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Research Article

Development of a Scaffolding-Based E-Module Integrated with Educational Games on Market Equilibrium Material to Enhance the Problem-Solving Skills of Grade X Students at SMA Negeri 1 Kelapa, West Bangka

Artika Meilinda Widyaningsih Sinaga[1]*, Rosidah[2]

[1-2] Universitas Negeri Yogyakarta, Indonesia.
* Corresponding Author: artikasinaga15@gmail.com

Abstract: This study aims to develop, validate, and test the effectiveness of a scaffolding-based e-module integrated with educational games on the topic of market equilibrium to improve students' problem-solving skills in economics learning. The research utilized the ADDIE development model, which includes the stages of analysis, design, development, implementation, and evaluation. A total of 72 students from SMA Negeri 1 Kelapa participated in the study, divided into experimental and control groups. Data were collected through validation questionnaires, pre-tests, and post-tests. The results showed that the e-module obtained a very high level of feasibility, with average validation scores of 3.86 from material experts, 3.88 from media experts, 3.95 from teachers, and 3.49 from students, indicating that the product met the quality criteria for instructional media. Furthermore, effectiveness testing revealed that students in the experimental class achieved an N-Gain score of 0.56, categorized as moderate, which was significantly higher than the control class score of 0.30. These results suggest that the scaffolding-based e-module integrated with educational games is both feasible and effective in enhancing students' problem-solving skills and learning engagement in economics education.

Keywords: Educational Games; e-Module Development; Market Equilibrium; Problem-Solving Skills; Scaffolding-Based Learning.

1. Introduction

The digital era has brought significant transformations to the field of education, particularly in the ways of learning, teaching, and accessing information, all of which are now characterized by interconnectivity and rapid information flow (Chellapan et al., 2018). Global education that integrates technology encourages cross-cultural collaboration and broader knowledge acquisition (Calvo et al., 2020). Technological innovations hold great potential in expanding equitable access to education and providing personalized learning support according to students' needs (Tare et al., 2022). One of the essential skills students must possess in the digital age is problem-solving ability, which constitutes a key component of 21st-century competencies (Trilling & Fadel, 2009; UNESCO, 2023). However, the PISA 2022 results reveal that the majority of Indonesian students still perform at low levels in reading, mathematics, and science (OECD, 2023), indicating weaknesses in their problem-solving skills.

This finding is particularly concerning since the World Economic Forum (2022) identifies problem-solving as one of the most in-demand skills in the global workforce. In response, the Indonesian government, through the Merdeka Curriculum, emphasizes the importance of developing students' competencies and critical thinking skills to equip them for real-world challenges (Kemendikbud, 2024). One of the learning innovations that aligns with this vision is the use of e-modules. E-modules have been proven effective in enhancing

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comprehension and critical thinking because they are interactive, flexible, and capable of presenting animations and simulations to support learning (Hastiningrum & Haryanto, 2020; Sari & Yustika, 2023). However, at SMA Negeri 1 Kelapa, West Bangka, the utilization of e-modules remains suboptimal. Based on preliminary observations, 70.9% of students experience difficulties in understanding the topic of market equilibrium, particularly in calculating demand and supply functions and constructing related graphs. The average problem-solving score among students was only 50.42, below the school's competency standard (Primary Data, 2025).

To address this issue, it is essential to develop a scaffolding-based e-module that systematically guides students through complex concepts step by step (Chang & Yang, 2023). Moreover, the integration of educational games within the e-module is believed to enhance students' learning motivation and problem-solving skills (Fahlevi & Yuliani, 2021; Maulana et al., 2021). Based on these considerations, this study is entitled "Development of a Scaffolding-Based E-Module Integrated with Educational Games on Market Equilibrium Material to Enhance the Problem-Solving Skills of Grade X Students at SMA Negeri 1 Kelapa, West Bangka."

