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Research Article

Development of a Discovery Learning Model with a Meaningful Learning Approach to Improve Students' Critical Thinking Skills in Economics at SMAN 2 Tulang Bawang Udik

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Abstract: This study developed a Discovery Learning model with a Meaningful Learning approach to improve students' critical thinking skills in Economics at SMAN 2 Tulang Bawang Udik. The study used the ADDIE model and produced a conceptual model, lesson plans, student worksheets, and HOTS assessment instruments. Expert validation results showed that the products were feasible, practicality tests obtained a very practical category, and effectiveness tests with a Nonequivalent Control Group design showed that the critical thinking of students in the experimental class was higher than that of the control class. These results confirm that this learning model is feasible, practical, and effective, and can be a guide for teachers for active, contextual, and high-level thinking skills-oriented learning. Additionally, the integration of Discovery Learning and Meaningful Learning provides a structured and student-centered learning process that encourages learners to construct knowledge independently while connecting concepts to real-life contexts. The resulting learning tools also support teachers in implementing systematic instruction that fosters student engagement and deeper understanding. Overall, the developed model contributes to improving instructional quality in Economics education and offers an innovative alternative for enhancing students' cognitive abilities, particularly in critical thinking.

Keywords: ADDIE Model; Critical Thinking; Discovery Learning; Economics Education; Meaningful Learning.

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1. Introduction

In the era of globalization and increasingly dynamic information flows, critical thinking skills have become an essential competency that students must possess to confront the complexities of 21st-century challenges. Individuals are no longer sufficient merely memorizing information; they are required to analyze, evaluate, interpret, and make decisions based on diverse data and situations. The Indonesian government has emphasized the importance of critical thinking through the National Education Standards in Government Regulation No. 57 of 2021 and the Process Standards in Ministerial Regulation No. 16 of 2022, which encourage active, creative, collaborative, and student-centered learning.

The subject of economics holds a strategic role in developing critical thinking skills, as it examines social phenomena, public policy, and decision-making processes in everyday life. Students are expected to analyze data, evaluate policy arguments, and reason through economic solutions rationally (Surasa et al., 2017; Poniam, 2025). However, instructional practices in secondary schools continue to face challenges. Observations at SMAN 2 Tulang Bawang Udik indicate that economics learning is still dominated by teacher-centered lectures, limited exploration, and insufficient facilitation of higher-order thinking activities such as analysis, synthesis, and evaluation (Primadoniati, 2020; Ginanto et al., 2024). Consequently,

students' critical thinking skills have not developed optimally. This is reflected in preliminary findings from class XII.1, in which 56.67% of students scored below 75, indicating low critical thinking ability based on higher-level Bloom's taxonomy indicators. Interviews with teachers further revealed that limited time, administrative burdens, and a lack of innovation in instructional models are major constraints.

To address these issues, Discovery Learning is viewed as an appropriate learning model because it emphasizes exploratory activities, problem-solving, and independent discovery processes (Irnajuliana et al., 2025; Fariidah et al., 2025). This model is considered capable of stimulating critical thinking through systematic stages such as stimulation, problem identification, data collection and processing, verification, and generalization (Dari & Ahmad, 2020). However, to ensure that the discovery process becomes more meaningful, integration with the Meaningful Learning approach is essential. Ausubel's theory highlights that learning becomes meaningful when new information is substantially connected to students' prior knowledge and experiences (Huda & Djono, 2025; Dewi et al., 2025). This integration allows students' discoveries to be more guided and relevant to real-life contexts.

Beyond the urgency created by global demands, the transformation of learning paradigms in Indonesian education further underscores the need for instructional models that foster deep intellectual engagement. The rapid integration of digital technology in classrooms, combined with shifts in socio-economic structures, requires students to navigate vast information networks and evaluate complex economic phenomena. In this context, critical thinking is not merely an academic requirement but a foundational life skill that empowers students to construct rational judgments, challenge assumptions, and develop well-reasoned solutions. Educational institutions therefore face increasing pressure to design learning environments that nurture reflective inquiry and analytical rigor, particularly in subjects such as economics that inherently involve multidimensional and interrelated concepts.

