

DEVELOPMENT OF A PROJECT-BASED LEARNING E-MODULE FOR RHYTHMIC GYMNASTICS TO IMPROVE CRITICAL THINKING SKILLS OF ELEMENTARY SCHOOL STUDENTS

Imam Santosa^{1a}, Yudha Febrianta^{2b*}

¹²Program Studi Magister Pendidikan Dasar, Universitas Muhammadiyah Purwokerto

^a*imam8800@gmail.com*

^b*yudhafebrianta@ump.ac.id*

(*) Corresponding Author

yudhafebrianta@ump.ac.id

ARTICLE HISTORY

Received : 19-06-2026

Revised : 28-07-2026

Accepted : 30-07-2026

KEYWORDS

E-module;
Rhythmic gymnastics;
Project-based learning;
Critical thinking skills;
Elementary school

ABSTRACT

Rhythmic

Rhythmic gymnastics learning in elementary schools still faces limitations in the availability of interactive learning materials that can foster students' critical thinking skills. This study aimed to develop a Project-Based Learning (PjBL)-based rhythmic gymnastics e-module to improve the critical thinking skills of fifth-grade students at SDN 1 Sokanandi. The study employed a research and development (R&D) method using the ADDIE model, consisting of five stages: analysis, design, development, implementation, and evaluation. The sample consisted of 20 students in the experimental group and 20 students in the control group. Data were collected through expert validation, written tests, and documentation and analyzed using IBM SPSS Statistics 26 through normality tests, homogeneity tests, the Mann-Whitney U test, and effect size analysis. The results showed that the developed e-module met the feasibility criteria based on media and material expert validation. Students in the experimental group who used the PjBL-based e-module achieved higher critical thinking skill scores than those in the control group ($p < 0.05$), with an effect size of 0.86, categorized as large. These findings indicate that the PjBL-based rhythmic gymnastics e-module has the potential to support the development of elementary school students' critical thinking skills. Teachers can utilize this e-module as an active and innovative alternative learning medium in physical education.

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INTRODUCTIONS

Physical education is an important role in elementary education because it contributes to the development of students' physical abilities while fostering their character development. Through movement-based activities, physical education not only promotes physical fitness but also instils values such as discipline, responsibility, cooperation, confidence, and decision-making skills in various situations (Iqbal, 2021; Nuraini et al., 2024). In accordance with the demands of 21st-century learning, physical education should also be directed towards developing critical thinking skills as an essential student competence, enabling them to understand information, provide reasoning, evaluate

actions, and determine appropriate solutions (Hu et al., 2016; Arini et al., 2023; Qasserras & Qasserras, 2023).

One of the physical education learning topics with the potential to develop critical thinking skills is rhythmic gymnastics. Learning rhythmic gymnastics requires not only movement accuracy but also coordination, balance, creativity, and the ability to design and refine movement sequences according to rhythm (Juliasti et al., 2020; Maratis et al., 2023). These characteristics provide opportunities for students to make decisions, evaluate movement outcomes, and reflect on the learning process. Therefore, rhythmic gymnastics has the potential not only as a means of developing motor skills but also as a context for cultivating critical thinking abilities.

Despite this potential, physical education learning in elementary schools still faces challenges in creating learning experiences that encourage critical thinking development. Physical education instruction often emphasises movement practice, while activities that encourage students to analyse, evaluate, and reflect on the learning process remain limited (Prasetyo & Ma'arif, 2021). Limited learning media also reduces students' opportunities to engage in independent learning and reflect on their practical performance (Saputri et al., 2024). A similar condition was found at SDN 1 Sokanandi, where rhythmic gymnastics learning was still dominated by direct demonstrations with limited instructional resources. This condition caused students to rely more on imitating teacher demonstrations rather than understanding movement concepts, exploring variations, and evaluating their own performance.

One alternative solution to address these challenges is the development of multimedia-based e-modules. E-modules enable learning materials to be presented through the integration of text, images, videos, animations, and interactive exercises, allowing students to gain richer learning experiences (Nurhidayat, 2024). According to the cognitive theory of physical education, multimedia learning, presenting information through integrated visual and verbal channels, can enhance students' conceptual understanding (Mayer, 2021; Clark & Mayer, 2023). In physical education, multimedia e-modules allow students to review movement sequences independently according to their learning needs (Wulandari & Febrianta, 2024). Furthermore, the integration of technology in learning can facilitate learning processes that are more critical, flexible, engaging, and aligned with students' characteristics (Firmadani, 2020; Mao et al., 2023).

