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Design and development of innovation towards contemporary educational innovation

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Abstract

This academic article aims to present the principles of systematic design and development of educational innovations through research methodology, alongside protocols for effectiveness evaluation. The design and development of contemporary educational innovation require integration between principles of innovation and technology implementation, diverse new teaching methodologies, analysis of modern learners' needs, and feasibility studies as foundational data for systematic innovation design using the analysis, design, development, implementation, and evaluation (ADDIE) model. This universal flexible model facilitates efficient learning activities with clearly defined stages: analysis, design, development, implementation, and evaluation. The process involves experimental implementation, data collection, systematic evaluation, and quality improvement through research and development methodology to create practical educational innovations. The development methodology, quality verification, and innovation evaluation procedures include: 1) internal validity verification content validity and innovation characteristics assessed by experts across four aspects: innovation specifics, design standards, techniques, and aesthetics; 2) external validity verification through innovation efficiency testing (E1/E2); 3) innovation effectiveness index (EI) determination; and 4) assessment of actual learning outcomes. The challenge yielded from this process is achieving contemporary educational innovation that is both efficient and effective, aligned with technological changes and supportive of diverse future learner skills.

Keywords: ADDIE model, Contemporary education, Educational innovation, Effectiveness index, Efficiency testing, Innovation efficiency.

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Contents

Contribution of this paper to the literature
This academic article presents principles for the systematic design and development of educational innovations using research methodology, along with examples of efficiency and effectiveness evaluation, and clear calculation methods to establish standards for producing and developing new educational innovations.

1. Introduction

In today's rapidly advancing technological world, educators must possess knowledge of educational technology concepts, theories and innovations that enhance learning quality. They must be able to analyse problems arising from the use of technological and information innovations, access diverse learning resources and networks and design, create, implement, evaluate and improve innovations. This enables educators to stay current; to select, design, create and enhance educational innovations that facilitate effective learning; and to develop technology and information systems that allow learners to access diverse learning resources efficiently (Sinthapanon, 2017). Numerous research studies present advancements in educational technology and innovation. For instance, Johnson, Patel, and Thurston (2022) examined AI-enhanced learning environments: A systematic review of implementation and outcomes. Ramirez and Singh (2023) investigated the application of virtual reality applications in higher education: A meta-analysis of learning outcomes. Additionally, Anwar, Sofyan, Ratnaningsih, and Am (2024) studied digital technology practices for vocational teachers in the Industrial Revolution 4.0: Mediating technology self-efficacy.

Innovation represents both the process and outcome of developing and applying new concepts to create value, whether through products, services, processes or novel approaches that enhance efficiency and solve problems. Innovation extends beyond mere 'novelty' to practical implementation and sustained beneficial impact (Aktas, Aktamis, & Higde, 2024). Many educators have developed innovations for educational use, defining educational innovation as new creations, including concepts, approaches, systems, models, methods, processes, media and techniques designed to address educational challenges, generate positive outcomes aligned with curricula and effectively solve problems or develop learner capabilities (Anderson, 2019). Kottenstette and Paga (2022) state that innovation, in the context of innovative schools, refers to new approaches in educational administration and management that enable schools to be flexible and adaptable to learner needs, including more flexible curricula, modern teaching methods and appropriate administrative restructuring for school contexts. Evidently, innovation is crucial to education, with quality innovations capable of effectively addressing problems and supporting student learning.

The quality of educational innovation reflects its value across various dimensions and indicates its potential for broader implementation in learning development. This quality depends on factors such as theoretical synthesis for design and experimental processes, particularly the validation of innovation-related instruments. If these instruments lack quality, conclusions become unreliable and cannot be effectively scaled. Therefore, researchers must carefully consider quality assessment and verification before actual implementation (Chomya & Thaireukham, 2022).

This article presents aspects of innovation design and development using the ADDIE model, a contemporary and flexible universal format that facilitates efficient learning activities. It includes innovation quality and efficiency assessment through: 1) internal validity verification of content and innovation characteristics by experts, and 2) external validity verification through efficiency testing during implementation, as well as evaluation of contemporary educational innovation usage. The focus is on systematic processes following research and development (R&D) methodology, quality verification of innovations, and applied statistical methods for evaluating the implementation of innovations. This will benefit educators and educational researchers interested in pursuing knowledge of reliable and academically sound innovation development processes for enhancing the efficiency and effectiveness of modern educational management.