Despite these broader expectations, empirical conditions in schools reveal persistent gaps between policy aspirations and classroom realities. Many teachers continue to rely on conventional lecture-based methods because they are perceived as efficient for content coverage, yet such approaches tend to reinforce passive learning habits. Students often become recipients of information rather than active constructors of knowledge. In economics learning, where abstract concepts such as scarcity, opportunity cost, market dynamics, and policy impacts require contextual interpretation, this pedagogical mismatch becomes especially problematic. Students may understand definitions but struggle to apply them to real-world economic issues, indicating the absence of deeper cognitive processing that is essential for critical thinking development.

In light of these challenges, innovation in learning design becomes not only relevant but imperative. Discovery Learning offers a pathway to transform instructional practices by positioning students as investigators who generate understanding through inquiry-driven processes. However, research has shown that discovery-based methods alone may lead to fragmented comprehension if learners lack sufficient cognitive scaffolding. This is where the Meaningful Learning approach complements the model. By emphasizing the integration of new knowledge with students' prior cognitive structures, Meaningful Learning ensures that the discovery process is not random but conceptually anchored. This synergy allows learning to progress from superficial recall to profound conceptual insight, particularly in economics where prior experiences in daily financial decisions, consumption habits, and social interactions can serve as powerful cognitive entry points.

Based on these needs, this study focuses on developing a Discovery Learning model integrated with the Meaningful Learning approach to enhance students' critical thinking skills in economics at SMAN 2 Tulang Bawang Udik. This research is expected to produce an innovative, applicable, and empirically effective learning model that supports high-quality economics instruction and equips students with the critical thinking skills urgently required in the 21st century.

2. Preliminaries or Related Work or Literature Review

Grand Theory

This study employs Jean Piaget's constructivist theory, which emphasizes learners as active constructors of knowledge through assimilation and accommodation. This approach has been proven to enhance critical thinking, as students independently evaluate, analyze, and draw conclusions (Hidayah, 2021). Therefore, Discovery Learning combined with Meaningful

Learning is relevant because it encourages exploration, reflection, and the meaningful application of concepts.

Learning Models

A learning model is a systematic framework for designing and managing the learning process to ensure it is effective, efficient, and motivating for students (Magdalena et al., 2021; Khoerunnisa & Aqwal, 2020). Several popular models that support meaningful and student-centered learning include:

Cooperative Learning

Emphasizes collaboration in small, heterogeneous groups to enhance content understanding, social skills, and critical thinking (Alwi et al., 2023; Erlia et al., 2024; Utami et al., 2021).

Problem-Based Learning (PBL)

Uses real-world problems as learning contexts to develop critical thinking and independent learning skills (Purba & Sinaga, 2019; Rahman et al., 2016).

Project-Based Learning (PJBL)

Engages students in real projects to apply knowledge and skills, enhancing motivation and practical competence (Safaruddin et al., 2020).

Discovery Learning

Helps students actively discover concepts, improving learning outcomes, scientific literacy, and student engagement (Alfieri et al., 2011; Dahlan, 2017; Suryawan et al., 2021).

Discovery Learning Model

Discovery Learning is a learning model that emphasizes active student involvement in independently discovering concepts, thereby enhancing comprehension, motivation, and critical thinking skills (Fajri, 2019; Putri et al., 2017). This model focuses on exploration, interaction with the environment, and cognitive processes, with the teacher serving as a facilitator (Nurrohmi et al., 2017; Setyawan & Kristanti, 2021). Its main stages include stimulation, problem identification, data collection, analysis, verification, and generalization (Prasetyo & Kristin, 2020). Its strengths lie in promoting independent learning and 21st-century skills, although it requires more time and intensive guidance (Wedekaningsih et al., 2019; Puspitasari & Nurhayati, 2019).

Meaningful Learning

Meaningful Learning is an instructional approach that emphasizes deep conceptual understanding by connecting new information to students' existing knowledge (Ausubel in Diputera et al., 2024). This approach encourages active engagement, reflection, collaboration, and cognitive processing to build long-lasting understanding that is relevant to students' real-life experiences (Ekayanti & Astawa, 2022).

Its key characteristics include the connection between new information and prior knowledge, contextual relevance, goal orientation, and collaborative learning (Nurhasanah & Pujiati, 2025). Its implementation includes activating prior knowledge, using advance organizers, promoting active engagement, fostering social interaction, encouraging reflection, applying formative assessments, and facilitating the application of concepts in real-life contexts (Herlambang & Ruslan, 2025).

