
Critical thinking skills of teacher education students: A comparative study across study programs

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Abstract

This study assessed the critical thinking (CT) proficiency of undergraduate students in the Faculty of Teacher Training and Education at Universitas Al Washliyah. This cross-sectional study included 190 undergraduate students from four study programmes: Biology Education, Mathematics Education, English Education, and Indonesian Language Education. The Indonesia Critical Thinking Skills Test (INCRITS) was used to assess CT skills. Data were analysed using descriptive statistics, a one-sample *t*-test, an independent-samples *t*-test, Pearson's correlation, and one-way ANOVA in SPSS version 22. Statistical significance was set at $p < .05$. Of the 190 participants, 189 had valid total CT scores. The mean CT score was 12.71 ($SD = 3.49$), which was significantly lower than the predetermined reference value of 17.10, $t(188) = -17.29$, $p < .001$. A one-way ANOVA showed a statistically significant difference in CT scores among the four study programmes, $F(3, 186) = 12.30$, $p < .001$, $\eta^2 = .166$. Overall, students' CT performance was below the predetermined reference level. These findings underline the need to strengthen CT development in teacher education, and future research should examine the variables associated with CT among pre-service teachers.

Keywords

Assessing, critical thinking, undergraduate students

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Introduction

Critical thinking skills and dispositions refer to the ability and inclination to analyse, evaluate, and reason effectively through complex problems and situations (Aslan, 2022; Wu et al., 2023). Critical thinking skills involve interpretation, analysis, evaluation, inference, and explanation, whereas critical thinking dispositions include truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and maturity of judgement (Fikriyati et al., 2022). Critical thinking is crucial for students because it enhances learning outcomes and promotes higher-order thinking (Ahmed & Ibrahim, 2023). It enables students to analyse, evaluate, and synthesise information effectively, which leads to better problem-solving and decision-making (Chen, 2022). Studies show that students who engage in critical thinking demonstrate improved performance, motivation, and cognitive levels (Raj et al., 2022). By fostering critical thinking, educators can help students navigate the complexities of modern life and education and encourage them to think independently and logically. Therefore, integrating critical thinking into daily learning activities and providing tasks that stimulate critical thinking are essential for nurturing well-rounded and informed individuals (Trúšiková & Velmovská, 2022).

The ability to think critically is an invaluable tool for education students, who, upon graduation, will become teachers responsible for developing their own students' critical thinking and leaders in the field of education (Dowd et al., 2018; Klahr et al., 2019). Given its importance, the teaching of critical thinking has become one of the central activities of universities in Indonesia. Critical thinking skills have been taught longitudinally and integrated into classroom activities at Indonesian universities in general and at Universitas Al Washliyah in particular. However, there is no formal, standardised training in how to teach critical thinking. Critical thinking skills are crucial for college students because they enhance learning outcomes and foster innovation (Mao, 2023). Traditional education systems often overlook the development of critical thinking; in language teaching, for example, instruction has tended to focus solely on language skills (Qu, 2022). Research has emphasised the significance of critical thinking in higher education, particularly the fostering of these skills through reflective writing (Yeh et al., 2023). Encouraging students to question, optimising teaching methods, and improving assessment techniques are key strategies for cultivating critical thinking among college students (Ng et al., 2022).

A person's critical thinking skills can determine their success in everyday life and, later, in the workplace. Critical thinking also helps future teachers focus on the information available to them and use it wisely. Although critical thinking is important in any field, it is considered especially important in academia because it allows students to analyse, evaluate, and restructure their thinking. Previous research has regarded critical thinking (CT) as an important skill for university students in the field of teaching, as it raises teaching quality and engages students actively in learning (Bezanilla et al., 2023; Kadrija et al., 2022). Despite its importance, research shows that students' ability to use CT skills remains low. International assessment data point in the same direction: in the Programme for International Student Assessment (PISA) 2022, Indonesian 15-year-olds obtained mean scores of 359 in reading, 366 in mathematics, and 383 in science, all well below the OECD averages (OECD, 2023). Various factors may explain this

problem. Inadequacies in educational planning and policy, frequent curriculum changes, current leadership and management practices in educational institutions, insufficient use of appropriate active learning methods, low student motivation, and reliance on traditional evaluation methods are considered the main factors that have hindered the improvement of CT over the years (García-Carmona, 2020). One study identified several barriers to students' critical thinking: perceptions, poor metacognitive skills, a fixed mindset, heuristics, biases, and the perceived difficulty of thinking itself (Persky et al., 2019).