To ensure that e-modules function not only as information sources but also as tools for active learning, an instructional approach that engages students in knowledge construction is required. One relevant approach is Project-Based Learning (PjBL), which provides learning experiences through authentic project completion. PjBL encourages students to plan, investigate, create products, and evaluate their work, thereby supporting the development of critical thinking and problem-solving skills (Jalinus & Nabawi, 2017; Muhibbullah et al., 2024). The implementation of PjBL-based modules contributes to critical thinking development because students are directly involved in identifying solutions and producing meaningful outcomes (Baidowi et al., 2023; Nurahmania & Wardatunnissa, 2025). In the context of rhythmic gymnastics, PjBL integration can be implemented through projects involving the development of movement sequences that require students to select, create, practise, and evaluate their own movements. This approach provides more meaningful learning experiences because students are not merely receiving movement examples but are also engaged in thinking processes and decision-making activities (Maulana et al., 2025).

Previous studies have indicated that PjBL-based e-modules contribute positively to students' learning development. However, most existing studies have been conducted in general subjects, such as science and other academic disciplines (Antari et al., 2023; Adha et al., 2023). Furthermore, research on digital media development in physical education has primarily focused on learning outcomes, conceptual understanding, and motor skills rather than the development of higher-order thinking skills (Saputri et al., 2024; Wulandari & Febrianta, 2024).

Unlike previous studies that developed e-modules, PjBL approaches, or gymnastics learning separately, this study develops a PjBL-based rhythmic gymnastics e-module that integrates project learning stages into movement activities to support students' critical thinking skills. The PjBL stages, including determining essential questions, designing projects, developing schedules, monitoring processes, assessing outcomes, and evaluating learning experiences (Permendikbud No. 103 Tahun 2014), are implemented through activities involving the design, practice, and evaluation of rhythmic gymnastics movement sequences. This integration is designed so that each learning activity within the e-module facilitates six critical thinking indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990, as cited in Mastuti et al., 2022). Therefore, the developed e-module

not only supports motor skill development but also facilitates critical thinking development through project-based learning experiences.

Based on these considerations, this study aims to develop a project-based learning (PjBL)-based rhythmic gymnastics e-module that meets feasibility criteria for supporting elementary school students' critical thinking skills. This study is expected to provide theoretical contributions to the development of technology-based physical education innovations and active learning models. Practically, the developed product can serve as an alternative learning medium for teachers in implementing more interactive rhythmic gymnastics instruction while supporting the development of students' critical thinking skills.

RESEARCH METHOD

This study employed a Research and Development (R&D) method aimed at developing a learning product in the form of a Project-Based Learning (PjBL)-based rhythmic gymnastics e-module and evaluating its feasibility and effectiveness in improving elementary school students' critical thinking skills. The R&D method was selected because it not only focuses on product development but also involves validation and effectiveness testing to ensure that the developed product meets learning needs (Setyosari, 2016; Hamzah, 2020).

The development of the e-module followed the ADDIE model developed by Branch (2009), which consists of five stages: analysis, design, development, implementation, and evaluation. The ADDIE model was selected because it provides a systematic framework for developing learning products, beginning with needs analysis, product design, development and validation, implementation in the learning process, and product evaluation. Through these stages, the product can be continuously improved before being implemented with students (Rayanto, 2020). The development stages are presented in figure 1.

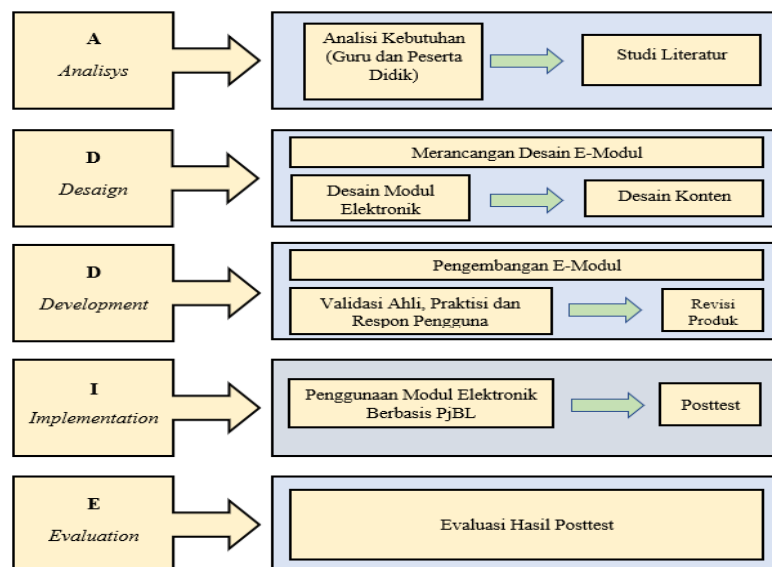


Figure 1. ADDIE Development Model (Branch, 2009) Adapted to the Research Context

Source: Adapted from Instructional Design: The ADDIE Approach (Branch, 2009)

The study was conducted from January to May 2026 at SD Negeri 1 Sokanandi, Indonesia. The research participants consisted of all fifth-grade students in the 2025/2026 academic year, totaling 40 students. The sampling technique used was saturated sampling (total sampling), as all members of the population were involved in the study (Asrulla et al., 2023). The participants were divided into two groups: an experimental group consisting of 20 students who received instruction using the PjBL-based rhythmic gymnastics e-module and a control group consisting of 20 students who received conventional instruction commonly implemented by the teacher. The grouping was based on

existing classes (intact groups) rather than individual randomization.