Framework

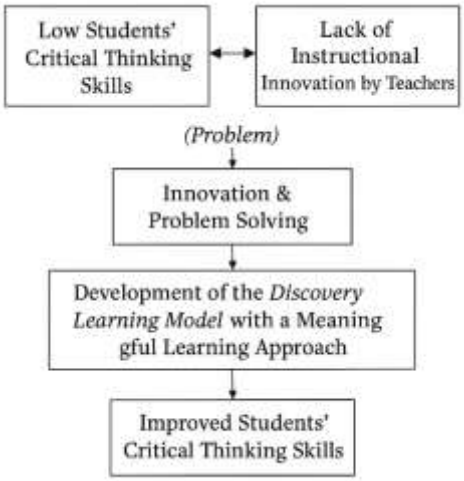


Figure 1. Conceptual Framework

3. Materials and Method

Development Model

This study employs the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) as an instructional development framework (Sugiyono, 2016). The ADDIE model is iterative and flexible, allowing continuous revisions based on feedback to refine the product. The products developed include the Discovery Learning model, discovery-based teaching materials, and critical-thinking evaluation instruments, all of which are tested for effectiveness and practicality.

Development Procedures

This study utilizes the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) as an iterative and flexible instructional development framework (Branch, 2019; Sugiyono, 2016).

Analyze

Needs analysis is conducted regarding learning requirements, student characteristics, and teacher challenges to identify the necessity of developing a Discovery Learning model based on Meaningful Learning capable of enhancing critical thinking skills.

Design

The model and its supporting components are designed, including lesson plans, worksheets, contextual teaching materials, evaluation instruments, and scenarios for product trials and validation.

Develop

An initial prototype is constructed, validated by experts and teachers, and subsequently revised to produce a feasible, valid model ready for testing.

Implement

Field testing is conducted in Grade X at SMAN 2 Tulang Bawang Udik to assess the model's implementation and impact on critical thinking skills through pretest–posttest, observations, and questionnaires.

Evaluate

Formative evaluation is carried out throughout development to ensure continuous improvement, while summative evaluation assesses the model's effectiveness in improving students' critical thinking skills.

Data Collection Techniques and Instruments

Research data are collected to evaluate the effectiveness of the Discovery Learning model based on Meaningful Learning in improving students' critical thinking skills. The instruments used include:

Expert Validation Sheets

Used by learning and subject-matter experts to assess content feasibility, alignment with the curriculum, and model effectiveness.

Interviews

Gather information on the curriculum, methods, learning media, and the challenges faced by teachers and students.

Observation

Evaluates classroom implementation of the model using a "Yes/No" checklist for each instructional indicator.

Teacher Response Questionnaire

Measures teachers' perceptions of the model's practicality, flexibility, and relevance to real-world contexts using a 4-point Likert scale.

Student Response Questionnaire

Collects students' perceptions of the ease and practicality of learning using the developed model.

Critical Thinking Assessment

Essay questions based on critical thinking indicators (analysis, evaluation, and creation) aligned with Bloom's Taxonomy to measure improvements in critical thinking skills in economics.

Data Analysis Techniques

The research data consist of qualitative data (interviews, observations, needs analysis questionnaires) and quantitative data (expert validation scores, teacher and student practicality tests, pretest–posttest critical thinking scores) (Sugiyono, 2017).

Feasibility Test of the Model

Expert validation scores are analyzed using a 1–4 Likert scale to assess content feasibility, student engagement, material relevance, and model effectiveness.

Practicality Test

Teacher and student questionnaire scores are converted into percentages to determine the product's practicality category.

Effectiveness Test

A quasi-experimental design with pretest–posttest is used for the experimental and control classes. Improvements in critical thinking skills are analyzed using N-Gain and tested for significance through a Paired Sample t-test (experimental class) and an Independent Sample t-test (experimental vs. control class) with $\alpha = 0.05$.

4. Results and Discussion

Product Development Results

This section describes the process of developing the Discovery Learning Model with a Meaningful Learning Approach to improve students' critical thinking skills in the economics subject, specifically on the topic of cash and non-cash payment instruments for Grade X students of SMAN 2 Tulang Bawang Udik. The development process followed the ADDIE research and development model. The following is a description of the product development process.

