ISSN 1392-0340 (Print)
ISSN 2029-0551 (Online)
https://doi.org/10.15823/p.2026.162.10

Pedagogika / Pedagogy
2026, t. 162, Nr. 2, p. 198–222 / Vol. 162, No. 2, pp. 198–222, 2026

VYTAUTO DIDŽIOJO UNIVERSITETO ŠVIETIMO AKADEMIJA

Students' Learning Outcomes Under Project-Based Learning: A Critical Thinking Perspective on Inflation Topics

Ari Data[1], Selvita Eka Eviana Purba[2*], Emirensiana Adha[3], Agustina Butar-Butar[4]

[1] Nusa Cendana University, Economics Education Department, Faculty of Teacher Training and Education, Adisucipto St., Penfui, Kupang City, East Nusa Tenggara, Indonesia, ari.data@staf.undana.ac.id
[2] Nusa Cendana University, Economics Education Department, Faculty of Teacher Training and Education, Adisucipto St., Penfui, Kupang City, East Nusa Tenggara, Indonesia, selvita_purba@staf.undana.ac.id – *Corresponding Author
[3] Nusa Cendana University, Economics Education Department, Faculty of Teacher Training and Education, Adisucipto St., Penfui, Kupang City, East Nusa Tenggara, Indonesia, emirensiana_adha@staf.undana.ac.id
[4] Nusa Cendana University, Economics Education Department, Faculty of Teacher Training and Education, Adisucipto St., Penfui, Kupang City, East Nusa Tenggara, Indonesia, agustina.butarbutar@staf.undana.ac.id

Annotation. This study examines the effect of PjBL on economics learning outcomes in price index and inflation topics, considering critical thinking ability. Drawing on quasi-experimental data and analyzed using two-way ANOVA, PjBL leads to significantly higher learning outcomes than traditional instruction, while critical thinking ability independently affects achievement. No significant interaction effect, indicating PjBL is effective across different levels of critical thinking ability.

Keywords: *critical thinking level, economics learning, inflation, learning outcomes, project-based learning.*

Introduction

Inflation is a crucial macroeconomic indicator in senior high school economics learning because it is directly related to price changes, purchasing power, and everyday

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economic dynamics. However, the nature of the topic requires higher-order thinking skills, as students must interpret price data, analyze causal relationships, and relate them to real-world economic contexts. Abstract instructional approaches may limit students' conceptual understanding and encourage surface learning, making inflation concepts difficult to grasp when detached from students' economic experiences (Reimann, 2004; Tang, 2023).

From a constructivist perspective, meaningful learning occurs when students actively construct knowledge through experience, social interaction, and reflection rather than passively receive information (Prakash Chand, 2023; Vygotsky, 1978). Consistent with this view, deep learning develops when learners actively process and connect knowledge to meaningful experiences. Biggs (2011) argued that deep learning occurs when students actively process, connect, and reconstruct knowledge based on meaningful learning experiences. In line with criticisms regarding the dominance of abstract approaches in economics education (Deaton, 2024), previous studies have shown that contextual learning involving authentic data, case analysis, field investigations, and project activities can enhance conceptual understanding and economic reasoning (Becker & Watts, 2001; Caviglia-Harris, 2020; Gijbels, 2014; Hazlett & Hill, 2003). One instructional approach that embodies these constructivist principles is Project-Based Learning (PjBL), which engages students in constructing knowledge through projects based on real-world situations.

PjBL places students at the center of learning through investigation, collaboration, and problem-solving in authentic contexts. In the context of inflation learning, PjBL enables students to collect price data from their surrounding environment, construct price indices, calculate inflation rates, and analyze factors contributing to price changes (Purba et al., 2025). Through these activities, students do not merely learn economic concepts theoretically but develop understanding based on their own experiences and observations. Morton & Rezny emphasized that active and contextual learning strategies can improve economic understanding while reducing misconceptions. Numerous studies have demonstrated that PjBL effectively improves learning outcomes across various disciplines, including science (Khafah et al., 2023) and the humanities (Montessori et al., 2024; Nielsen, 2024). In economics education, projects derived from real economic phenomena allow students to connect theoretical concepts with directly observed conditions, thereby strengthening their abilities to analyze, evaluate, and reflect upon economic data (Cortázar et al., 2021; Skliarova, 2021). However, the effectiveness of PjBL does not occur automatically. Cognitive Load Theory suggests that complex learning activities may impose excessive cognitive demands when they are not supported by clear task structures, adequate scaffolding, and effective teacher guidance (Kirschner et al., 2006; Sweller et al., 2019). In inflation and price index topics, cognitive demands become even more challenging because students must simultaneously integrate numerical skills, data analysis, and economic reasoning (Binetti et al.,

2024). Therefore, the success of PjBL in these topics largely depends on students' ability to manage and process information throughout the learning process.

Within this context, critical thinking emerges as an important cognitive characteristic. Critical thinking is commonly defined as the ability to systematically analyze information, evaluate evidence-based arguments, and draw logical and reflective conclusions (Elder, 2020; Ennis, 2011; Facione, 2015; Usman et al., 2024). According to Information Processing Theory, effective learning occurs when learners are able to select, organize, and integrate new information into their existing knowledge structures (Atkinson & Shiffrin, 1968). Students with higher levels of critical thinking tend to analyze, evaluate, and interpret information more deeply (Facione, 2015), resulting in stronger conceptual elaboration. In contrast, students with lower levels of critical thinking often struggle to process complex information and are more likely to adopt surface learning approaches that emphasize memorization and limited understanding (Biggs, 2011; Entwistle & McCune, 2013). In learning inflation and price index concepts, critical thinking is particularly important because students are required to interpret price data, identify patterns of economic change, and evaluate the implications of inflationary phenomena.