2. Conceptual Overview

Educational innovation refers to new methods, concepts, processes, techniques, practices, products, or works derived from applying knowledge and creative thinking to systematically change, improve and develop work that affects educational management's efficiency and effectiveness. Product innovation emphasises facilitating individual learner development, with specific development models to enhance self-learning efficiency and effectiveness (Asanok, 2018). Therefore, educators must design and create educational innovations that align with teaching content, foster student learning and seek improved approaches to generate new forms of educational innovation that enhance educational quality (Anderson, 2019). In an era of rapid technological and innovative development, education must adapt to keep pace with changes. Research serves as a crucial tool in developing and evaluating educational innovation and technological effectiveness to maximise benefits for learners and the educational system. The concepts related to educational innovation and technology include.

2.1. Research Characteristics in Innovation

Anderson (2019) classified educational innovation and technology research into three categories: 1) R&D, such as the development of digital instructional media, educational applications, online learning systems, and digital assessment tools; 2) experimental research, such as comparing traditional teaching methods with the use of technology, testing the efficiency of innovations, and studying learning achievements after the implementation of these innovations; and 3) survey research, such as studying the needs for educational technology, surveying technology readiness, and evaluating the adoption of innovations.

2.2. Innovation Research Concepts

Johnson and Smith (2020) proposed approaches for educational innovation and technology research comprising:
1) research question formulation through problem and needs analysis, feasibility studies, and research scope definition; 2) innovation design considering practical implementation; and 3) testing and evaluation through sample group trials, systematic data collection, analysis and improvement.

2.3. Contemporary Innovation Design Concepts

The author presents the widely accepted design process concept, the ADDIE model, developed in 1970 by the US Army's Center for Educational Technology. This flexible model, with clearly defined steps, facilitates effective learning activities and has gained widespread acceptance. It consists of analysis, design, development, implementation, and evaluation (Kurt, 2018). Subsequently, both domestic and international educators have applied the ADDIE model to instructional design (Lumbantoruan & Herman, 2025), educational administration design (Saengkudloh, 2023), curriculum design (Denmolee, Techapahapong, & Chanchai, 2022; Trust & Pektas, 2018), and educational innovation design (Salas-Rueda, Salas-Rueda, & Salas-Rueda, 2020).

Analysis Phase. Determining innovation design components through.

1)Identifying learner groups.
2)Identifying teaching and learning activity problems.
3)Defining lesson objectives or goals.
4)Identifying content related to lesson objectives or goals.

Design Phase. Using analysis phase data to design innovations through.

1)Defining innovation and its components.
2)Applying learning theories integrated into innovation.
3)Determining teaching techniques/methods, learning activities and implementation timeframes.
4)Establishing learning assessment criteria aligned with lesson objectives.

Development Phase. Creating and developing innovation through.

1)Internal validation by experts.
2)External validation through learner trials (Richey, 2005), including.
2.1) Creating innovation according to design specifications and expert evaluation tools.
2.2) Expert review and revision based on feedback.
2.3) Trial implementation with non-target groups sharing similar characteristics through one-to-one testing, small group testing and field trials.

Implementation Phase. Applying the developed innovation to target groups or samples, following the designed instructional activity procedures.

Evaluation Phase. Assessing learner outcomes after innovation implementation to measure the achievement of specified objectives through self-assessment, learner assessment or collaborative assessment, using results to further develop the efficiency of the learning process.

3. Methodology

In contemporary innovation research processes, after educators or researchers develop an innovation, they must: 1) verify the innovation's quality through expert evaluation to ensure it can effectively enhance learning processes, with modifications made according to expert recommendations before trials; 2) determine innovation efficiency (E_1/E_2) through three sequential trials one-to-one (1:1), small group (1:10), and field trial (1:100); 3) calculate the innovation's effectiveness index (EI) showing the percentage gains in learning progress; and 4) evaluate learning outcomes from actual implementation with target groups or samples, measuring achievement, capabilities, or skills after innovation-based instruction. The details of these processes are as follows:

3.1. Innovation Quality Verification

This process employs knowledge-based and rational judgment to verify the quality of innovation through internal validation by a panel of experts (Richey, 2005). The primary consideration is whether the innovation appropriately aligns with problems, content, objectives, theoretical concepts, techniques, methods, assessment measures, and learner characteristics (Finch & French, 2019). This verification examines the characteristics of innovation and content validity as follows:

3.1.1. Innovation Characteristics Verification. This Examination Covers Four Key Aspects

1) Innovation characteristics: Each innovation type has specific attributes varying in concreteness or abstractness, depending on learner group appropriateness and learning objectives. Educators must select innovations suitable for learner contexts (Mingsiritham, 2016).
2) Design standards: Effective learning innovation design facilitates clear communication and learner comprehension. Evaluation criteria typically include alignment with learning objectives, teacher and student manuals, design techniques, learning activities, data accuracy, organisation and aesthetics. For computer-based learning innovations (e.g., web-based instruction, computer-assisted instruction, e-books), additional quality verification includes screen design, evaluation of text, graphics, audio, video and screen control elements (Mingsiritham, 2016).
3) Technical standards: Presentation techniques significantly influence innovation engagement and communication effectiveness. Educational techniques must clearly present content without ambiguity, maintain interest, effectively demonstrate comparisons, facilitate understanding and ensure ease of use.
4) Aesthetic standards: this encompasses precision, accuracy, orderliness and learner engagement through age-appropriate design techniques.

3.1.2. Content Validity

Content validity refers to an instrument's ability to measure the intended content accurately. The key consideration is selecting representative content samples that adequately cover the measurement domain. Independent expert panels evaluate whether content samples sufficiently represent and cover the intended measurement scope (Worakham, 2018). Additionally, innovation quality assessment forms typically involve five experts using developed assessment forms, often employing rating scales. The evaluation results must achieve an acceptable mean rating of 3.51 to 5.00 (a high to very high level) to indicate satisfactory quality. Assessment forms evaluate various aspects, including design, technical implementation, and content appropriateness.

3.2. Determining Educational Innovation Effectiveness

The process of determining educational innovation effectiveness involves external validation through student implementation and evaluation, as outlined by Richey (2005). This methodology encompasses two primary phases: the try-out phase and the trial-run phase (Promwong, 2013), establishing a systematic approach to innovation assessment. The evaluation framework utilises the E_1/E_2 efficiency criteria, typically set at 80/80, though adjustable based on content complexity. For particularly challenging content, the threshold may be modified to 75/75. The first efficiency measure (E_1) represents process efficiency, evaluating continuous learning behaviours through formative assessments such as group activities, worksheets, learning behaviours and interim assignments. The second measure (E_2) quantifies outcome efficiency through summative assessment following the completion of the instructional intervention. The implementation process follows three sequential phases, as follows.

Individual Testing Phase (1:1). This initial phase involves three students representing diverse cognitive abilities (high, medium and low). The evaluation focuses on assessing the innovation's appropriateness, examining language clarity, instructional coherence, content relevance, temporal requirements and student comprehension. Findings inform subsequent refinements prior to broader implementation.

Small Group Testing Phase (1:10). This intermediate phase encompasses 6–12 students, maintaining cognitive diversity but utilising different participants from the initial phase. The refined innovation undergoes testing, with efficiency calculations (E_1/E_2) informing further enhancements to achieve optimal pedagogical effectiveness.

Field Testing Phase (1:100). The culminating phase involves classroom-wide implementation with 30–100 students, representing varied cognitive abilities but excluding previous participants. This comprehensive evaluation utilises the innovation refined through earlier phases, with final E_1/E_2 efficiency calculations determining overall effectiveness.

Through this systematic progression, educational innovations undergo rigorous validation, ensuring their pedagogical efficacy and practical applicability in authentic learning environments. This methodological approach aligns with established educational research practices, providing empirical evidence of instructional effectiveness through quantitative and qualitative assessment measures.

The process demonstrates a commitment to evidence-based educational practice, incorporating iterative refinement based on systematic feedback and empirical evaluation. This comprehensive approach ensures that educational innovations meet established standards of effectiveness while maintaining practical applicability in diverse learning contexts.

The following sections present examples of data analysis on the efficiency and effectiveness of innovations, along with tables displaying statistical results in sequential order. It should be noted that the data sources for all tables in this article were not collected from any sample groups. The numbers were created solely for illustrative purposes of calculation and statistical analysis, to provide readers with a clearer understanding of the concepts.

Calculating E_1/E_2 Efficiency Ratios for Educational Innovation Performance. According to Neungchalerm (2017), the E_1/E_2 efficiency ratios are calculated using the following formulas.

$$E_1 = \frac{\left(\frac{\Sigma X}{n}\right)}{A} \times 100$$

Here:

E_1 : Represents process efficiency.