Several studies have examined factors that influence the improvement of CT skills, such as experience level, education level, active learning strategies, and learning styles. Liu et al. (2016), for example, reported that students with higher levels of education demonstrated stronger CT skills. Factors that can enhance students' critical thinking include teachers' teaching skills (Nguyen et al., 2023), learning through experience (Daryanes et al., 2023), collaboration, problem-solving, authentic problems, critical discussion, cognitive conflict, and negotiation (Xu et al., 2023), and problem-based learning (Razak et al., 2022). However, few studies have used the Indonesia Critical Thinking Skills Test (INCRITS) to examine these issues. Moreover, little research has examined the critical thinking skills of teacher education students, who will be the future teachers responsible for shaping their students' critical thinking. Therefore, this study aimed to examine the critical thinking skills of teacher education students at Universitas Al Washliyah across four study programmes (Biology Education, Mathematics Education, English Education, and Indonesian Language Education) and to compare INCRITS results across these programmes.

Methodology

Study design

A cross-sectional study was conducted to assess and compare the critical thinking skills of students in the Faculty of Teacher Training and Education, Universitas Al Washliyah (UNIVA). A standardised multiple-choice test, the Indonesia Critical Thinking Skills Test (INCRITS), was used to assess students' critical thinking skills. INCRITS is designed to measure the cognitive and metacognitive aspects of critical thinking and was administered as a performance-based assessment rather than a self-report questionnaire.

The study included undergraduate students enrolled in the Faculty of Teacher Training and Education who took part in teaching assistantship activities at junior and senior high schools between February and June 2025. The study population consisted of 190 students from four teacher education programmes: Biology Education, Mathematics Education, English Education, and Indonesian Language Education. All 190 students who participated in the teaching assistantship activities during this period were invited to take part in the study. After the study objectives and procedures had been explained, informed consent was obtained from all participants before INCRITS was administered. The test was administered in person under standardised testing conditions, and all 190 students completed it ($N = 190$).

Study instrument

INCRITS was used to assess students' critical thinking skills in this study. The research instrument consisted of two parts: a demographic questionnaire and INCRITS. INCRITS is a

standardised multiple-choice test designed to assess six domains of critical thinking: interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Before the main data collection, the instrument was reviewed by educational experts to assess its content validity, and the test items were revised on the basis of their feedback to improve clarity and appropriateness. A pilot test was then conducted with 32 students who had participated in teaching assistantship activities. These students had characteristics comparable to those of the main-study participants but were not included in the main study. The pilot test evaluated the reliability and clarity of the instrument before its administration in the main study. Based on the pilot responses ($n = 32$), Cronbach's alpha was 0.84, indicating good internal consistency.

INCRITS is a standardised 55-minute test consisting of 47 multiple-choice items covering six domains of critical thinking: interpretation (7 items), analysis (8 items), evaluation (8 items), inference (6 items), explanation (8 items), and self-regulation (10 items). Each item has four response options, one of which is correct. The test uses dichotomous scoring: a correct answer is scored 1 and an incorrect answer 0. Total scores therefore range from 0 to 47, with higher scores indicating stronger critical thinking skills.

Critical thinking is widely recognised as an important skill in education. However, there is little agreement on how it should be assessed among university students. Just as definitions and teaching methods vary, so do the tools used to measure CT outcomes, and no single standard has been adopted across studies. Standardised CT tests are among the most widely used assessment tools, particularly with students in the health professions. INCRITS measures cognitive and metacognitive skills related to CT across six domains: interpretation, analysis, evaluation, inference, explanation, and self-regulation. It was selected for this study because it provides a structured assessment of multiple CT domains rather than relying on self-reported perceptions.

Data collection and analysis

Students' names were obtained from university records. The test was administered to the students in person. Students were informed of the purpose of the study and asked to give their consent at the time of testing; participation was voluntary. A week later, reminders were sent to those who had not responded the first time.

All data were analysed using the Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated. The Kolmogorov–Smirnov test was used to assess the normality of the distribution of quantitative data in each group. Where data for more than two groups were normally distributed and variances were homogeneous, one-way analysis of variance (ANOVA) was used for between-group comparisons. A one-sample t -test was used to compare the sample mean with the reference value, an independent-samples t -test was used to compare mean CT and subdomain scores by gender, and Pearson's correlation coefficient was used to examine associations between variables. A p -value $< .05$ was considered statistically significant.