From this perspective, critical thinking functions not only as a learning outcome but also as a cognitive characteristic that may influence the effectiveness of instructional approaches. Previous studies indicate that students with higher critical thinking abilities tend to benefit more from problem-based and project-based learning because they are better able to manage complex information, evaluate alternative solutions, and make data-driven decisions (Bara et al., 2025; Khabibah & Sukarmin, 2025; Rambe, 2020). These findings suggest that the success of instructional approaches involving investigation and problem-solving activities is strongly influenced by students' ability to process and utilize information critically. In inflation learning, the characteristics of PjBL, including authentic inquiry, price data collection, analysis of economic changes, and evaluation of inflationary impacts, require substantial engagement of students' critical thinking skills.

However, the influence of critical thinking on the effectiveness of project-based learning may not be absolute. From a social constructivist perspective, scaffolding and collaboration can help students perform beyond their initial capabilities (Vygotsky, 1978). Within PjBL, group work, discussions, collaborative investigations, and project presentations create a learning environment that continuously facilitates scaffolding. Therefore, although students with higher critical thinking abilities are expected to possess advantages in processing complex information, the social and cognitive support available in PjBL may reduce differences in students' initial abilities, allowing those with lower levels of critical thinking to benefit from the learning process as well.

Although numerous studies have confirmed the effectiveness of PjBL in improving learning outcomes and critical thinking skills, several research gaps remain. First,

most studies have focused primarily on the direct effects of PjBL on learning outcomes without adequately considering students' cognitive characteristics as factors that may influence instructional effectiveness (Cortázar et al., 2021; Purba et al., 2025; Tafakur et al., 2023). Second, research examining the implementation of PjBL in economics education, particularly in inflation and price index topics, remains limited (Hasan et al., 2023; Hastuti, 2024; Julita & Armiati, 2025). Third, although Cognitive Load Theory suggests that complex project tasks may present different challenges for students with varying cognitive abilities, empirical evidence regarding whether critical thinking strengthens or does not influence the effectiveness of PjBL in economics learning remains inconclusive.

Based on these gaps, we aim to examine the effect of Project-Based Learning on economics learning outcomes in inflation topics while considering students' critical thinking ability as a cognitive characteristic that may influence instructional effectiveness. Accordingly, the following hypotheses are proposed:

H1: There is a significant difference in economics learning outcomes on inflation topics between students taught using the Project-Based Learning (PjBL) model and those taught using traditional instruction.

H2: There are significant differences in economics learning outcomes on inflation topics among students with high, medium, and low levels of critical thinking ability.

H3: There is a significant interaction between the learning model and critical thinking ability on economics learning outcomes in inflation topics.

Theoretical Overview

Project-Based Learning and Learning Outcomes

Project-Based Learning (PjBL) has been widely examined as one of the most effective instructional approaches for improving students' learning outcomes. According to Thomas (2000), PjBL emphasizes in-depth inquiry into authentic problems or questions, enabling students not only to acquire conceptual knowledge but also to develop analytical and reflective skills. A study by Sari et al. (2024) reveals that the integration of computational thinking within collaborative PjBL not only enhances students' problem-solving abilities but also strengthens their capacity to apply concepts to real-world situations. This perspective aligns with Dewey's (1938) view that learning should be grounded in direct experiences relevant to students' lives, through which critical thinking skills can be cultivated via interactive processes.

These findings underscore that project-based learning enables students to identify problems, design problem-solving strategies, and critically evaluate alternative solutions (Sánchez-García & Reyes-de-Cózar, 2025; Setiaji et al., 2025; Skliarova, 2021; Susanto

et al., 2025). Such cognitive processes promote deeper information processing, allowing students not merely to memorize concepts but to understand, apply, and evaluate knowledge meaningfully. Consequently, stronger conceptual understanding is reflected in higher learning outcomes. This process explains why PjBL often yields superior learning outcomes compared to traditional instruction. Nevertheless, the effectiveness of PjBL is highly dependent on several supporting factors. First, the quality of instructional design and teacher involvement plays a crucial role in its success. Research indicates that well-structured projects, clearly defined learning objectives, and active teacher guidance are essential for enabling PjBL to effectively foster critical thinking skills (Shi & Li, 2024). Second, students' participation and engagement are also critical factors. High levels of participation facilitate active collaboration, idea exploration, and solution discovery, while relevant and engaging projects have been shown to motivate students to take an active role in the learning process (Sarwanti et al., 2024; Yulhendri et al., 2023).

Students' Critical Thinking

Critical thinking is recognized as one of the essential competencies in modern education because it supports problem-solving, decision-making, and lifelong learning (Molinari & Dupler, 2005; Vincent-Lancrin, 2024). This competency is important not only in educational settings but also across various aspects of life, as it enables individuals to participate actively in society, innovate, and adapt to rapid changes. Critical thinking is understood as a multidimensional process involving reflective judgment, analysis, synthesis, evaluation, and decision-making based on relevant information and evidence (Vincent-Lancrin, 2024). Individuals with strong critical thinking skills are able to understand problems systematically, evaluate information objectively, construct logical arguments, and draw accountable conclusions. Therefore, critical thinking can be viewed as the ability to utilize knowledge and cognitive strategies to produce rational decisions (Fahim & Masouleh, 2012).