ΣX: Denotes the sum of all scores.
A: Represents the total possible score.
N: Indicates the total number of students.

$$E_2 = \frac{\left(\frac{\Sigma Y}{n}\right)}{B} \times 100$$

Here:

E_2 : Represents learning outcome efficiency.

ΣY: Denotes the sum of post-test scores.
B: Represents the total possible post-test score.
N: Indicates the total number of students.

Interpretation Guidelines. The acceptable variance threshold is set at ±2.5% from the established criterion (Chomya & Thaireukham, 2022). For instance, with an 80/80 criterion:

1. Acceptable range: 77.50–82.50.
2. Below 77.50: Indicates substandard efficiency.
3. Above 82.50: Indicates superior efficiency.

Additionally, the differential between E_1 and E_2 should not exceed 5% to maintain instructional balance. A significant disparity suggests:

1. If $E_1 > E_2$: Formative assessments may be too lenient.
2. If $E_2 > E_1$: Summative assessments may be too lenient.

Example Analysis. An E_1/E_2 ratio of 81.56/80.17 demonstrates optimal efficiency because:

1. Both values fall within the ±2.5% acceptable range.
2. The differential between E_1 and E_2 is less than 5%.

This statistical framework provides a robust methodology for evaluating the effectiveness of educational innovations, ensuring that both process and outcome metrics align with established pedagogical standards.

Based on the analysis of Tables 1 and 2, learners achieved 85.00% accuracy during learning activities (process efficiency) and 84.67% on post-learning assessments (outcome efficiency). With the established efficiency criterion (E_1/E_2) set at 80/80, the developed educational innovation demonstrates an efficiency ratio of 85.00/84.67, meeting the prescribed standards. The differential between E_1 and E_2 values falls within the acceptable range of less than 5%.

Table 1. Example of small group innovation efficiency data analysis.

Student	Scores from practice activities (10 points per topic)						Post-test score (30)
	1	2	3	4	5	Total	
1	6	7	7	8	8	36	24
2	7	6	8	8	9	38	24
3	7	8	7	9	9	40	25
4	7	6	8	8	8	37	24
5	8	9	10	10	9	46	26
6	8	8	9	10	9	44	25
7	9	9	8	10	9	45	25
8	9	8	9	10	9	45	26
9	10	9	8	10	9	46	27
10	10	9	9	10	10	48	28
Total						425	254
Average						42.50	25.40
Efficiency						85.00 (E_1)	84.67 (E_2)

Table 2. Example of small group innovation efficiency results.

N	During learning			Post-learning			Efficiency value E_1/E_2
	A	$\sum X$	E_1	B	$\sum Y$	E_2	
10	50	425	85.00	30	254	84.67	85.00/84.67

3.3. The Effectiveness Index (EI)

The EI represents a differential ratio measurement with specific characteristics and interpretive guidelines:

Maximum Value and Range. The EI has a maximum value of 1.00, with no defined minimum, as it can fall below −1.00. A negative value indicates that pre-test scores exceeded post-test scores, suggesting ineffective learning intervention (Chomya & Thaireukham, 2022; Neungchalerm, 2017).

Key Interpretative Principles. When students achieve perfect post-test scores, the EI consistently equals 1.00, regardless of pre-test performance (except when pre-test scores are also perfect). This indicates 100% learning progress or the complete achievement of learning objectives. The calculation of EI requires prior determination of the E_1/E_2 values, where E_2 corresponds to academic achievement scores identical to the post-test scores used in the EI calculation.

Assessment Context. The EI calculation provides a quantitative measure of educational effectiveness while acknowledging the influence of learners' prior knowledge. This metric, combined with E_1/E_2 efficiency ratios, offers a comprehensive evaluation framework for educational innovations, ensuring a robust assessment of pedagogical interventions and learning outcomes.

$$EI = \frac{P_2 - P_1}{(N \times A) - P_1}$$

Here:
P_1: Aggregate pre-test scores.
P_2: Aggregate post-test scores.
N: Total number of students.
A: Maximum possible score.

Table 3: Example of the effectiveness index of the innovation.

Table 3. Results of calculating the effectiveness index of the innovation.