Data were collected through expert validation questionnaires, critical thinking skills tests, student response questionnaires, and documentation. The critical thinking skills instrument consisted of an essay test containing six items. Each item was developed based on Facione's six critical thinking indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990, as cited in Mastuti et al., 2022). The instrument was designed according to the rhythmic gymnastics content and PjBL-based learning activities, with each item measuring students' abilities to understand information, analyze movement-related problems, evaluate practical performance, draw conclusions, provide explanations, and reflect on the learning process. Before being used in the study, the instrument was tested for validity using Pearson Product Moment correlation and reliability using Cronbach's alpha to ensure its suitability for measuring students' critical thinking skills.

Before implementation in the learning process, the e-module was validated by two experts, namely a media expert and a physical education content expert. The validation process assessed the aspects of content feasibility, presentation, visual design, and language quality. The validation results were used as the basis for product revision to ensure that the developed e-module met the feasibility criteria before being implemented with students. The validation data were analyzed descriptively using a five-point Likert scale. The feasibility percentage was calculated using the following formula:

$$P = \frac{f}{N} \times 100\%$$

P represents the feasibility percentage, f represents the obtained score, and N represents the maximum score. The obtained percentage was then categorized into very feasible, feasible, moderately feasible, less feasible, and not feasible based on the criteria proposed by Sugiyono (2019).

The effectiveness testing of the e-module was conducted using a quasi-experimental design with a pretest-posttest control group design. Both groups were given a pretest before the intervention to determine their initial critical thinking skills. Subsequently, the experimental group received instruction using the PjBL-based rhythmic gymnastics e-module, while the control group participated in conventional instruction. After the learning process was completed, both groups were administered a posttest to identify changes in students' critical thinking skills.

Data analysis began with descriptive statistics to describe the pretest and posttest data, including the mean, maximum score, minimum score, and standard deviation. Improvement in critical thinking skills was analyzed using the N-Gain Score to determine the level of improvement after the learning intervention. The N-Gain value was calculated using the formula developed by Hake (1999):

$$g = \frac{\text{Skor Posttest} - \text{Skor Pretest}}{\text{Skor Maksimum} - \text{Skor Pretest}}$$

The N-Gain values were categorized into three levels: high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$). Before hypothesis testing, prerequisite analyses were conducted through the Shapiro-Wilk normality test and Levene's test for homogeneity using IBM SPSS Statistics 26. The data were considered normally distributed when the significance value (Sig.) was greater than 0.05, while the data were considered homogeneous when the Levene's test significance value was also greater than 0.05. If both assumptions were fulfilled, differences between groups were analyzed using the Independent Samples t-Test. However, if one of the assumptions was not met, the Mann-Whitney U Test was applied as a non-parametric alternative. Hypothesis testing decisions were based on the significance value (Sig. 2-tailed), where H_0 was rejected and H_1 was accepted if Sig. < 0.05 , while H_0 was accepted if Sig. ≥ 0.05 (Field, 2018).

In addition to testing statistical significance, this study also calculated the effect size to determine the magnitude of the influence of the e-module on students' critical thinking skills. The interpretation of effect size followed Cohen's criteria, namely small effect (0.10), medium effect (0.30), and large effect (≥ 0.50) (Field, 2018).

RESULTS AND DISCUSSION

RESULT

The development of the Project Based Learning (PjBL)-based rhythmic gymnastics e-module in this study followed five stages of the ADDIE model, namely analysis, design, development, implementation, and evaluation.

Each stage had different objectives and outputs but was interconnected, where the results of one stage became the basis for implementing the next stage. Through these stages, the product development process was conducted systematically, starting from identifying learning needs to evaluating the quality and effectiveness of the developed e-module. The description of each development stage is presented as follows.

1. Analysis

The analysis stage was conducted to identify learning needs as the foundation for developing a Project Based Learning (PjBL)-based rhythmic gymnastics e-module. The analysis included needs analysis, student characteristics analysis, learning material analysis, and analysis of school facilities and infrastructure.

The results of observations and interviews with physical education teachers at SD Negeri 1 Sokanandi showed that rhythmic gymnastics learning was still dominated by demonstration and assignment methods. Teachers explained the materials verbally and demonstrated movements that were then imitated by students. The instructional materials used were still limited to textbooks and videos accessed from the internet, indicating that there was no specifically designed learning media that matched the characteristics of elementary school students.