Analysis

The analysis stage in developing the Discovery Learning model based on Meaningful Learning was conducted to understand the learning context of the economics subject in Grade X at SMAN 2 Tulang Bawang Udik. The results of the analysis include:

1) Curriculum and Economics Subject

   A review of the Merdeka Curriculum (Economics CP Phase E, BSKAP No. 046/2025) shows that economics learning aims to develop students who are capable of understanding, analyzing, and making economic decisions rationally. Observations show that learning practices are still dominated by lectures and memorization drills, which are less aligned with higher-order thinking skills (HOTS).

2) Student Characteristics

   Most students tend to be passive and have low critical thinking skills, as shown by their difficulties in analyzing, evaluating, and concluding contextual problems. The Meaningful Learning approach is integrated to make the material more relevant to students' experiences and encourage critical thinking.

3) Learning Problems

   Identified problems include: teacher-centered learning, low student engagement, learning media limited to textbooks, and lack of linkage between theory and social realities.

4) Learning Objectives

An analysis of objectives based on the Learning Outcomes (CP) indicates that students are expected to be able to analyze types, advantages, disadvantages, and impacts of the development of cash and non-cash payment instruments.

Table 1. Learning Outcomes (CP) and Learning Objective Flow for Economics Subject, Phase E.

Learning Outcomes – IPS (Economics) Phase E	Learning Objective Flow
Examining the nature of economics as a science studying human efforts to meet life needs; distinguishing bank and non-bank financial products as the basis for using products and services, financial risks, and preparing personal financial reports	• Understanding scarcity as the core of economic problems. • Understanding priority scales as a basis for determining needs to be fulfilled. • Understanding the relationship between scarcity and opportunity cost. • Understanding the concept of market equilibrium and its modeling in tables and curves. • Understanding the concept of payment systems and the concept of money as a means of payment. • Understanding various forms of cash and non-cash payment instruments used in Indonesia and their application. • Understanding the concept of banks and non-bank financial industries and their various products.

Source: Research Data Processing, 2025

5) Resource Analysis

SMAN 2 Tulang Bawang Udik has adequate facilities to support technology-based learning, including electricity, internet access, and smartphone use for learning activities. Teachers also possess basic knowledge of various learning models. These conditions were important considerations in designing the lesson plans (RPP) and student worksheets (LKPD) for the Discovery Learning model based on Meaningful Learning.

Design

After all foundational information for development was obtained during the analysis stage, the next step was the design stage. At this stage, various planning and product design activities were carried out as illustrated in the following process design diagram.

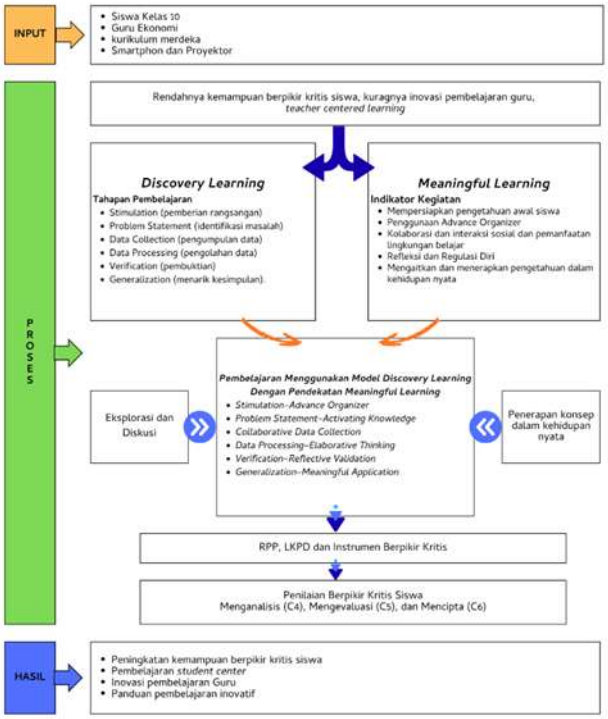


Figure 2. Instructional Design of the Learning Model.

1) Stages of Designing the Learning Model

The development of this learning model integrates Discovery Learning with Meaningful Learning to enhance students' critical thinking skills. The design stages include:

a) Stimulation: Presenting contextual phenomena and trigger questions.
b) Problem Statement: Guiding students in formulating problems from the stimulus.
c) Data Collection: Students collaboratively collect data from various sources.
d) Data Processing: Categorizing, analyzing, and interpreting data.
e) Verification: Students present findings and receive feedback.
f) Generalization: Drawing conclusions and linking concepts to real-life experiences.

