technopreneurship-based entrepreneurship E-Module can be declared effective in improving students' learning outcomes with moderate effectiveness.

4.7. Product Revisions

The Technopreneurship-based Entrepreneurship E-Module underwent a revision process based on expert validations from both material and media reviewers. The material expert validation indicated that no major corrections were required, although the expert recommended proceeding to the product development stage to enhance the overall quality of the module. Meanwhile, the media expert validation provided several suggestions for improvement, resulting in revisions related to visual and design aspects of the e-module. One key recommendation was to replace the cover, which was revised by adding class information to better reflect the context of the e-module development. Overall, these revisions contributed to refining the module to ensure it was more effective, visually appealing, and aligned with the intended instructional objectives.

5. MANAGERIAL IMPLICATIONS

The findings of this research provide several managerial implications that can be applied by educational institutions, teachers, curriculum developers, and policymakers to improve entrepreneurship learning in the digital era:

5.1. Enhancing Digital-Based Learning Innovation

The significant improvement in student learning outcomes after using the technopreneurship e-module indicates that managers and school leaders should prioritize the integration of digital instructional media to enhance learning engagement and effectiveness. Investing in digital platforms and training programs can help sustain the quality of technology-based learning.

5.2. Supporting Teacher Capacity Building

The development and successful implementation of the e-module show the importance of teachers' digital competencies. Education managers should provide regular professional development programs to strengthen teachers' skills in preparing, managing, and utilizing digital learning resources effectively.

5.3. Strengthening Curriculum Alignment with Industry Needs

The technopreneurship focus emphasizes the growing need for entrepreneurial and digital skills. School leaders and curriculum planners should integrate digital entrepreneurship competencies into the curriculum to better prepare students for real-world business environments and future employment opportunities.

5.4. Improving Learning Infrastructure and Accessibility

The reliance on digital learning materials requires adequate infrastructure support. Managers should ensure that schools are equipped with reliable internet access, devices, and digital learning environments to facilitate smooth implementation of technology-enhanced learning.

6. CONCLUSION

This research has examined the development of technopreneurship-based e-modules in entrepreneurial learning. The development method used is the ADDIE model, which involves analysis, design, development, implementation, and evaluation. The results showed that using technopreneurship based e-modules in entrepreneurial learning contributed significantly to students' understanding, entrepreneurial skills, and innovative and technology-conscious attitudes. This e-module uses the latest information and communication technology, such as multimedia, video, animation, and interactive, to enhance students' learning experience. The implementation of e-modules through learning experiments in entrepreneurship classes yielded positive results. Evaluations conducted through instruments such as questionnaires and tests show that e-modules effectively increase students' understanding of the concepts of entrepreneurship and technopreneurship. Thus, the development of technopreneurship-based e-modules on entrepreneurial learning can be used as a modern and relevant learning approach to technological developments. This e-module can be used as a reference for educators and

curriculum makers in enriching existing entrepreneurial learning methods. This research provides insights and recommendations for integrating technopreneurship into entrepreneurial learning so that students can acquire the knowledge, skills, and attitudes necessary to become innovative and technology-conscious entrepreneurs in today's digital age.

The development of technopreneurship-based e-modules has significant managerial implications for educational institutions and industry stakeholders. For school administrators and curriculum developers, the integration of technopreneurship learning materials supports institutional innovation and aligns entrepreneurial education with the demands of the digital economy. This research highlights the necessity for managers and education policymakers to invest in digital infrastructure, teacher training, and continuous content updates to maintain technological relevance.

For industry stakeholders, especially those involved in entrepreneurship incubation, this study provides insights into how schools can become partners in nurturing future technopreneurs equipped with digital competence and creativity. The use of technopreneurship e-modules can also serve as a bridge between academia and industry, facilitating collaboration in designing problem-based learning projects, mentoring programs, and digital business simulations. Therefore, this research encourages educational managers and business leaders to view technology-driven entrepreneurial learning not merely as an instructional innovation but as a strategic investment in human capital development to sustain competitiveness in the digital era.

7. DECLARATIONS

7.1. About Authors

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7.2. Author Contributions

Conceptualization: MF; Software: SR; Validation: DY and MM; Formal Analysis: HS and MF; Investigation: SR; Resources: DY; Data Curation: MM; Writing Original Draft Preparation: HS and MF; Writing Review and Editing: SR and DY; Visualization: RP; All authors, MF, SR, DY, MM & HS have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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