The analysis of the learning process also showed that students tended to focus on imitating movements demonstrated by the teacher without understanding the objectives or concepts behind each movement sequence. This condition caused students to have limited involvement in activities requiring them to analyze, evaluate, provide reasoning, and improve their performed movements. Consequently, learning activities emphasized motor skill mastery rather than the development of critical thinking skills.

Based on the analysis of student characteristics, fifth-grade students were found to be more interested in learning media that presented colorful images, instructional videos, animations, and interactive activities. Students also showed higher enthusiasm when they were given opportunities to work collaboratively and produce simple products rather than merely following teacher demonstrations. These findings indicated that students needed learning media that were more attractive, interactive, and provided opportunities for active learning.

The analysis of learning materials showed that rhythmic gymnastics competencies require students not only to perform movements but also to understand movement sequences, technical accuracy, rhythm suitability, body coordination, and the ability to creatively arrange movement combinations. These characteristics are closely related to critical thinking skills, particularly in interpreting information, analyzing movements, evaluating practice outcomes, drawing conclusions, explaining reasons for selecting movements, and improving the obtained results.

Based on the analysis results, a learning medium was needed that could integrate materials, demonstration videos, interactive exercises, and project-based activities into a unified learning experience. Therefore, a Project Based Learning (PjBL)-based rhythmic gymnastics e-module was developed to facilitate students' independent, active, and collaborative learning while supporting the development of critical thinking skills throughout the learning process.

2. Design

The design stage was conducted as a follow-up to the needs analysis results obtained in the previous stage. At this stage, the researcher began developing the design of a Project Based Learning (PjBL)-based rhythmic gymnastics e-module that was appropriate for the characteristics of fifth-grade elementary school students. The planning process considered students' abilities to understand movements, learn collaboratively, and develop critical thinking skills through simple and contextual learning activities.

The initial step in this stage was determining learning objectives and organizing the materials to be included in the e-module. The designed materials consisted of the definition of rhythmic gymnastics, benefits of rhythmic gymnastics, movement elements, basic movement techniques, and examples of simple movement sequences. The materials were arranged systematically so that students could understand concepts before performing practical activities.

Furthermore, the researcher designed PjBL-based learning activities adjusted to elementary school students' abilities. The project activity was designed as a simple group task in which students developed and practiced rhythmic gymnastics movement sequences by considering movement suitability, rhythm, and group cooperation. Through this activity, students were encouraged to observe movement examples, select appropriate movements, provide reasons for their movement arrangements, and evaluate their practice results.

At this stage, the components of the e-module were also designed, including the cover page, user instructions, learning objectives, rhythmic gymnastics materials, movement examples through images and videos, project activity steps, comprehension exercises, reflection sheets, and evaluation activities. The arrangement of these components aimed to enable the e-module to be used independently by students or as supporting material during teacher-led learning.

In addition to designing the content, the researcher prepared research instruments used to assess product quality and effectiveness. The instruments included media expert validation sheets, material expert validation sheets, student response questionnaires, and critical thinking skills assessment instruments. The critical thinking indicators referred to Facione, consisting of interpretation, analysis, evaluation, inference, explanation, and self-regulation. The output of the design stage was an initial blueprint of the PjBL-based rhythmic gymnastics e-module, which served as a guideline for the product development process. This design was then used as the basis for producing the e-module ready for validation and implementation in learning activities.

3. Development

The development stage was carried out by transforming the product design developed in the design stage into a tangible product in the form of an interactive e-module based on traditional games for long jump learning materials for seventh-grade junior high school students. The e-module was developed as a digital learning resource that can be accessed through computers, laptops, and Android devices or smartphones, thereby supporting both independent learning and classroom learning activities. The product can be used in both online and offline learning environments according to instructional needs. The e-module integrates various components, including text, images, YouTube instructional videos, exercises, assessments, and learning activities based on traditional games designed according to students' characteristics. This integration aims to provide a more engaging learning experience and support the improvement of students' learning motivation and long jump skills.

The prototype of the e-module was systematically organized, beginning with the introductory section, followed by the presentation of learning materials and project activities, and concluding with the learning evaluation. The introductory section consists of the cover page, preface, table of contents, e-module user guide, learning outcomes, learning objectives, criteria for achieving the learning objectives, and a concept map, which provides an overview of the content and learning sequence presented in the e-module.

The content section presents fundamental concepts related to long jump, including the definition of long jump, learning objectives, basic techniques of approach run, take-off, flight, and landing, as well as various practice activities presented through explanations, supporting images, and YouTube instructional videos. In addition to the material presentation, the e-module is equipped with project-based activities, independent exercises, and student worksheets designed to train students' abilities to interpret, analyze, evaluate, explain, and reflect on the learning process. The integration of multimedia elements and Project-Based Learning (PjBL) stages in the e-module provides opportunities for students to actively engage in designing, practicing, and evaluating long jump movement sequences, thereby supporting the development of critical thinking skills.