2) Implementation of Meaningful Learning Concepts:

a) Activating students' prior knowledge.
b) Using advance organizers to link new knowledge with existing knowledge.
c) Encouraging collaboration, social interaction, and environmental exploration.
d) Developing students' reflection and self-regulation
e) Connecting learning to real-life contexts.

3) Integration of Discovery Learning and Meaningful Learning

Each stage of Discovery Learning is aligned with Meaningful Learning components, such as linking stimulation with advance organizers, data collection with social collaboration, and generalization with real-life application.

Development Stage

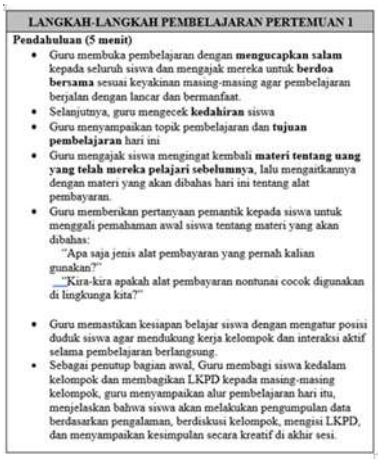
The development stage focused on preparing instructional materials to be used during learning. The products developed include:

1) Lesson Plan (RPP)
2) Student Worksheet (LKPD)
3) Assessment Instruments

Product Development Results

Figure 3. LKPD Cover Design.

Figure 4. Font and Foreign Term Writing in LKPD.



LANGKAH-LANGKAH PEMBELAJARAN PERTEMUAN 1

Pendahuluan (5 menit)

- Guru membuka pembelajaran dengan **mengucapkan salam** kepada seluruh siswa dan mengajak mereka untuk **berdoa bersama** sesuai keyakinan masing-masing agar pembelajaran berjalan dengan lancar dan bermanfaat.
- Selanjutnya, guru mengecek **kedahiran** siswa
- Guru menyampaikan topik pembelajaran dan **tujuan pembelajaran** hari ini
- Guru mengajak siswa mengingat kembali **materi tentang uang yang telah mereka pelajari sebelumnya**, lalu mengaitkannya dengan materi yang akan dibahas hari ini tentang alat pembayaran.
- Guru memberikan pertanyaan pemantik kepada siswa untuk menggali pemahaman awal siswa tentang materi yang akan dibahas:
  "Apa saja jenis alat pembayaran yang pernah kalian gunakan?"
  "Kira-kira apakah alat pembayaran nontunai cocok digunakan di lingkunga kita?"
- Guru memastikan kesiapan belajar siswa dengan mengatur posisi duduk siswa agar mendukung kerja kelompok dan interaksi aktif selama pembelajaran berlangsung.
- Sebagai penutup bagian awal, Guru membagi siswa kedalam kelompok dan membagikan LKPD kepada masing-masing kelompok, guru menyampaikan alur pembelajaran hari itu, menjelaskan bahwa siswa akan melakukan pengumpulan data berdasarkan pengalaman, berdiskusi kelompok, mengisi LKPD, dan menyampaikan kesimpulan secara kreatif di akhir sesi.

Figure 5. Preliminary Activities in the Lesson Plan (RPP).

Figure 6. QR Code in LKPD.

Implementation Stage

The implementation stage was conducted through field trials after expert validation declared the product feasible. The trials used a Nonequivalent Control Group Design consisting of an experimental class and a control class, including:

Pretest to measure initial critical thinking ability.
Discovery Learning with Meaningful Learning in the experimental class.
Conventional instruction in the control class.
Posttest to evaluate improvement in critical thinking.
Observation of instructional implementation by the economics teacher.

The trial was conducted according to the school schedule, using standard classroom facilities such as projectors, whiteboards, and the developed learning materials (RPP, LKPD, teaching materials, evaluation instruments).

Table 2. Characteristics of Field Trial Subjects.