Results

All 190 students completed the test; 125 (65.79%) were female and 65 (34.21%) were male. Sixty-eight students were enrolled in Biology Education, 35 in Mathematics Education, 45 in English Education, and 42 in Indonesian Language Education. Most students (67.89%) were 20 years old (see Table 1).

Table 1. *Participants' characteristics*

Variables	n	%
Gender		
Female	125	65.79
Male	65	34.21
Marital status		
Married	15	7.89
Single	175	92.11
Department		
Biology Education	68	35.79
Mathematics Education	35	18.42
English Education	45	23.68
Indonesian Language Education	42	22.11
Age (years)		
20	129	67.89
21	28	14.74
22	12	6.32
23	10	5.26
24	11	5.79

A one-sample *t*-test was conducted to determine whether students' mean critical thinking score differed significantly from the predetermined reference value of 17.10. The mean score ($M = 12.71$, $SD = 3.49$) was significantly lower than the reference value, $t(188) = -17.29$, $p < .001$, indicating that students' overall critical thinking performance was below the specified benchmark (Table 2).

Table 2. *One-sample t-test of critical thinking scores (test value = 17.10)*

INCRITS Total	N	Mean	SD	Test Value	<i>t</i>	<i>p-value</i>
	189	12.71	3.49	17.10	-17.29	< .001

Table 3. *Independent-samples t-test for critical thinking and its subscales by gender (male $n = 65$, female $n = 125$)*

Scales	Gender	Mean	SD	t	p -value	Interpretation
Critical Thinking	Male	3.59	1.70	0.120	.905	Not significant
	Female	3.56	1.52			
Analysis	Male	5.58	1.65	1.811	.072	Not significant
	Female	5.09	1.98			
Evaluation	Male	5.16	2.22	-1.370	.172	Not significant
	Female	5.60	1.85			
Inference	Male	4.81	2.05	4.301	<.001	Significant
	Female	3.57	1.52			
Explanation	Male	5.08	1.97	-1.719	.087	Not significant
	Female	5.57	1.64			
Self-regulation	Male	6.92	2.23	-1.221	.224	Not significant
	Female	7.33	2.13			

Note. t and p values were recalculated from the reported group means, standard deviations, and sample sizes (male $n = 65$; female $n = 125$). A two-tailed significance level of $\alpha = .05$ was used.

An independent-samples t -test was conducted to examine whether students' CT scores and subscale scores differed by gender. As shown in Table 3, there was no statistically significant difference in the overall CT score between male ($M = 3.59$, $SD = 1.70$) and female students ($M = 3.56$, $SD = 1.52$), $t(188) = 0.120$, $p = .905$. Similarly, no statistically significant gender differences were observed for Analysis ($t = 1.811$, $p = .072$), Evaluation ($t = -1.370$, $p = .172$), Explanation ($t = -1.719$, $p = .087$), or Self-regulation ($t = -1.221$, $p = .224$).

A statistically significant gender difference was found only for the Inference subscale, on which male students obtained a higher mean score ($M = 4.81$, $SD = 2.05$) than female students ($M = 3.57$, $SD = 1.52$), $t(188) = 4.301$, $p < .001$. Overall, these findings indicate that gender was not significantly associated with most dimensions of CT, with the exception of this subscale.

Pearson's correlation coefficient was used to examine the associations between students' CT scores and demographic characteristics, including age, gender, study programme, and marital status. The results showed weak positive correlations between age and the Analysis subscale ($r = .109$, $p = .006$) and between age and the Self-regulation subscale ($r = .160$, $p = .028$). These findings indicate that older students tended to obtain slightly higher Analysis and Self-regulation scores, although these relationships were weak.

A one-way ANOVA was conducted to determine whether CT scores differed among students from the four study programmes: Biology Education, Mathematics Education, English Education, and Indonesian Language Education. The analysis revealed a statistically significant difference in CT scores among the four groups, $F(3, 186) = 12.30$, $p < .001$, $\eta^2 = .166$. The effect size indicates that approximately 16.6% of the variance in CT scores was associated with study programme, which represents a large effect by conventional benchmarks. Descriptively, Mathematics Education students obtained the highest mean CT score ($M = 15.48$, $SD = 3.55$), followed by English Education students ($M = 13.33$, $SD =$

3.23) and Biology Education students ($M = 12.10$, $SD = 3.61$). Although earlier results suggested a significant difference between the Mathematics Education and Biology Education groups, the exact pairwise significance values cannot be verified because the original post hoc output is unavailable. The present analysis is therefore interpreted at the omnibus ANOVA level, and no specific pairwise differences are claimed.