Critical thinking consists of several interrelated dimensions. The first dimension comprises cognitive skills, including the abilities to analyze, evaluate, and interpret information, provide explanations, draw inferences, and engage in self-regulation. These skills enable individuals to process information systematically and make decisions based on logical reasoning. The second dimension involves affective dispositions, including open-mindedness, curiosity, truth-seeking, systematic thinking, and confidence in reasoning (Facione, 2015). The third dimension is metacognitive regulation, which refers to the ability to plan, monitor, and evaluate one's own thinking processes (Ku & Ho, 2010). Although distinct, these three dimensions are closely interconnected in shaping an individual's critical thinking ability (Quinn et al., 2020). In educational contexts, critical thinking can be identified through several indicators. Rubiyanti et al. (2020) explain that critical thinking indicators include the ability to provide simple

explanations, develop basic skills, draw conclusions, offer further explanations, and determine appropriate strategies or actions.

Critical thinking ability can also be distinguished according to different levels, namely high and low levels of critical thinking. Individuals with high levels of critical thinking demonstrate stronger analytical and reasoning abilities, are capable of asking probing questions to examine assumptions, and can solve complex problems through mature reflective processes. In contrast, individuals with lower levels of critical thinking tend to provide simpler explanations, encounter difficulties when dealing with complex problems, and possess limited capacity to evaluate and revise their own thinking processes (Forood & Farahani, 2013; Ku & Ho, 2010).

Critical thinking is closely related to Higher Order Thinking Skills (HOTS). Critical thinking refers to the ability to analyze, evaluate, and draw logical and reflective conclusions based on available evidence. HOTS, on the other hand, encompasses higher-level cognitive processes such as analysis, evaluation, and creation, while also incorporating critical, creative, logical, reflective, and metacognitive thinking (Asok et al., 2016; Rahayu & Alsulami, 2024). Consequently, HOTS has a broader scope than critical thinking because it includes not only analytical and evaluative processes but also the ability to generate solutions and solve problems. HOTS-based instruments are generally developed based on the revised Bloom's Taxonomy, which emphasizes higher-order cognitive processes of analysis, evaluation, and creation (Epinasti et al., 2021). Although HOTS encompasses various higher-order thinking abilities, critical thinking remains one of its central components because activities such as analyzing information, evaluating arguments, and making inferences constitute essential elements of higher-order thinking (Asok et al., 2016). Therefore, HOTS-based instruments can be used to represent critical thinking measurement when the indicators specifically reflect critical thinking dimensions such as interpretation, analysis, evaluation, and inference (Epinasti et al., 2021; Khaeruddin & Amin, 2020).

In economics education, critical thinking enables students to understand causal relationships among economic phenomena, evaluate available information, and make decisions based on relevant data and evidence. Students with higher levels of critical thinking are generally better able to analyze complex economic problems, connect economic concepts to real-world situations, and evaluate alternative solutions rationally. In contrast, students with lower levels of critical thinking tend to rely on memorization and often experience difficulties when confronted with problems requiring deeper analysis and reasoning. Consequently, critical thinking can contribute to improved economics learning outcomes, particularly in topics that require conceptual understanding and higher-order cognitive abilities (Borg & Stranahan, 2010; Facione, 2015; Gustiara, 2025; Sekwena, 2023).

Methodology

We designed this study using a quasi-experimental approach with a non-equivalent control group pretest–posttest design (Creswell, 2014) and a 2×3 factorial design. The factorial design was employed to examine the main effects of the instructional model and students' critical thinking ability, as well as the interaction effect between these two variables on students' learning outcomes. The first factor is the learning model (Project-Based Learning vs. traditional learning), and the second factor is students' critical thinking ability (high, medium, low). The dependent variable is students' posttest score on price index and inflation topics (see Table 1).

Table 1
Factorial Research Design

Model	High Critical Thinking (B1)	Moderate Critical Thinking (B2)	Low Critical Thinking (B3)
PjBL (A1)	A1B1	A1B2	A1B3
Traditional (A2)	A2B1	A2B2	A2B3

This study involved 162 eleventh-grade students from State Senior High School XYZ in Malaka Regency, East Nusa Tenggara, who were enrolled in the economics track. The participants were divided into two groups: an experimental group (n = 80) and a control group (n = 82). The school was selected purposively based on curriculum equivalence, student characteristics, and the availability of public senior high schools in Malaka Regency. In total, 162 students participated in the study, comprising the experimental group (n = 80) and the control group (n = 82).

Table 2
Characteristics of Research Participants

School	Group	n	Male	Female	17 years	16 years
SMA X	Experimental	35	9	26	31	4
	Control	36	11	25	31	5
	Total	71	20	51	62	9
SMA Y	Experimental	25	15	10	23	2
	Control	25	16	9	22	3
	Total	50	31	19	45	5
SMA Z	Experimental	20	12	8	18	2
	Control	21	12	9	18	3
	Total	41	24	17	36	5

Note: Experimental group received Project-Based Learning (PjBL), while control group received traditional instruction.

Research Instruments

The test instruments used in this study consisted of 20 Higher Order Thinking Skills (HOTS)-based multiple-choice items that had been validated and tested for reliability to measure students' critical thinking ability, and 20 multiple-choice test items designed to measure students' economics learning outcomes. The instruments were developed based on critical thinking indicators adapted from the revised taxonomy of Anderson and Krathwohl (2001), with an emphasis on three higher-order cognitive domains: analyzing (C4), evaluating (C5), creating (C6). The critical thinking instrument consisted of 20 multiple-choice items developed using a Higher Order Thinking Skills (HOTS)-based approach. Although HOTS covers broader cognitive abilities, including creativity and problem-solving, this instrument was specifically designed to assess critical thinking processes. The items were developed based on critical thinking indicators, including interpretation, analysis, evaluation, and inference, which represent students' ability to understand information, analyze evidence, evaluate arguments, and draw logical conclusions.