2. Preliminaries or Related Work or Literature Review

2.1 Constructivist Theory (Piaget and Vygotsky)

The constructivist theory emphasizes that students actively construct knowledge through personal experiences and social interactions. Piaget highlights the processes of assimilation and accommodation, while Vygotsky underscores the importance of the Zone of Proximal Development (ZPD) and gradual assistance. This theory forms the foundation for technology-based learning innovations such as interactive e-modules, which foster both independent and collaborative knowledge construction (Plass et al., 2015; Sun et al., 2023).

2.2 Learning Materials

Learning materials are systematically organized instructional resources designed to help students achieve predetermined competencies. They serve not merely as supporting tools but as essential components of the learning process, aligned with learning objectives, students' characteristics, and instructional strategies (Cahyadi, 2019; Tomlinson, 2014). Hence, learning materials play a crucial role in creating effective and meaningful learning experiences.

2.3 E-Module (Electronic Module)

An e-module is an electronic learning resource that integrates information technology with interactive learning content such as text, images, and videos to assist students in achieving the desired competencies (Sumarmi et al., 2021; Putro et al., 2024). With its systematic and engaging presentation, the e-module serves as a more effective medium for self-directed learning compared to conventional printed modules.

2.4 Scaffolding

Scaffolding refers to structured assistance provided by teachers to students who face learning difficulties, enabling them to gradually achieve understanding and learning autonomy (Samana, 2013; Gibbons, 2015; Swastika & Utami, 2025). Through scaffolding, teachers act as facilitators who guide students in developing cognitive abilities and solving problems independently.

2.5 Educational Games

Educational games are technology-based digital games that integrate key game elements such as goals, rules, interactivity, and feedback with instructional content to create enjoyable, engaging, and motivating learning experiences. Through gameplay, students can develop both cognitive and social skills, in line with Piaget's and Vygotsky's theories on the role of play in learning (Plass et al., 2015; Hou & Li, 2014; Rahardja et al., 2019; Mathew et al., 2019).

2.6 Market Equilibrium in Economics

Economics as a subject explores human efforts to meet their needs and remains highly relevant to everyday life (Kemdikbudristek, 2022). Economic learning emphasizes students' abilities to inquire, formulate problems, think analytically, and collaborate effectively in understanding concepts such as market equilibrium.

2.7 Problem-Solving Skills

Problem-solving skills refer to students' ability to utilize their knowledge, thinking abilities, and understanding to find solutions to various problems they encounter (Liando et al., 2025; Ansori & Herdiman, 2019). These skills require interactive learning processes that enable students to analyze situations, explore alternative solutions, and independently verify the validity of information.

3. Materials and Method

3.1 Development Model

This study employs a Research and Development (R&D) approach aimed at producing a scaffolding-based e-module integrated with educational games on the topic of market equilibrium to enhance the problem-solving skills of tenth-grade high school students. The development process follows the ADDIE model, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation.

3.2 Data Collection Techniques

Data collection techniques refer to the methods used by researchers to obtain the necessary information for the study (Sugiyono, 2021). The techniques applied in this research include: A. Observation, conducted to identify the conditions of economics learning and the characteristics of students. B. Interviews, carried out to gather insights from economics teachers regarding the needs for e-module development. C. Questionnaires, administered to obtain feedback from teachers, students, and experts on the developed e-module. D. Tests, used to measure students' problem-solving skills through pre-test and post-test instruments.

4. Results and Discussion

4.1 Product Development Results

The developed product is a scaffolding-based e-module integrated with educational games on the topic of Market Equilibrium for Grade X high school students, designed to enhance their problem-solving skills. The development process followed the ADDIE model, consisting of five stages: Analyze, Design, Development, Implementation, and Evaluation.

4.1.1 Analysis Stage (Analyze)

This stage comprised four main components:

a) Needs Analysis: Based on observations and interviews at SMA Negeri 1 Kelapa, it was found that students struggled to understand economic concepts and required engaging, accessible, and interactive learning materials.
b) Content Analysis: The content was aligned with the Merdeka Curriculum, focusing on the core concept of market equilibrium.
c) Technology Analysis: All students owned Android smartphones, and the school provided Wi-Fi access, making the use of a digital-based e-module feasible.
d) Curriculum Analysis: The e-module was designed in accordance with the Merdeka Curriculum, emphasizing critical reasoning, learning outcomes related to market equilibrium, and learning objectives based on the CP (Learning Outcomes) and ATP (Learning Objectives Flow).