The core section of the e-module was the Project Activity, presented on pages 12–22, which integrated the syntax of Project Based Learning (PjBL). The first stage (page 12) encouraged students to observe the *Senam Anak Indonesia Hebat* video, identify problems, and discuss them with their groups. The second stage (pages 13–14) contained activities for designing rhythmic gymnastics movement sequences according to musical rhythm. The third stage (pages 15–16) involved preparing practice schedules and dividing group responsibilities. The fourth stage (pages 17–19) guided students to practice and refine movements based on teacher feedback. The fifth stage (pages 20–21) consisted of presenting project outcomes through group performances and peer assessment. The final stage (page 22) involved reflection activities to evaluate the project process and outcomes and plan improvements for future learning.

The closing section of the e-module contained a summative assessment based on case studies consisting of six essay questions. The assessment was designed to measure students' critical thinking skills in analyzing problems related to rhythmic gymnastics implementation, providing solutions to group challenges, developing practice strategies, and explaining reasons based on the learned concepts. Thus, the e-module functioned not only as a medium for delivering learning materials but also as a tool for developing students' critical thinking skills through contextual

and project-based learning activities.



Figure 2. PJBL-Based Rhythmic Gymnastics E-Module

Source: Research Documentation (2026)

Before being used in the learning trial, the developed e-module was first validated by media experts and subject matter experts to determine the product feasibility level. Media expert validation was conducted to assess the aspects of appearance, design, navigation, interactivity, and ease of use of the e-module, while subject matter expert validation was conducted to evaluate the suitability of the content, accuracy of concepts, material presentation, and alignment with learning outcomes. The validation results were used as a basis for revising and improving the product so that the e-module met the criteria for use as a learning medium.

Table 1. Feasibility Test Results of the PJBL-Based Rhythmic Gymnastics E-Module

No.	Validator	Number of Assessment Aspects	Obtained Score	Maximum Score	Percentage	Category
1	Media Expert	10	43	50	86%	Feasible
2	Material Expert	18	70	90	77.78%	Highly Feasible

Source: Primary research data (2026)

Based on the validation results, the Project-Based Learning (PjBL)-based rhythmic gymnastics e-module received positive evaluations from the validators. The media expert gave a score of 86%, categorized as highly feasible, while the subject matter expert gave a score of 77.78%, categorized as feasible. These results indicate that the developed e-module has an appropriate media design and learning content that supports rhythmic gymnastics instruction. The suggestions provided by the validators were used to revise and refine the product before its implementation in the learning process.

4. Implementation

The implementation stage was carried out by applying the Project-Based Learning (PjBL)-based rhythmic gymnastics e-module in fifth-grade physical education learning after the product had undergone a validation and refinement process. The implementation involved both an experimental group and a control group. Before the learning activities began, both groups were given a pretest to determine the students' initial critical thinking skills.

The control group participated in learning activities using the methods commonly applied by the teacher without the use of the PjBL-based e-module. Meanwhile, the experimental group participated in learning activities using the e-module designed according to the stages of PjBL. The learning activities began with the presentation of problems related to designing rhythmic gymnastics movement sequences provided in the e-module. Subsequently, students worked collaboratively in groups to design the project, determine the movements to be developed, and prepare a practice schedule. During the project implementation process, students practiced, discussed, and refined their movement sequences based on observations and teacher guidance. In the final stage, students presented their project outcomes in the form of rhythmic gymnastics movement sequences and reflected on the learning process they had completed. The difference in treatment between the two groups was used to examine the contribution of e-module

implementation to students' critical thinking skills. Documentation of the implementation of the PjBL-based rhythmic gymnastics e-module is presented in the following figure.



Figure 2. Implementation of the Project-Based Learning-Based Rhythmic Gymnastics E-Module

Source: Research Documentation (2026)

After all learning activities were completed, both groups were given a posttest to determine changes in students' critical thinking skills. The implementation data were then analyzed to examine the effectiveness of using the PjBL-based rhythmic gymnastics e-module.

5. Evaluation

The evaluation stage was conducted to determine the achievement of the development objectives of the Project-Based Learning (PjBL)-based rhythmic gymnastics e-module based on the data obtained during the implementation process. The evaluation was carried out by analyzing changes in students' critical thinking skills after participating in learning activities using the e-module compared with learning activities without the use of the e-module. The evaluation analysis aimed to determine the extent to which the PjBL-based e-module contributed to improving students' critical thinking skills.

The evaluation analysis employed a quasi-experimental design using a pretest-posttest control group design. Data on students' critical thinking skills were obtained from the pretest and posttest results of the experimental and control groups. The measurement results were subsequently analyzed using descriptive statistics, improvement analysis (N-Gain), and hypothesis testing to determine the effectiveness of the PjBL-based rhythmic gymnastics e-module in improving students' critical thinking skills. Descriptive statistics were used to provide an overview of students' initial and final abilities in both groups through the mean score, minimum score, maximum score, and standard deviation. The results of the descriptive statistical analysis are presented in table 2 below.