In the initial stage, the test instrument comprised 25 items, which were subsequently validated by two experts: a lecturer in economics education and an economics teacher. Following item analysis, 20 items met the eligibility criteria. The validity test results indicated that 23 items were valid, with correlation coefficients (r) ranging from 0.321 to 0.658 (r-table = 0.334; n = 35). Reliability testing using the Kuder–Richardson Formula 20 (KR-20) yielded an r_{11} value of 0.846, indicating very high reliability. For the economics learning outcomes test, 23 items were found to be valid, while two items were deemed invalid. The reliability of this instrument was also calculated using the Kuder–Richardson Formula 20 (KR-20), resulting in a reliability coefficient of 0.8237. Item difficulty analysis showed that 21 items fell within the acceptable category, with difficulty indices ranging from 0.30 to 0.70, whereas four items were classified as unsuitable. Meanwhile, the discrimination index analysis revealed that 23 items demonstrated good discriminating power. Therefore, 20 items were determined to be valid and reliable for use as instruments to measure students' economics learning outcomes in this study. Each correct answer was assigned a score of 1, while an incorrect answer was assigned a score of 0. The total raw score was then converted into a scale of 0–100 to represent students' economics learning outcomes.

Research Methodology

Prior to the implementation of the study, Prior to the implementation of the study, we provided guidance to the teachers involved regarding the learning procedures and the use of instructional materials. To minimize the teacher effect, the same teacher taught both the experimental and control classes at each school. The study was conducted over five consecutive meetings, with a time allocation of 2 × 45 minutes per meeting. The learning materials included Unweighted Price Index, Weighted Price

Index (Laspeyres, Paasche, Marshall–Edgeworth, Drobisch– Bowley and Irving Fisher) as well as the concept of inflation, its types, causes, and impacts. Both groups received the same core content, number of meetings, and evaluation instruments, but differed in the instructional approach.

Instruction in the experimental class was designed using a project-based approach that emphasized authentic data collection, analysis, and presentation of results.

Meeting 1: Critical Thinking Pretest and Introduction to Price Indices. First, we administered a critical thinking ability test as the basis for grouping students into high, medium, and low categories. Then, the teacher explained the basic concepts of price indices and price changes in daily life. Second, Project 1 was assigned (group work, 5–6 students per group): interviewing local vendors, recording types of goods, current and previous month prices, identifying causes of price changes, examining impacts on buyers and sellers, recording quantities purchased when prices change, and organizing the data into price and quantity tables.

Meeting 2: Unweighted Price Index and Laspeyres Weighted Price Index. First, the teacher explained the concepts of the unweighted price index and the Laspeyres price index. Second, three groups presented the results of their interviews from the previous week. Third, students completed Exercise 1 (five items, 15–20 minutes) to assess learning outcomes for the session.

Meeting 3: Weighted Price Indices. First, the teacher explained the Paasche, Marshall–Edgeworth, Drobisch – Bowley and Irving Fisher price indices. Second, Project 2 was assigned, requiring students to calculate price indices based on the interview data collected by each group. Third, students completed Exercise 2 (five items) to measure their learning outcomes.

Meeting 4: Inflation and Price Data Analysis. First, three groups presented the results of the previous project. Second, the teacher explained the concept of inflation, its types, causes, and impacts. Third, Project 3 was assigned, in which students analyzed price changes from the interview data, calculated inflation rates, determined inflation categories, identified real impacts on merchants and buyers, prepared a project report, and created an infographic on inflation. Fourth, students completed Exercise 3 (five items) to assess learning outcomes.

Meeting 5: Project Presentation and Posttest. First, each group presented the results of their data analysis and project infographics. Second, students and the teacher jointly summarized the observed price and inflation phenomena based on the field data. After the instructional activities, students completed a 20-item posttest to measure their overall economics learning outcomes on price index and inflation topics.

The control group studied the same instructional content but was taught using a traditional lecture-based approach with worked examples, without project-based activities or field investigations.

Meetings 1–5**.** The teacher delivered the material using the whiteboard and slides, provided sample problems that were solved collectively, and administered Exercises 1, 2, and 3 at the end of each session using the same items as those given in the experimental class. The pretest and posttest were administered in the first and fifth meetings, respectively, following the same procedures as in the experimental class. Thus, the primary difference between the two groups lay in the inclusion of field-based investigative projects, context-based problem-solving, and presentation activities, which are key characteristics of the Project-Based Learning model.

Data Analysis

Hypothesis testing was conducted using a two-way analysis of variance (two-way ANOVA) with a 2×3 factorial design. The first factor was the instructional model (Project-Based Learning and traditional instruction), while the second factor was students' critical thinking ability, which was categorized into high, moderate, and low levels. Students were classified into high, moderate, and low critical thinking levels using a norm-referenced categorization based on Azwar (2012); Budiyono (2016). Scores ≥ Mean + 0.5 SD were categorized as high, scores within Mean ± 0.5 SD as moderate, and scores < Mean − 0.5 SD as low. The dependent variable in this analysis was students' economics learning outcomes on inflation topics. Prior to conducting inferential analysis, posttest scores of learning outcomes were examined to ensure that the assumptions of ANOVA were met. Normality was tested using the Kolmogorov–Smirnov test to confirm that the data distribution approximated normality, and homogeneity of variances was assessed using Levene's Test of Equality of Error Variances to ensure equal variances across groups. All statistical tests were conducted at a significance level of $\alpha = 0.05$ (Budiyono, 2016). When the ANOVA results indicated significant differences, further analysis was performed using the Games–Howell post hoc test to identify specific groups that exhibited significant mean differences, including comparisons across rows, columns, and cells.