4.1.2. Design Stage (Design)

This phase involved:

a) Material Preparation: The learning material was developed according to CP and TP, emphasizing the enhancement of problem-solving skills and validated by content experts.
b) E-Module Framework Design: The e-module was created using Canva, incorporating images, videos, and interactive quizzes to support educational game based learning.

1) Cover

The cover serves to attract students' attention so that they are interested in learning the material. This section presents an introductory video of an e-module based on integrated scaffolding educational games designed using Artificial Intelligence (AI) video. The cover is shown below:

Figure 1. Cover.

2) Table of Contents

The Table of Contents, also known as the menu, is created by providing links to each feature in the menu, so that when clicked, the subchapter material will lead to the material to be read. The following is the menu display.

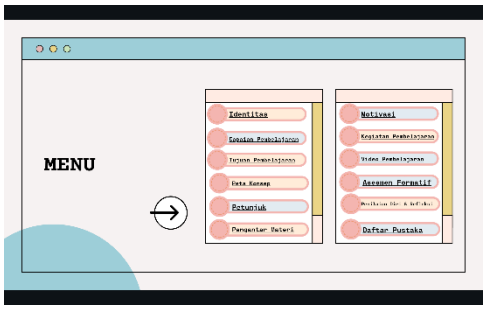

Figure 2. Table of Contents.

3) Introduction

The introduction consists of the E-Module Identity, Learning Outcomes (CP), Learning Objectives (TP), and instructions for using the e-module.

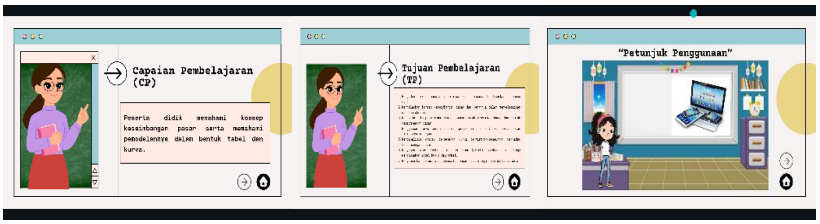

Figure 3. Introduction.

4) Concept Map

Concept maps display visual representations in the form of diagrams that serve to support learning and facilitate understanding. The following is an example of a concept map.

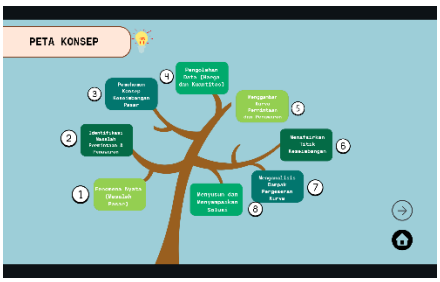

Figure 4. Concept Map.

5) Learning Material

The material in the e-module consists of an introduction to the material, concepts of demand, supply, and market equilibrium. Each subchapter has an automatic link that can be clicked to directly access the material. If you want to return to the previous material or continue to the next material, you can click the next and home logos as explained in the e-module user guide.

Figure 5. Learning Material.

6) Assessment

Assessment in the Merdeka Curriculum serves to measure understanding and evaluate the learning process, including diagnostic, formative, and summative assessments. In this e-module, diagnostic assessment is applied using the scaffolding technique, where questions are arranged in stages based on difficulty level (levels 1–3) and equipped with a clue feature to assist students.

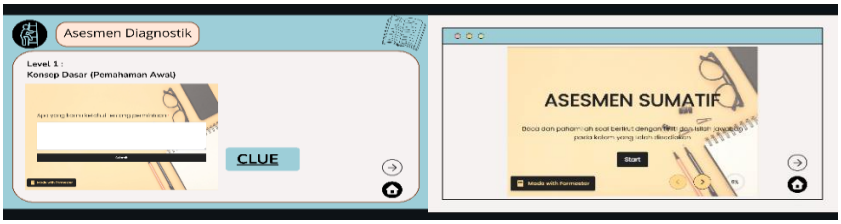

Figure 6. Assessment.