Variable	Experimental Class	Control Class
Number of Students	30	30
Gender (M/F)	14 Male, 16 Female	15 Male, 15 Female
Learning Model	Discovery Learning + Meaningful Learning	Conventional Learning
Main Material	Cash and Non-cash Payment Instruments	Cash and Non-cash Payment Instruments
Time Allocation	3 × 45 minutes (3 meetings)	3 × 45 minutes (3 meetings)

Source: Research Data Processing, 2025

Observation Results of Instructional Implementation – Experimental Class

Observations showed that the learning syntax could be implemented well. In the first meeting, students showed enthusiasm toward the e-wallet case stimulus, although some still struggled to formulate problems independently. In the second and third meetings, skills in collecting and processing data improved, although teacher guidance was still needed.

$$Percentage\ of\ Implementation = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100$$

With the following criteria for interpreting the percentage of implementation:

Table 3. Interpretation Criteria for Learning Implementation Percentage.

Percentage (%)	Category
81–100	Very Good
61–80	Good
41–60	Fair
21–40	Poor
0–20	Very Poor

Source: Sugiyono, Educational Research Methods, 2019

The results of the learning implementation assessment by the observer (economics teacher) in the experimental class are presented in the following table:

Table 4. Observation Results–Experimental Class.

Learning Activities	Score Obtained	Implementation (%)	Category
Meeting 1	20	100%	Very Good
Meeting 2	20	100%	Very Good
Meeting 3	20	100%	Very Good

Source: Research Data Processing, 2025

Based on observations, the average percentage of implementation of the experimental class was 100% (Very Good), indicating that teachers and students carried out all stages of Discovery Learning with a Meaningful Learning approach as planned.

Control Class Observation Results

In the control class, observations showed that learning was carried out well, with students following the teacher's explanations and activities according to the LKPD guidelines.

Table 5. Observation Results of Learning Implementation in the Control Class

Learning Activities	Score	Implementation (%)	Category
Meeting 1	20	100%	Very Good
Meeting 2	20	100%	Very Good
Meeting 3	20	100%	Very Good

Source: Research Data Processing, 2025

The results of observations in the control class showed an average implementation rate of 100% (Very Good), indicating that all stages of learning were carried out according to plan.

Pretest and Posttest Results

The pretest results showed that the average initial critical thinking ability of the experimental class was 45.33 and that of the control class was 48.17, with no significant difference. After learning, the posttest showed an increase in both groups, with the experimental class experiencing a higher increase than the control class.

Table 6. Comparison of Pretest and Posttest Results

Group	Pretest Mean	Posttest Mean	Improvement
Experimental	45.33	79.00	33.67
Control	48.17	75.33	27.16

Source: Research Data Processing, 2025

Evaluation

The evaluation stage aimed to assess the validity, practicality, and effectiveness of the Discovery Learning model based on Meaningful Learning. The evaluation ensures that the product is suitable for broader use in improving students' critical thinking skills in economics.

Product Feasibility

Feasibility was determined through expert validation of content, sequence, language, and appearance.

Table 7. Product and Instrument Feasibility Test Results.

No	Aspect Assessed	Number of Indicators	Average Score	Percentage (%)	Category
1	Discovery Learning Model with Meaningful Learning Approach	11	3.00	93.25	Feasible
2	HOTS Instrument for Cash and Non-cash Payment Materials	12	12	100	Very Feasible

Source: Research Data Processing, 2025

The results of validation by experts show that the learning products are "suitable" with recommendations ready for testing, while the HOTS instruments for assessing students' critical thinking are "highly suitable" and ready for use in field trials.

Product Practicality

The practicality survey results show that the learning product is considered practical based on the responses of 1 teacher and 10 students after limited testing.

Table 8. Practicality Analysis Results.

No	Respondent	Average Score	Percentage	Category
1	Teacher	3.7	92.5%	Very Practical
2	Students	3.6	89.5%	Very Practical

Source: Research Data Processing, 2025

The average practicality score of 3.6 (90%) falls into the very practical category, indicating that the product is easy to understand and use in real learning conditions.

Product Effectiveness

Measured by comparing pretest and posttest scores in the experimental and control classes using N-Gain and t-tests.

Table 9. Results of the N-Gain Test for Critical Thinking Skills Assessment.

Class	Pretest Mean	Posttest Mean	N-Gain Score	Category
Experimental	45.33	79.00	0.61	Medium
Control	48.17	75.33	0.52	Medium

Source: Research Data Processing, 2025

The calculation results show that the N-Gain value for the experimental class is 0.61 and for the control class is 0.52, both of which are in the moderate category, with the experimental class showing a higher increase. These values are then interpreted into percentages to assess the effectiveness of learning.