Results and Discussion

Based on the estimated mean posttest scores (Table 3), we found that the Project-Based Learning (PjBL) model produced higher learning outcomes than traditional instruction across all levels of critical thinking ability. Among students with high critical thinking ability, the mean posttest score in the PjBL group (M = 70.32; SE = 2.60; 95% CI [65.18–75.47]) was higher than that of the traditional learning group (M = 63.28; SE = 2.69; 95% CI [57.96–68.60]). At the moderate level of critical thinking ability, the largest mean difference was observed, with students in the PjBL group achieving the highest scores (M = 73.48; SE = 3.02; 95% CI [67.51–79.45]), whereas students in the

traditional instruction group obtained substantially lower mean scores (M = 57.08; SE = 2.96; 95% CI [51.24–62.93]). Similarly, among students with low critical thinking ability, the PjBL group continued to demonstrate superior performance (M = 63.85; SE = 2.84; 95% CI [58.23–69.46]) compared to the traditional learning group (M = 51.72; SE = 2.69; 95% CI [46.40–57.04]). Overall, this pattern indicates that PjBL consistently resulted in higher economics learning outcome scores across all categories of critical thinking ability.

***Table* 3**
*Descriptive Data Critical Thinking * Model*

Critical Thinking	Model	N	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
High	PjBL	31	70.322	2.604	65.177	75.467
	Traditional	29	63.275	2.692	57.956	68.595
Medium	PjBL	23	73.478	3.023	67.505	79.451
	Traditional	24	57.083	2.960	51.236	62.930
Low	PjBL	26	63.846	2.844	58.228	69.463
	Traditional	29	51.724	2.692	46.404	57.043

The Estimated Marginal Means (EMMs) results (Table 4) reveal differences in mean posttest scores based on levels of critical thinking ability after controlling for other factors in the ANOVA model. Students with high critical thinking ability achieved the highest estimated mean posttest score (M = 66.80; SE = 1.87; 95% CI [63.10–70.50]), followed by students with moderate critical thinking ability (M = 65.28; SE = 2.12; 95% CI [61.10–69.46]). In contrast, students with low critical thinking ability exhibited the lowest estimated mean posttest score (M = 57.79; SE = 1.96; 95% CI [53.92–61.65]). Descriptively, our analysis revealed a downward trend in posttest scores as the level of critical thinking ability decreased. Furthermore, the Estimated Marginal Means for the instructional model indicate that students taught using Project-Based Learning (PjBL) obtained higher estimated mean posttest scores (M = 69.22; SE = 1.63; 95% CI [65.99–72.44]) than those who received traditional instruction (M = 57.36; SE = 1.61; 95% CI [54.19–60.54]). The substantial mean difference between the two instructional models descriptively demonstrates that PjBL is more effective in improving students' learning outcomes than traditional instruction.

***Table* 4**

Estimated Marginal Means Posttest

	Mean	Std.Error	95% Confidence Interval	
Critical Thinking				
High	66.799	1.873	63.099	70.499
Moderat	65.281	2.116	61.102	69.46
Low	57.785	1.958	53.917	61.653
Model				
PjBL	69.22	1.63	65,99	72.44
Traditional	57.36	1.61	54.19	60.54

Table 5

Hypotesis Test

Source	df	Mean Square	F	Sig.	Hypothesis
Critical_Thinking	2	1292.976	6.148	.003	Supported
Model	1	5625.467	26.749	.000	Supported
Critical_Thinking * Model	2	291.922	1.388	.253	Not Supported

R Squared = .210 (Adjusted R Squared = .185)

The results of the two-way analysis of variance indicated that the overall research model was significant, $F(5,156) = 8.30$, $p < .001$, with an R^2 value of 0.21, indicating that the combination of the learning model and critical thinking ability explained approximately 21% of the variance in posttest scores. Partially, critical thinking ability had a significant effect on learning outcomes, $F(2,156) = 6.15$, $p = .003$, with a small to moderate effect size (partial $\eta^2 = 0.073$), suggesting that differences in levels of critical thinking ability were associated with differences in students' learning achievement. In addition, our analysis showed that the learning model had a significant and stronger effect on learning outcomes, $F(1,156) = 26.75$, $p < .001$, with a moderate to large effect size (partial $\eta^2 = 0.146$), confirming the superiority of the Project-Based Learning model over traditional learning in improving students' learning outcomes. However, no significant interaction was found between the learning model and critical thinking ability on learning outcomes, $F(2, 156) = 1.39$, $p = .253$, with a very small effect size (partial $\eta^2 = 0.017$). These findings confirm that the effect of the learning model on learning outcomes is relatively consistent across all levels of critical thinking ability.

Table 6

Post-hoc Games-Howell Test

(I) Critical Thinking	(J) Critical Thinking	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Upper Bound	Lower Bound
High	Moderat	1.8103	2.76314	.790	-4.7719	8.3924
	Low	9.4621(*)	3.00421	.006	2.3115	16.6128
Moderat	High	-1.8103	2.76314	.790	-8.3924	4.7719
	Low	7.6518	3.30075	.058	-.2013	15.5050
Low	High	-9.4621(*)	3.00421	.006	-16.6128	-2.3115
	Moderat	-7.6518	3.30075	.058	-15.5050	.2013

* The mean difference is significant at the .05 level.