7) Educational Games

Educational games are designed to stimulate thinking, improve concentration, and make lessons more interesting for students. One part of educational games is quizzes designed using digital platforms. The quizzes in this e-module use a formester that can be accessed directly through Canva.

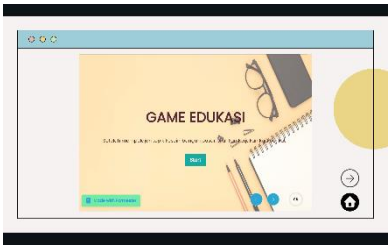

Figure 7. Educational Games.

8) 8. Learning Videos

The instructional videos in this e-module are intended to provide assistance if students still have difficulty understanding how to solve problems related to demand functions, elasticity, and market equilibrium. The instructional videos use YouTube videos created by researchers.

Figure 8. Learning Videos.

9) Summary

A summary is a systematic, clear, and easy-to-understand overview of learning material so that students can study independently.

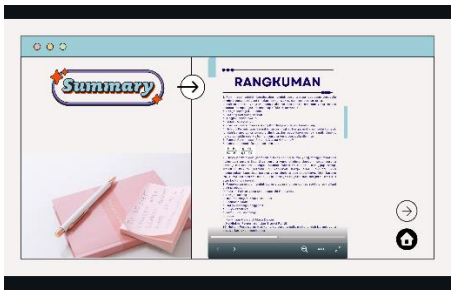

Figure 9. Summary

10) Reflection

Reflection aims to evaluate the learning process, identify successes and obstacles, and formulate improvements. In this e-module, reflection is carried out through a Google Form that contains impressions, input, criticism, and expectations for improving the quality of learning.

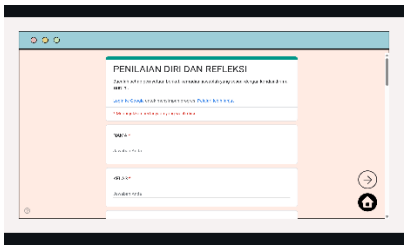

Figure 10. Reflection

11) 11. Closing Section

The conclusion of the e-module presents an AI-based video that conveys a message to students after they have completed the entire series of activities in the e-module on market equilibrium based on integrated scaffolding educational games.

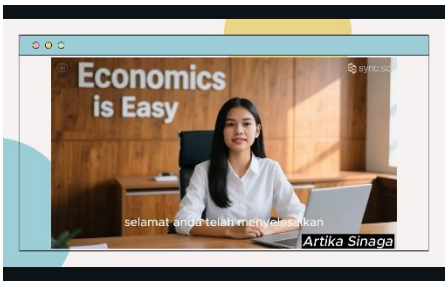

Figure 11. Closing Section

12) 12. References

The Bibliography contains various references used in the creation of the e-module, including references from books, articles, and other reading materials.

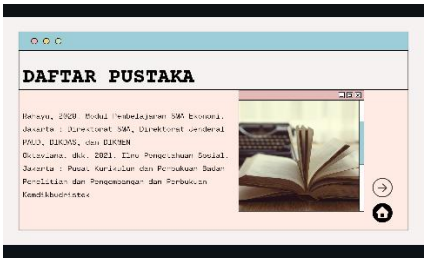

Figure 12. References

4.2. Product Effectiveness Test Results

The effectiveness of the scaffolding-based e-module integrated with educational games on market equilibrium material was analyzed using an independent t-test. Prior to testing, prerequisite analyses normality and homogeneity tests were conducted.

4.2.1. Normality Test The normality test determines whether the residual values are normally distributed. A regression model is considered normal if the significance value exceeds 0.05.