Number of students	Full score	Total pre-test scores	Total post-test scores	Effectiveness index (EI)
39	30	709	976	0.5744

3.4. Assessment of Learning Outcomes for Students Using the Innovation

After the instructor or researcher has validated the innovation through expert review and made revisions based on recommendations, the next step is to conduct a trial to determine its effectiveness with students (not the target group or sample group) and calculate the effectiveness index. The final step is evaluating the learning outcomes of students who studied using the developed innovation. The instructor or researcher may conduct the assessment in two ways: comparing learning achievement between pre- and post-test scores and comparing learning achievements against predetermined criteria (Pankaew, 2018). The details are as follows.

3.4.1. Comparison of Pre and Post-Test Achievement

This is divided into three phases: pre-evaluation, which tests students' knowledge before learning activities begin; formative evaluation, which measures performance through, for example, activities, worksheets, knowledge sheets, quizzes during the course, and exercises; and summative evaluation, which tests students' knowledge after completing the learning activities with the innovation. In evaluating learning outcomes, the instructor or researcher compares students' test scores after completing the innovative learning management (post-test) to determine whether they are higher than before learning (pre-test). If the comparison shows that students' post-test scores are significantly higher than their pre-test scores (in cases where the students are a sample group), this indicates that the innovation can effectively enhance students' learning processes. The comparison of pre- and post-test learning achievements using the innovation employs t-test statistics (dependent group) (Srisaard, 2017) (in the case of sample groups) using the following formula.

$$T = \frac{\sum D}{\sqrt{\frac{N\sum D^2 - (\sum D)^2}{N-1}}}$$

Here:
D: Represents the difference between paired scores.
N: Represents the sample size or number of score pairs.

For examples of data analysis tables showing students' pre- and post-test scores using the innovation, the author presents Tables 4 and 5. If instructors or researchers wish to use these table formats in their research. All details are presented in Table 4.

Table 4. Example of student data analysis results from pre- and post-tests using computer-assisted instruction.

Student no.	Score		Score difference (D)	Squared difference (D^2)
	Pre-test score (30)	Post-test score (30)		
1	18	28	10	100
2	14	25	11	121
3	18	28	10	100
4	20	28	8	64
5	15	29	14	196
…	…	…	…	…
…	…	…	…	…
30	17	28	11	121
Total	545	792	247	2,389
$\bar{X}$	18.17	26.40	8.23	
SD	2.59	1.61		

$$t = \frac{247}{\sqrt{\frac{(30 \times 2{,}389) - (247)^2}{30 - 1}}}$$

Here, t = 12.88.

Table 5. Example of comparative analysis of learning achievement using a t-test for students using the innovation.

Test scores	Number of students (N)	Mean ($\bar{x}$)	Standard deviation (SD)	Score difference (D)	t-test
Pre-test	30	18.17	2.59	8.23	12.88
Post-test	30	26.40	1.61		

Note: $t_{(0.05,9)} = 1.6991$. Statistically significant at the 0.05 level.

From the critical values of the t table, where df = 29 at the .05 level (one-tail), the critical value is 1.6991, and the calculated t-value is 12.88, which is greater than the critical t-value. This indicates that students who learned using the innovation achieved significantly higher post-test scores than pre-test scores at the .05 level of statistical significance.

When conducting research with a target group of students (Rather than a sample group), researchers can directly compare the mean pre-test scores with the mean post-test scores (without requiring t-test statistics). For example, from Table 5, the pre-test mean score was 18.17 (60.56%) and the post-test mean score was 26.40 (88.00%), demonstrating that students who used computer-assisted instruction achieved higher learning outcomes after instruction.

3.4.2. Comparison of Learning Achievement Against Predetermined Criteria

This evaluation method typically focuses on post-learning assessment rather than pre-learning measurement. The target group's knowledge is tested, and their scores are compared against predetermined percentage criteria, such as 75%, 80%, or 85%. These criteria should be established based on factors including content difficulty and the contextual learning environment.

To test the difference between the mean post-learning achievement using the innovation against an 80% criterion, researchers can employ the one-sample t-test for small sample sizes (n < 30) (Wongrattana, 2021) using the formula.

$$T = \frac{\bar{x} - \mu}{\frac{S}{\sqrt{n}}}$$

Here:

$\bar{x}$: Mean post-test score of the sample group.
μ: Score value at 80% criterion.
S: Standard deviation.
N: Sample size.

For examples of data analysis tables comparing post-learning achievement against the 80% criterion for students using the innovation, the author presents Tables 6 and 7.