Because the assumption of homogeneity of variances was not met ($F = 7.621$, $p < 0.05$), we conducted a follow-up analysis using the Games–Howell test, which is robust to unequal variances and sample sizes (Field, 2018). The results of the Games–Howell post-hoc test showed that students with high critical thinking ability had significantly higher economics learning outcomes than students with low critical thinking ability, with a mean difference of 9.46 points ($p = .006$; 95% CI [2.31, 16.61]). In contrast, the comparison between students with high and moderate critical thinking ability did not show a significant difference (MD = 1.81; $p = .790$; 95% CI [−4.77, 8.39]). Similarly, the comparison between students with moderate and low critical thinking ability did not show a statistically significant difference (MD = 7.65; $p = .058$; 95% CI [−0.20, 15.51]). These findings confirm that improvements in economics learning outcomes become more evident when students are able to reach a high level of critical thinking, rather than merely transitioning from a low to a moderate level.

Overall, our findings support the first and second hypotheses but do not support the third hypothesis. These findings are discussed as follows. First, project-based learning is more effective than traditional learning in improving students' understanding of price index and inflation concepts. The superiority of PjBL is reflected in higher posttest scores in the experimental group across all levels of critical thinking ability. This indicates that PjBL provides relatively consistent benefits for students with high, moderate, and low critical thinking ability. Theoretically, these results are in line with the perspective of Maros et al. (2023), who emphasize that economics learning at the secondary level aims to prepare students to adapt to changes in everyday life. Active involvement of both students and teachers during the learning process is a crucial factor. In this study, such active involvement was realized through a series of field investigation projects carried out by students over five consecutive meetings. Students did not merely receive conceptual explanations from the teacher, but were also directly involved in

collecting price data, processing data, engaging in group discussions, and presenting their analytical results, thereby making the learning process more meaningful.

The implementation of PjBL in learning about price indices and inflation enabled students to construct knowledge through direct experience. During the initial session, we introduced the concept of price indices through the context of price changes occurring in students' surrounding environments. Before the learning process began, most students had already experienced observing fluctuations in the prices of goods as consumers in their daily lives. PjBL allowed these everyday experiences to be integrated with formal economic concepts related to price indices and inflation, resulting in deeper and more meaningful conceptual understanding. This finding is consistent with constructivist theory, which argues that meaningful learning occurs when students actively process, connect, and reconstruct knowledge based on experience and empirical evidence (Mardiana et al., 2025; Skliarova, 2021; Tafakur et al., 2023). Furthermore, through projects involving interviews with local merchants and the recording of prices of basic commodities, students began to connect theoretical concepts with real economic phenomena encountered in everyday life. As stated by Purba (2023) price indices constitute a key indicator for understanding inflation and broader macroeconomic dynamics. In this study, students not only learned the formulas for unweighted and weighted price indices in an abstract manner but also applied them directly to data obtained from interviews. The process of calculating price indices and inflation rates using actual data helped students understand concepts that are inherently mathematical and abstract in a more concrete way.

This process can also be explained through Piaget's constructivist mechanisms of assimilation and accommodation (Cohen & Waite-Stupiansky, 2017). When students collected and analyzed price data from their surroundings, they attempted to connect new information with their prior knowledge regarding everyday price increases (assimilation). Subsequently, through the calculation of price indices and the analysis of empirical data, they revised and adjusted their existing cognitive structures, leading to a more accurate understanding of inflation and price index concepts (accommodation). Therefore, the projects undertaken by students not only strengthened their theoretical understanding but also developed their ability to analyze empirical data in ways that resemble real-world economic practices.

The linkage between theory and real-life experience is further reinforced by Linh (2024) who emphasizes that when students process price data, create graphs, and develop infographics, they are essentially building economic understanding through authentic and guided investigative activities. In this study, learning activities were characterized by the preparation of project reports and inflation infographics that were presented by students. These activities encouraged students to evaluate data, draw conclusions, and communicate analytical results systematically – all of which are important indicators of critical thinking ability in economics learning. In contrast, in

the control class, learning was conducted using a traditional approach through lectures, limited discussions, and the completion of sample problems. Although the material, time allocation, and evaluation instruments were the same as those in the experimental class, the absence of project activities and field investigations caused students to play a more passive role as recipients of information. This condition potentially limited students' opportunities to develop deep conceptual understanding and context-based critical thinking skills, resulting in relatively lower learning outcomes compared to the PjBL group (Guo et al., 2024).

Second, the results revealed that significant differences in learning outcomes occurred only between students with high and low levels of critical thinking ability. This finding highlights the important role of critical thinking in helping students understand concepts related to price indices and inflation. From the perspective of Information Processing Theory, learning success depends on students' ability to select, organize, and integrate new information into their existing knowledge structures (Atkinson & Shiffrin, 1968). In this context, students with higher critical thinking ability tend to be more effective in engaging in cognitive elaboration, evaluating information, and linking empirical data with economic concepts. Consequently, they are better able to understand the relationships among price changes, price index calculations, and inflation phenomena at a conceptual level compared with students with lower critical thinking ability. These results are consistent with previous studies by Cindiati et al. (2021); D'Alessio et al. (2019); Lv et al. (2025), which suggest that critical thinking functions as an important cognitive mechanism in helping students understand learning materials. In project-based learning, students with lower levels of critical thinking were not allowed to learn passively. Instead, they were systematically guided to engage in authentic activities such as collecting price data, constructing tables, calculating price indices, analyzing inflation rates, and presenting their findings. These activities functioned as a form of cognitive scaffolding(Maghfiroh & Muttaqin, 2025), helping students develop conceptual understanding gradually through structured learning experiences. This condition can be explained through Vygotsky (1978) concept of the Zone of Proximal Development (ZPD), which suggests that students can achieve higher levels of understanding when supported by teachers and peers. Through group discussions, task sharing, collaborative problem-solving, and project presentations, students with lower critical thinking ability were provided opportunities to learn from the thinking strategies of more capable peers and to receive assistance in completing tasks that initially exceeded their individual capabilities. This process contributed to narrowing the achievement gap between students with low and moderate critical thinking ability, resulting in differences that were smaller than theoretically expected. Nevertheless, PjBL did not completely eliminate the cognitive advantages possessed by students with high critical thinking ability. Students in this group continued to

demonstrate stronger abilities in analyzing complex data, drawing evidence-based conclusions, and linking project findings to more abstract macroeconomic concepts.