Table 1. Normality Test Results

Variabel Kelas	N	Sig (Shapiro-Wilk)	Keterangan
Pretest-Kontrol	36	0,443	Normal
Posttest-Kontrol	36	0,270	Normal
Pretest-Eksperimen	36	0,412	Normal
Posttest-Ekseperimen	36	0,115	Normal

Source: Processed from primary data, 2025

All groups yielded significance values greater than 0.05, indicating that the data were normally distributed.

4.2.2. Homogeneity Test

The homogeneity test aims to determine the variance (diversity) of data from two groups. The variance homogeneity test is performed using Levene's Test. A good regression model has a homogeneous variance value, which is a significance of more than 0.05. The results of the homogeneity test using SPSS are presented in the following table:

Table 2. Homogeneity Test Results.

Dasar Pengujian	*Levene Statistic*	*Sig*	Keterangan
Based on Mean	1,911	0,131	Homogen
Based on Median	1,534	0,208	Homogen
Based on Median Adjusted	1,534	0,209	Homogen
Base on Trimmed Mean	1,970	0,121	Homogen

Source: Processed from primary data, 2025

The results of the homogeneity of variance test show that the pretest and posttest scores for both the control and experimental classes have a significance value of 0.05, so it can be concluded that the data has a homogeneous variance.

4.2.3. Hypothesis Testing

After confirming that the pretest and posttest data for the experimental and control classes were normally distributed and homogeneous, a t-test was conducted to determine the results of the hypothesis regarding the effectiveness of the developed product.

1) Paired Sample T-test

Table 3. Results of the Paired Sample T-test in the Pre-test Post-test Effectiveness Test for the Control Class.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	41,67	36	14,092	2,349
	Posttest	58,47	36	15,667	2,611

Paired Sample Test									
Paired Difference									
					95 % Confidence Interval of the Differen				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Df	Sig. (2-tailed)
Pair 1	Pretest-Posttest	-16.806	9,423	1.570	-19,994	-13,617	-10,701	35	<, 001

Source: Compiled from primary data, 2025

The results of the paired sample t-test in the control class showed an increase in the average score from 41.67 to 58.47, with a strong correlation ($r = 0.805$; $p < 0.001$). The t-test yielded $t = -10.701$; $p < 0.001$, indicating a significant difference between the pretest and posttest. This means that the use of printed books still improves problem-solving skills, albeit to a limited extent, with a Cohen's d effect = -1.783 (large category).

2) Paired Sample T-test

Table 4. Results of the Paired Sample T-test in the Effectiveness Test of the Pre-test Post-test of the Experimental Class.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	36,67	36	14,590	2,432
	Posttest	70,42	36	18,837	3,139

Paired Sample Test									
Paired Difference									
					95 % Confidence Interval of the Differen				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Df	Sig. (2-tailed)
Pair 1	Pretest-Posttest	-33,750	11.61	1.935	-37,679	-29,821	-17,440	35	<, 001

Source: Compiled from primary data, 2025

The results of the paired sample t-test in the experimental class showed a significant increase from an average of 36.67 to 70.42, with a correlation of $r = 0.788$; $p < 0.001$. The value of $t = -17.440$; $p < 0.001$ confirms a significant difference between the pretest and posttest. An increase of 33 points and Cohen's d = -2.907 (very large category) indicate that the use of an e-module based on integrated educational game scaffolding is very effective in improving students' problem-solving skills. Thus, H_0 is rejected and H_a is accepted at a significance level of 0.05.

3) Uji Paired Sample T-test

Table 5. Results of the Paired Sample T-test in the Pre-test Post-test Effectiveness Test of the Experimental Class Experiment

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nilai	Equal variances	2,57	0,113	-2,925	70	0,005	-11,944	4,083	-20,089	-3,800
	Equal variances not assumed			-2,925	67,751	0,005	-11,944	4,083	-20,093	-3,796

Source: Compiled from primary data, 2025

The results of the independent sample t-test show that the posttest average for the control class was 58.47 and for the experimental class was 70.42, with t = -2.925; p = 0.005 < 0.05, which means that there is a significant difference in problem-solving skills between the two classes. The difference of 11.94 points and Cohen's d value = -0.689 (moderate category) indicate that the game-integrated scaffolding-based e-module is more effective than printed books. Thus, H_0 is rejected and H_a is accepted at a significance level of 0.05.