Table 2. Descriptive Statistics of Pretest and Posttest Scores

	Group	N	Total Score	Min	Max	Mean	Std. Deviation
Critical Thinking Skill (Pretest)	Control	20	243	10	18	12.15	2.159
	Experimental	20	246	9	17	12.25	2.403
Critical Thinking Skill (Posttest)	Control	20	370	16	22	18.50	1.987
	Experimental	20	511	22	29	25.55	1.986

Source: Primary research data processed using IBM SPSS Statistics 26

The descriptive statistical analysis showed that the initial critical thinking skills of students in the control and experimental groups were relatively comparable. This was indicated by the pretest mean scores, with the control group obtaining a mean score of 12.15 and the experimental group obtaining 12.25. After the learning intervention, both groups showed improvements in critical thinking skill scores; however, the improvement in the experimental group was higher than that of the control group. The experimental group achieved a posttest mean score of 25.55, while the

control group obtained 18.50. These differences indicate that the use of the PjBL-based rhythmic gymnastics e-module provided learning experiences that supported the development of students' critical thinking skills. Through project activities incorporated in the e-module, students were not only involved in learning movement techniques but also engaged in analyzing, evaluating, making decisions, and reflecting on their practice outcomes.

After identifying students' initial and final abilities through pretest and posttest scores, the next stage involved analyzing improvement using the N-Gain Score. This analysis aimed to determine the magnitude of changes in students' critical thinking skills in both the experimental and control groups after the learning process. The N-Gain calculation was conducted by comparing the difference between pretest and posttest scores with the maximum possible score to determine the level of improvement achieved by each group. The results of the critical thinking skill N-Gain analysis are presented in table 3.

Table 3. N-Gain Score of Critical Thinking Skills

Variable	Group	Pretest	Posttest	N-Gain
Critical Thinking Skill	Control	12.15	18.50	0.36
	Experimental	12.25	25.55	0.75

Lilliefors Significance Correction

Source: Primary research data processed using IBM SPSS Statistics 26

The N-Gain calculation showed that both groups experienced improvement in critical thinking skills after participating in the learning process, although the level of improvement differed. The control group demonstrated moderate improvement with an N-Gain score of 0.36, while the experimental group showed higher improvement with an N-Gain score of 0.75, categorized as high. These findings indicate that learning activities using the PjBL-based rhythmic gymnastics e-module provided richer learning experiences for developing students' critical thinking skills. Student involvement in project activities, including designing movement sequences, determining strategies, and evaluating practice outcomes, provided opportunities to develop analytical skills, reasoning abilities, and reflection during the learning process.

After determining the level of improvement through N-Gain analysis, prerequisite tests were conducted to determine the appropriate statistical technique for hypothesis testing. The normality test was performed to examine whether the pretest and posttest data from the experimental and control groups followed a normal distribution. In this study, the Shapiro-Wilk test was used because the number of participants in each group was fewer than 50 students. Data were considered normally distributed when the significance value was greater than 0.05. The results of the normality test for critical thinking skills are presented in Table 4.

Table 4. Normality Test
Tests of Normality

	Group	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Critical Thinking Skill (Pretest)	Control	0.197	20	0.041	0.857	20	0.007
	Experimental	0.241	20	0.003	0.890	20	0.027
Critical Thinking Skill (Posttest)	Control	0.249	20	0.002	0.888	20	0.025
	Experimental	0.259	20	0.001	0.914	20	0.076

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

Lilliefors Significance Correction

Source: Primary research data processed using IBM SPSS Statistics 26

The normality test results showed that most critical thinking skill data from the control and experimental groups did not meet the assumption of normal distribution. Based on the Shapiro-Wilk test, the significance values of the pretest data in both groups and the control group posttest data were below 0.05, whereas the experimental group posttest data showed a significance value above 0.05. These findings indicate that the overall data distribution did not satisfy the normality assumption. Therefore, the comparison analysis between groups was conducted using the nonparametric Mann-Whitney U Test rather than a parametric test.

The next stage involved a homogeneity test to determine whether the variances between the experimental and

control groups were similar. The homogeneity test was conducted as a prerequisite analysis to examine whether the data distribution in both groups had relatively similar characteristics. The analysis used Levene's Test, with data considered homogeneous when the significance value was greater than 0.05. The results of the homogeneity test are presented in table 5.