Third, we found no significant interaction between instructional model and critical thinking ability. This indicates that the positive effect of PjBL on learning outcomes was relatively consistent across students with high, moderate, and low levels of critical thinking ability. This finding is noteworthy because critical thinking is often regarded as a cognitive characteristic that may influence students' success in project-based learning environments. Previous studies have shown that students with higher critical thinking ability tend to benefit more from problem-based and project-based learning because they are better able to manage complex information, evaluate alternative solutions, and make data-driven decisions (Bara, 2025; Khabibah & Sukarmin, 2025; Rambe, 2020). Accordingly, it could be theoretically assumed that the effectiveness of PjBL would vary according to students' levels of critical thinking ability. However, our findings indicate that the learning gains produced by PjBL were relatively similar across all critical thinking categories. This finding suggests that PjBL is not only effective for students who already possess strong critical thinking skills but is also capable of improving learning outcomes among students with moderate and low levels of critical thinking ability (Duncan, 2020; Handayani et al., 2024; Sudarwati et al., 2025). Furthermore, PjBL promotes collaboration, communication, creativity, and problem-solving skills (Haryanti et al., 2024; Haswan et al., 2024; Nagamalla et al., 2024; Winarko, 2024). Collaborative and project-based activities actively engage students in critical thinking processes (Tusino et al., 2024). In other words, PjBL functions as an inclusive and adaptive instructional approach that provides structured support through project activities, discussions, and presentations, enabling students with varying cognitive abilities to benefit from the learning process.

This finding can also be explained from the perspective of social constructivism, which emphasizes the importance of social interaction, collaboration, and scaffolding in learning. According to Vygotsky's (1978) social constructivist theory, learning effectiveness is determined not only by students' individual cognitive abilities but also by the quality of social interactions occurring throughout the learning process. During project implementation, students did not work independently; rather, they actively collaborated in collecting price data, calculating price indices, analyzing inflation rates, and preparing investigation reports. Such interactions facilitated the transfer of thinking strategies, knowledge exchange, and cognitive support among group members, allowing students with lower critical thinking ability to develop sound conceptual understanding. As a result, the benefits of PjBL were distributed relatively evenly across students with different levels of critical thinking ability.

The findings of this study support the constructivist view that knowledge is actively constructed through meaningful learning experiences. Activities such as collecting price data, calculating price indices, and analyzing inflation enabled students to develop

economic understanding based on direct empirical experiences. Moreover, group work, discussions, and project presentations created a collaborative learning environment that encouraged the exchange of ideas, negotiation of meaning, and mutual cognitive support, allowing students with different levels of critical thinking ability to benefit from PjBL. Furthermore, the absence of a significant interaction effect may also be partly attributable to the relatively short duration of the intervention. The characteristics of PjBL generally require extended implementation over a longer period, whereas the present study was conducted within a limited timeframe. Consequently, students across all critical thinking categories were still adapting to similar project procedures and learning demands, which may have reduced the likelihood of observing substantial differences in cognitive responses. From the perspective of Cognitive Load Theory, this limited duration may have caused students' cognitive resources to be devoted primarily to adapting to project procedures rather than fully capitalizing on their differences in critical thinking ability (Mayani et al., 2025). These findings suggest that learning effectiveness is influenced not only by students' individual cognitive characteristics but also by the quality of learning experiences and social interactions embedded within instructional design. Therefore, our study contributes both theoretically and practically by demonstrating how project-based learning can be systematically implemented to enhance students' conceptual understanding in secondary-level economics education.

From a theoretical perspective, this study reinforces Information Processing Theory by demonstrating that critical thinking contributes to students' ability to process, organize, and integrate complex economic information into their existing knowledge structures. The finding that students with high critical thinking ability achieved better learning outcomes than those with low critical thinking ability supports the view that the quality of information processing is an important determinant of academic achievement. This study also contributes to the literature on Project-Based Learning and social constructivism. Although critical thinking significantly influenced learning outcomes, the absence of a significant interaction between critical thinking ability and PjBL indicates that the effectiveness of PjBL remains relatively consistent across different levels of critical thinking ability. This finding suggests that the collaborative and authentic investigative characteristics of PjBL enable students with varying levels of critical thinking ability to obtain relatively similar learning benefits. Consequently, this study extends current understanding of how collaborative learning environments can reduce achievement gaps arising from differences in students' cognitive characteristics.

From a practical perspective, these findings imply that economics instruction, particularly on topics related to inflation and price indices, can be made more effective when designed contextually through projects based on real-world price data. Such projects enable students to connect theoretical concepts with everyday economic phenomena. Therefore, the learning gains generated by PjBL depend not only on students' initial critical thinking ability but also on the extent to which teachers are able to design

learning experiences that are active, collaborative, reflective, and inquiry-based, thereby enabling students to develop deeper and more sustainable conceptual understanding.

Conclusion and Implication for Future Research

Based on the research findings, we conclude that project-based learning is able to facilitate deeper conceptual understanding through students' active involvement in the collection, processing, and analysis of authentic economic data. The topics of inflation and price indices require higher-order thinking skills, particularly in interpreting price data and analyzing economic cause–effect relationships, which are difficult to achieve through abstract and teacher-centered learning approaches. In this context, we found that Project-Based Learning (PjBL) is more effective than traditional learning in improving students' economics learning outcomes on inflation and price index topics. The advantages of PjBL are reflected in posttest scores that are consistently higher in the experimental group across all levels of critical thinking ability. We also found that critical thinking ability has a significant effect on learning outcomes; however, there is no interaction between the learning model and the level of critical thinking ability, indicating that the effectiveness of PjBL is relatively consistent across all student groups. These findings confirm that PjBL is an adaptive and inclusive learning approach for complex and data-driven economics content.