4) Gain-test

The extent of improvement in problem-solving skills can be seen using the normalized gain (n-gain) test results. The following N-Gain test results are presented in Table 43:

Table 6. Gain Values for the Control and Experimental Classes.

Hasil	Kelas Kontrol	Kelas Eksperimen
Rerata *Pretest*	41,67	36,67
Rerata *Posttest*	58,47	70,42
Skor Ideal	100	100
Skor Ideal – *Pretest*	58,33	63,66
Nilai *Gain*	0,30	0,56
Kriteria	Sedang	Sedang

Source: Compiled from primary data, 2025

The control class showed an increase in scores from 41.67 to 58.47 with a gain of 0.30 (moderate category), while the experimental class increased from 36.67 to 70.42 with a gain of 0.56 (moderate category). These results indicate that the game-based scaffolding e-module effectively improves the problem-solving skills of 10th grade students at SMA Negeri 1 Kelapa.

5. Comparison

The development of a scaffolding-based e-module integrated with educational games in this research presents significant innovations compared with previous state-of-the-art studies on digital learning and e-module design in economics education. Previous studies generally focused on developing static e-modules or digital textbooks that primarily emphasized the presentation of content and limited interactivity. For example, studies utilizing conventional e-modules (without scaffolding or gamification elements) showed improvement in conceptual understanding but often failed to foster higher-order thinking skills such as problem-solving and critical reasoning.

In contrast, the current study integrates scaffolding principles with educational game features, resulting in an e-module that not only delivers material interactively but also provides structured guidance for students to independently navigate problem-solving processes. This scaffolding approach supports learners progressively from initial understanding to mastery through hints, feedback, and tiered question levels. The integration of educational games further enhances motivation and engagement, aligning with recent pedagogical trends emphasizing game-based learning (GBL) and self-directed learning.

Quantitatively, the results of this study surpass those of previous implementations. The experimental class achieved a mean posttest score of 70.42 and a gain score of 0.56, compared with the control class which only reached 58.47 with a gain score of 0.30. The Cohen's d value of -2.907 (very large effect) indicates a stronger influence of this integrated model than that reported in earlier studies on traditional or partially gamified e-modules, which generally demonstrated moderate effectiveness (Cohen's d ≈ 0.5–0.8). These findings suggest that the proposed model provides a more powerful enhancement of problem-solving skills through its systematic combination of scaffolding and gamification elements. When compared to state-of-the-art frameworks such as problem-based learning (PBL) or flipped classroom models, this research also contributes a technological advancement by embedding scaffolding within a digital platform (Canva) and connecting it to interactive tools (Formester, AI-generated videos, and Google Forms).

This integration offers both pedagogical depth and technological accessibility, ensuring that the e-module can be implemented in various learning environments, including those with limited digital literacy. In summary, the developed e-module advances beyond previous digital learning innovations by effectively merging pedagogical scaffolding, game-based interactivity, and curriculum relevance (Merdeka Curriculum). Thus, this study contributes to the state-of-the-art in educational technology by providing an empirically validated model that not only enhances students' engagement but also significantly improves problem-solving competence in economics learning.

6. Conclusion

1) The study successfully developed an integrated game-based scaffolding e-module on market equilibrium using the ADDIE model systematically.
2) The validation results showed that the e-module had a very high feasibility level, with scores of 3.86 from subject matter experts, 3.88 from media experts, and 3.95 from economics teachers, while the student trial results scored 49, which is categorized as very good.
3) The e-module proved effective in improving students' problem-solving skills, as evidenced by t-test results showing significant differences before and after use, as well as between the experimental and control classes ($\alpha = 0.05$). In addition, the gain score of the experimental class (0.56, moderate category) was higher than that of the control class (0.30), indicating a more optimal improvement in learning outcomes.

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