**Table 5. Homogeneity Test
Test of Homogeneity of Variances**

	Levene Statistic	df1	df2	Sig.
Critical Thinking Skill Based on Mean (Pretest)	0.671	1	38	0.418
Based on Median	0.410	1	38	0.526
Based on Median and with adjusted df	0.410	1	37.986	0.526
Based on trimmed mean	0.640	1	38	0.429
Critical Thinking Skill Based on Mean (Posttest)	0.011	1	38	0.918
Based on Median	0.013	1	38	0.910
Based on Median and with adjusted df	0.013	1	37.892	0.910
Based on trimmed mean	0.002	1	38	0.961

Lilliefors Significance Correction

Source: Primary research data processed using IBM SPSS Statistics 26

Based on the homogeneity test results presented in table 5, the critical thinking skill data from the experimental and control groups showed equal variances. This was indicated by the significance values of both pretest and posttest data, which were above the criterion value of 0.05. Therefore, there was no significant difference in data variability between the two groups before and after the learning process. These results indicate that both groups had comparable data characteristics and were appropriate for further analysis of differences in learning outcomes.

Based on the prerequisite test results, the critical thinking skill data did not meet the normality assumption but fulfilled the homogeneity assumption. Since one of the requirements for parametric testing was not satisfied, namely data normality, hypothesis testing was conducted using the nonparametric Mann-Whitney U Test.

**Table 6. Hypothesis Test (Mann-Whitney U Test)
Test Statistics^a**

	Critical Thinking Skills (Pretest)	Critical Thinking Skills (Posttest)
Mann-Whitney U	196.500	1.000
Wilcoxon W	406.500	211.000
Z	-0.096	-5.416
Asymp. Sig. (2-tailed)	0.923	0.000
Exact Sig. [2*(1-tailed Sig.)]	0.925 ^b	0.000 ^b

a. Grouping Variable: Group

Source: Primary research data processed using IBM SPSS Statistics 26

The Mann-Whitney U Test results showed that the initial critical thinking skills of students in the control and experimental groups were comparable. This was indicated by the pretest significance value of 0.923 ($p > 0.05$), showing no significant difference between groups before the intervention. After the learning process, the posttest results showed a significance value of 0.000 ($p < 0.05$), indicating a significant difference in critical thinking skill achievement between the experimental and control groups. This difference suggests that students who participated in learning activities using the PjBL-based rhythmic gymnastics e-module achieved higher critical thinking skill scores compared with students who participated in conventional learning activities.

Furthermore, an effect size analysis was conducted to determine the magnitude of the difference in critical thinking skill achievement between groups. The results are presented in table 7.

Table 7 Effect size

Test	Z	N	Effect Size (r)
Learning Motivation (Pretest)	-0.096	40	0,02

Long Jump Skills (Posttest)	-5.416	40	0,86
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Source: Primary data calculated based on Mann–Whitney U test results from IBM SPSS Statistics 26.

The pretest effect size analysis showed that the difference in initial abilities between the two groups was categorized as a very small effect ($r = 0.02$), indicating that the experimental and control groups had relatively comparable initial critical thinking skills. In the posttest measurement, the effect size increased to $r = 0.86$, which was categorized as a large effect. This finding indicates a substantial difference in critical thinking skill achievement between students who learned using the Project-Based Learning (PjBL)-based rhythmic gymnastics e-module and those who participated in conventional learning. The effect size value further supports the results of the Mann–Whitney U Test, indicating that the implementation of the e-module was associated with higher critical thinking skill achievement in the experimental group.

DISCUSSION

The development of a Project-Based Learning (PjBL)-based rhythmic gymnastics e-module provides a learning experience that integrates physical activities with cognitive processes. The relatively equivalent initial critical thinking abilities between the experimental and control groups indicate that the differences in learning outcomes after the intervention were more likely associated with the implementation of the PjBL-based e-module rather than differences in students' initial abilities. This finding demonstrates that learning designed through project activities can create a process that encourages students to actively engage in understanding, processing, and applying information. These results are consistent with the constructivist perspective, which states that students construct knowledge through active and meaningful learning experiences. Schunk (2020) explains that students' involvement in learning activities enables the development of understanding through processes of constructing, connecting, and evaluating information. In this study, project activities embedded in the e-module encouraged students to design, practice, evaluate, and improve their performance, thereby optimally developing critical thinking skills.

The improvement in students' critical thinking skills occurred because each stage of PjBL implemented in the e-module provided opportunities to develop different aspects of critical thinking. The problem identification stage encouraged students to interpret problems related to rhythmic gymnastics movements. The project planning stage developed analytical skills in selecting and arranging movement sequences. During the project implementation stage, students engaged in inference processes when determining solutions to identified movement errors. In the presentation stage, students explained the reasons behind their movement choices, thereby strengthening their explanation skills. Furthermore, evaluating group performance developed students' evaluation skills, while reflection activities at the end of the lesson fostered self-regulation through identifying strengths and weaknesses during project completion. This integration of activities indicates that the e-module not only presents rhythmic gymnastics content but is also designed to develop the six critical thinking indicators proposed by Facione (1990, as cited in Mastuti et al., 2022), namely interpretation, analysis, inference, explanation, evaluation, and self-regulation. Arini et al. (2023) also demonstrated that Facione's indicators can be used to describe students' abilities to understand information, conduct analysis, and provide reasoning for decision-making. Therefore, the activities incorporated in the PjBL-based e-module provide appropriate opportunities to develop these critical thinking aspects.