Based on these findings, we recommend the implementation of PjBL in economics learning, particularly for inflation and price index topics, with an emphasis on the use of authentic price data and structured projects. PjBL can be utilized as an effective pedagogical strategy not only for students with high critical thinking ability, but also for students with moderate and low critical thinking ability through adequate instructional support. These findings provide an empirical basis for economics teachers to design learning that is more contextual, meaningful, and oriented toward strengthening conceptual understanding.

Limitations

This study has several limitations. First, the quasi-experimental design was conducted using existing classes rather than random assignment; therefore, uncontrolled factors such as students' prior experiences, motivation, and learning habits may have influenced the results. Second, although the critical thinking instrument was developed based on critical thinking indicators (interpretation, analysis, evaluation, and inference), the use of multiple-choice items may not fully capture the complexity of students' reasoning processes. Third, the implementation of Project-Based Learning was conducted within a limited period, whereas PjBL requires sufficient time for investigation, collaboration, and reflection. Finally, this study focused only on price

index and inflation topics, so the findings may not fully represent the application of PjBL and critical thinking perspectives in other economics topics.

For future research, other cognitive variables such as data literacy or self-regulated learning may be examined as moderators of PjBL effectiveness. Studies with longitudinal or mixed-methods designs are also needed to understand the long-term impact of PjBL on students' economic understanding and the development of higher-order thinking skills. Further studies may also examine the implementation of PjBL over a longer duration and across different economics topics to strengthen the generalizability of the findings.

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Mokinių mokymosi rezultatai taikant projektinį mokymąsi: kritinio mąstymo perspektyva nagrinėjant infliacijos temas

Ari Data[1], Selvita Eka Eviana Purba[2*], Emirensiana Adha[3], Agustina Butar-Butar[4]

[1] Nusa Cendana universitetas, Ekonomikos švietimo katedra, Mokytojų rengimo ir švietimo fakultetas, Adisucipto g., Penfui, Kupangas, Rytų Nusa Tengaros provincija, Indonezija, ari.data@staf.undana.ac.id
[2] Nusa Cendana universitetas, Ekonomikos švietimo katedra, Mokytojų rengimo ir švietimo fakultetas, Adisucipto g., Penfui, Kupangas, Rytų Nusa Tengaros provincija, Indonezija, selvita_purba@staf.undana.ac.id – *Autorius korespondentas
[3] Nusa Cendana universitetas, Ekonomikos švietimo skyrius, Mokytojų rengimo ir švietimo fakultetas, Adisucipto g., Penfui, Kupangas, Rytų Nusa Tengaros provincija, Indonezija, emirensiana_adha@staf.undana.ac.id
[4] Nusa Cendana universitetas, Ekonomikos švietimo skyrius, Mokytojų rengimo ir švietimo fakultetas, Adisucipto g., Penfui, Kupangas, Rytų Nusa Tengaros provincija, Indonezija, agustina.butarbutar@staf.undana.ac.id

Santrauka

Mokantis ekonomikos infliacijos temomis, reikia kritinio mąstymo įgūdžių, nes apima duomenų analizę, priežastinį samprotavimą ir realių ekonominių reiškinių interpretavimą. Tačiau abstraktūs ir į mokytoją orientuoti mokymo metodai dažnai riboja mokinių konceptualinį supratimą. Šio tyrimo tikslas – nustatyti projektinio mokymosi (angl. *Project Based Learning* – PjBL) poveikį mokinių mokymosi rezultatams ekonomikoje, ypač infliacijos temomis, atsižvelgiant į jų kritinio mąstymo gebėjimus. Tyrime buvo naudojamas kvazieksperimentinis dizainas su neekvivalentišku kontrolinės grupės išankstiniu ir posttestiniu testu bei 2×3 faktorialiniu dizainu. 162 vienuoliktos klasės mokinių imtis buvo padalinta į projektinio mokymosi ir tradicinio mokymosi grupes. Duomenys buvo analizuojami naudojant dvifaktorinį ANOVA ir Games–Howell „post hoc“ testą. Tyrimo rezultatai parodė, kad projektinis mokymasis reikšmingai pagerino mokymosi rezultatus, palyginti su tradiciniu mokymusi. Be to, kritinio mąstymo gebėjimai reikšmingai pagerino mokymosi rezultatus, o kritiškai mąstantys mokiniai pranoko savo bendraamžius, pasižyminčius prastesniu kritiniu mąstymu. Vis tik reikšmingos sąveikos tarp mokymosi modelio ir kritinio mąstymo gebėjimų nebuvimas rodo, kad projektinio mokymosi veiksmingumas išlieka pastovus, nepriklausomai nuo mokinių kritinio mąstymo lygio. Šis tyrimas praturtina ekonomikos švietimo literatūrą ir patvirtina, kad projektinis mokymasis tvirtai ir tolygiai gerina mokymosi rezultatus, nepaisant mokinių kritinio mąstymo įgūdžių skirtumų.

Esminiai žodžiai: *kritinio mąstymo lygis, ekonomikos mokymasis, infliacija, mokymosi rezultatai, projektinis mokymasis.*

Gauta 2026 04 07 / Received 07 04 2026
Priimta 2026 09 09 / Accepted 09 09 2026