Table 10. Interpretation of N-Gain Effectiveness Results in Percentage Form.

Class	N-Gain Score	N-Gain (%)	Effectiveness Category
Experimental	0.61	61.19%	Effective
Control	0.52	52.01%	Less Effective

Source: Research Data Processing, 2025

The interpretation of the N-Gain percentage shows that the experimental class scored 61.19% (quite effective), while the control class scored 52.01% (less effective). This indicates that the Discovery Learning model with a Meaningful Learning approach is more effective in improving students' critical thinking skills than conventional learning.

Prerequisite Tests

1) Normality test

Data were analyzed using Kolmogorov–Smirnov and Shapiro–Wilk tests through SPSS 29.0 with a significance level > 0.05. The test results showed that the data in each group were normally distributed. A summary of the results is presented in the following table.

Table 11. Normality Test Results.

Tests of Normality

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Value	PreKon	,127	30	,200*	,948	30	,152
	PosKon	,153	30	,072	,937	30	,073
	PreEks	,132	30	,192	,954	30	,215
	PosEks	,159	30	,051	,937	30	,076

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Source: Research Data Processing, 2025

The Shapiro–Wilk test results indicate that the pretest and posttest data in both the control and experimental classes are normally distributed (significance > 0.05). This indicates that the students' critical thinking skills before and after the treatment are evenly distributed and relatively homogeneous in each class, making them suitable for use in analyzing the effectiveness of the learning model.

2) Homogeneity Test

This test is conducted to examine whether several samples are homogeneous or not. The homogeneity test is intended to examine the similarity of variance between the pretest and posttest. The results of the homogeneity test are presented in the following table

Table 12. Homogeneity test results.

		Levene Statistic	df1	df2	Sig.
Value	Based on Mean	,860	3	116	,464
	Based on Median	,771	3	116	,512
	Based on Median and with adjusted df	,771	3	113,019	,512
	Based on trimmed mean	,898	3	116	,444

Source: Research Data Processing, 2025

The Levene test results show that the research data has homogeneous variance (Sig. > 0.05 on all calculation bases), meaning that the distribution of critical thinking skills among students in the experimental class and control class is relatively equal.

3) Independent Sample t-Test

Based on the prerequisites of normality and homogeneity being met, hypothesis testing was performed using the Independent Sample t-Test to compare the average posttest scores between the experimental class and the control class. The test results are presented in the following table.

Table 13. T-test Results.

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p			Lower	Upper
Nilai	Equal variances assumed	,012	,912	-2,094	58	,020	,041	-3,667	1,751	-7,171	-,162
	Equal variances not assumed			-2,094	57,994	,020	,041	-3,667	1,751	-7,171	-,162

Source: Research Data Processing, 2025

The results of the Independent Sample t-Test show a Sig. Levene's Test value of 0.912 (>0.05), indicating that the variances of the two groups are homogeneous. The t-value is -2.094 with a Sig. (2-tailed) of 0.041 (<0.05), indicating a significant difference in critical thinking skills between the experimental and control classes. The experimental class has a higher average of 3.67 points, showing that the Discovery Learning model with a Meaningful Learning approach is effective in improving students' critical thinking skills compared to conventional learning.

5. Conclusion

Based on the findings of the study, several conclusions can be drawn. The Discovery Learning model integrated with the Meaningful Learning approach was developed through the ADDIE framework, successfully combining the stages of Discovery Learning with the principles of Meaningful Learning, resulting in a product ready for classroom implementation. Expert validation rated the product as "Feasible," while limited trials indicated that it was "Highly Practical" and easily applied by both teachers and students. Field implementation further demonstrated that students in the experimental class achieved higher gains in critical thinking skills compared to the control group, supported by significant t-test results and an N-Gain score categorized as moderately effective. These outcomes confirm the model's effectiveness in improving students' critical thinking abilities.

Schools are encouraged to adopt this model to enhance students' critical thinking skills by providing adequate ICT facilities, stable internet connectivity, and a supportive learning environment while fostering teacher innovation. Teachers may employ this model as a student-centered active learning strategy by utilizing the provided lesson plans, worksheets, and critical thinking assessment tools, adapting the instructional stages to student

characteristics and classroom conditions. Future researchers are advised to expand the application of this model across different subjects and educational levels, integrate digital technologies, and conduct long-term studies to evaluate the model's effectiveness more comprehensively.

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