The effectiveness of the PjBL-based e-module in this study was also supported by the characteristics of PjBL, which positions students as the center of the learning process. During the learning activities, students did not merely follow teacher instructions but actively participated in completing projects through group collaboration and reflection on their learning outcomes. This finding is consistent with Antari et al. (2023), who reported that electronic modules based on Project-Based Learning (PjBL) improved students' learning outcomes by providing more active and meaningful learning experiences. Although the previous study was conducted in science learning, the underlying principle of project-based learning is similar, as both encourage students to learn through inquiry processes and produce a product or meaningful work.

Unlike the study by Adha et al. (2023), which developed a STEM-based e-module in physics learning, this research implemented a Project-Based Learning (PjBL)-based e-module in physical education through rhythmic

gymnastics activities. This difference indicates that the development of critical thinking skills is not limited to conceptual learning contexts but can also be achieved through learning involving motor activities. In this study, critical thinking skills developed when students designed movement sequences, determined solutions to movement errors, evaluated practice outcomes, and reflected on the learning process. These findings extend previous research by demonstrating that active learning-based e-modules can develop critical thinking skills while showing that such principles are also effective when applied in physical education contexts that combine physical activities with project-based problem solving.

Similarly, this study differs from Baidowi et al. (2023), who developed a Project-Based Learning (PjBL) module in vocational education to improve critical thinking skills. The present study was conducted with elementary school students whose learning characteristics differ from vocational learners. At the elementary level, project activities need to be adapted to students' developmental abilities through simpler and more contextual learning experiences. Nevertheless, previous findings reinforce that students' involvement in planning, implementing, and evaluating projects is an important factor in improving critical thinking skills. This process was reflected in the current study when students designed rhythmic gymnastics sequences, determined practice strategies, and evaluated the results of their group performances.

Within the context of physical education learning, this study also differs from Maratis et al. (2023), who examined the effects of gymnastics activities on students' physical fitness and cognitive abilities through rhythmic auditory stimulation exercises. Their study did not integrate digital learning media or the PjBL model into the learning process. However, their findings support the idea that gymnastics activities have potential not only for developing physical aspects but also cognitive abilities. The present study extends this perspective by demonstrating that the integration of digital e-modules and PjBL can strengthen rhythmic gymnastics learning, enabling students to gain learning experiences that simultaneously involve physical, cognitive, and social dimensions.

Overall, this study demonstrates that the Project-Based Learning (PjBL)-based rhythmic gymnastics e-module is effective in improving elementary school students' critical thinking skills. The main contribution of this study lies in the development of an e-module that integrates PjBL syntax, rhythmic gymnastics motor activities, and six critical thinking indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation, as proposed by Facione (1990, as cited in Mastuti et al., 2022), into a comprehensive learning design. This integration indicates that Physical Education learning is not only oriented toward mastering motor skills but can also foster higher-order thinking skills through structured project activities. Unlike previous studies that generally developed e-modules to improve learning outcomes or applied them in general subjects, this study extends the application of PjBL-based e-modules in Physical Education by connecting physical activities, critical thinking processes, and learning reflection within a single learning experience. Therefore, the developed e-module can serve as an alternative learning medium that supports active, collaborative learning and promotes the development of 21st-century skills.

CONCLUSION

The development of a Project-Based Learning (PjBL)-based rhythmic gymnastics e-module resulted in a learning medium that is feasible for use in rhythmic gymnastics instruction at the elementary school level. The implementation of the PjBL-based e-module contributed to higher critical thinking skills among students compared with conventional learning. These findings indicate that integrating an e-module with PjBL syntax can support rhythmic gymnastics learning that focuses not only on motor skills but also trains students to analyze, make decisions, evaluate, and improve their practice outcomes.

Theoretically, this study strengthens the view that integrating learning technology with the PjBL model can serve as an effective approach to developing higher-order thinking skills through learning experiences involving analysis, problem-solving, and evaluation processes. Practically, the developed e-module can be utilized by physical education teachers as an alternative learning resource to support more engaging and student-centered rhythmic gymnastics instruction. For schools, this product can serve as a digital learning innovation that supports the improvement of technology-based learning quality.

This study is limited to the implementation of a PjBL-based rhythmic gymnastics e-module among fifth-grade students in one elementary school with a limited number of participants. Therefore, future studies are recommended to examine the use of this e-module at different educational levels, with diverse student characteristics, and across various physical education topics. Further research may also involve larger sample sizes and longer-term measurements to examine the sustainability of critical thinking skill development after the implementation of the e-module.

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