Table 6. Example of comparative analysis of post-test learning achievement against the 80% criterion for students using the innovation.

No.	Learning achievement score	Compared to 80% criterion	Evaluation result	
			Pass	Fail
1	17	16	✓	-
2	17	16	✓	-
3	16	16	✓	-
…	…	…	✓	-
…	…	…	✓	-

No.	Learning achievement score	Compared to 80% criterion	Evaluation result	
			Pass	Fail
35	18	16	✓	-
Total	579	560	-	-
Mean	16.54	16.00	-	-
SD	0.78	0.00	-	-
Percentage			100	-

We test the difference between post-learning achievement mean scores using innovation in relation to the 80% criterion, utilizing the sample group testing method (Watchararat, 2009).

$$t = \frac{16.54 - 16}{\frac{0.78}{\sqrt{35}}}$$

$$t = 4.10$$

Table 7. Example Analysis of Post-learning Achievement Scores Compared to the 80% Criterion Using t-test.

Number of students	Full test score (Post-test)	Mean	Standard deviation	Criterion (80%)	t-test
35	20	16.54	0.78	16	4.1

Note: $t_{(0.05,34)} = 1.6909$. Statistically significant at the 0.05 level.

From Table 7, students who learned using the innovation achieved a mean post-test score of 16.54, equivalent to 82.70%. In comparison to the predetermined criterion, the students' post-learning achievement was significantly higher than the criterion at the 0.05 level of statistical significance.

For research conducted with a target group (rather than a sample group), researchers can directly compare the mean post-test scores against the 80% criterion without employing t-test statistics. For example, from Table 7, the mean post-test score was 16.54 (82.70%), indicating that students who learned using the innovation achieved learning outcomes exceeding the predetermined criterion.

4. Discussion and Conclusion

The development of educational innovations to address learning challenges or enhance students' learning processes requires educators and researchers to thoroughly understand the principles of innovation development. Educational innovations serve as crucial tools for knowledge transfer, stimulating student interest, promoting learning engagement, and facilitating improvements in both knowledge and skills development. Before developing any innovation, educators and researchers must first identify the root causes of instructional challenges, which may extend beyond academic achievement to include deficiencies in problem-solving abilities, technological competency, self-directed learning capabilities, creative thinking, or analytical reasoning skills. Educators must select appropriate innovations that align with student contexts and design them with practical implementation in mind.

The ADDIE model has emerged as a prevalent instructional design framework from the past to the present, offering flexibility and facilitating effective learning activity implementation through its systematic phases of analysis, design, development, implementation, and evaluation (Kurt, 2018). Lu and Sides (2022) applied the ADDIE model to university-level reading instruction, demonstrating how systematic analysis, design, development, implementation and evaluation can significantly enhance instructional effectiveness by enabling educators to create appropriate, dynamic learning experiences that positively influence learners.

The ADDIE model has proven applicable for designing educational innovations to address various instructional challenges and demonstrably improve student learning processes. After completing the design phase, educators must submit innovations for expert evaluation and modification based on feedback. This is followed by three-phase pilot testing individual, small group, and field trials to determine innovation effectiveness, calculate the effectiveness index, and verify learning progress before implementation with target groups or samples. Research findings consistently demonstrate that ADDIE-based innovations achieve high to very high-quality ratings. When implemented, these innovations typically meet or exceed established efficiency criteria and effectiveness indices. Post-implementation, results show significant improvements in students' knowledge, skills, and attitudes. This aligns with multiple educational studies. For example, Saengkudloh's (2023) research on developing a teaching practicum supervision system using the ADDIE model demonstrated overall system efficiency and high user satisfaction among 107 student teachers, 36 mentor teachers, 18 university supervisors, and 18 school administrators. Moreover, Muangthong's (2024) study on developing ADDIE model-based learning skill development modules for higher vocational certificate students showed 84.73/81.25 efficiency, significantly higher post-test achievement ($p < .05$), and very high ratings for practical skill development and learning motivation. Lastly, Lumbantoruan and Herman's (2025) research on a logarithm module with Jigsaw cooperative learning achieved excellence ratings from content experts (92.35%), teachers (91.45%), and students (95.81%), with a mean student achievement of 90.28, demonstrating significant learning improvements. These findings validate the ADDIE model's effectiveness in developing educational innovations that enhance learning outcomes across diverse educational contexts.

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