Discussion

This study aimed to investigate the CT skills of students in the Faculty of Teacher Training and Education at Universitas Al Washliyah. The mean CT score was 12.71 ($SD = 3.49$), significantly below the predetermined reference value of 17.10, indicating that students' overall CT performance fell short of the specified benchmark. This finding is consistent with Verawati et al. (2024), who reported that students' critical thinking disposition was below the critical threshold, with variability across indicators. The present findings reinforce the need to strengthen CT development among teacher education students through appropriate learning activities and assessment strategies. Low CT skills may limit students' decision-making, problem-solving, and preparation for professional life, as CT performance has been shown to predict real-world outcomes (Butler, 2012).

The gender analysis showed that gender was not significantly associated with overall CT scores or with most CT subscales in this sample. A significant difference was observed only on the Inference subscale, on which male students had a higher mean score than female students ($p < .001$). By contrast, Self-regulation scores did not differ significantly by gender ($p = .224$), although female students had a slightly higher descriptive mean. These findings are broadly consistent with studies reporting limited or non-significant gender differences in critical thinking (Álvarez-Huerta et al., 2024; Başak & Yücel, 2024). The present results should therefore be interpreted as sample-specific rather than as evidence of a general gender effect on critical thinking.

Apart from gender, a weak relationship was found between age and the Self-regulation subscale. Self-regulation shows considerable stability throughout childhood and adolescence, with individual differences shaped by personal characteristics and socialisation experiences, which may explain the modest age effects observed here (Moilanen, 2024). Katsantonis (2024) showed that metacognitive self-regulation differs across age groups and is shaped by motivational factors, suggesting that age alone is not a strong determinant. In addition to Self-regulation, age had a weak association with students' scores on the Analysis subscale ($r = .109$, $p = .006$). This finding differs from previous research reporting that age has a significant effect on students' critical thinking skills, particularly in analysis (Hartanto et al., 2020). Research also shows that students' critical thinking skills develop as they progress through different stages of education, reflecting their cognitive development and educational experiences (Harahap et al., 2024).

The comparison across study programmes showed a statistically significant overall difference, with Mathematics Education students obtaining the highest mean score and Biology Education students a lower mean. The mean difference between Mathematics Education and Biology Education was 3.38 points; based on the reported group means, standard deviations, and sample sizes, the estimated Cohen's d was 0.94 (two-tailed $p < .001$).

Because the original post hoc output was unavailable, this pairwise statistic should be interpreted as an estimate calculated from summary statistics rather than as an original post hoc result. The higher mean among Mathematics Education students may be related to experience with mathematical problem-solving and to pedagogical approaches that emphasise structured analysis (Jaelani et al., 2023; Sukriyah & Juniati, 2023). These explanations should not be interpreted as causal because the study used a cross-sectional design. Research has also shown that Biology Education students can develop CT skills through approaches such as lesson study (Hidayat & Santoso, 2021). For language education, Fernandes et al. (2024) examined how critical thinking can be facilitated when Indonesian students listen to and speak English as an additional language, and Utami et al. (2021) identified the teacher's facilitative role, digital literacy, and independent learning as key factors in EFL students' critical thinking development. The available statistical information did not allow verification of a specific difference between Indonesian Language Education and English Education students, so no such pairwise comparison is made here.

Although CT skills may improve with educational progression, the present cross-sectional study did not directly test changes across years of study. Previous research has reported CT gains associated with intentional instructional strategies and curricular integration (Abrami et al., 2015; Huber & Kuncel, 2016; Ralston & Bays, 2015). Few studies have directly compared CT performance across teacher education programmes using INCRITS; the programme-level comparison in this study therefore provides useful evidence, although replication in other settings is needed. The findings also indicate that students' CT skills need further development through active participation in learning and campus activities. Educational experiences that encourage analysis, discussion, problem-solving, and reflection may provide opportunities to strengthen CT skills.

Conclusion

The CT performance of undergraduate students at Universitas Al Washliyah was significantly below the predetermined reference value of 17.10, with a mean score of 12.71 ($SD = 3.49$). CT scores differed significantly across the four study programmes, $F(3, 186) = 12.30, p < .001, \eta^2 = .166$. Mathematics Education students had a higher mean CT score than Biology Education students, with a mean difference of 3.38 points and an estimated Cohen's d of 0.94 (two-tailed $p < .001$) based on the available summary statistics; because the original post hoc output was unavailable, this pairwise result should not be treated as an original post hoc estimate. Continued attention should be given to educational strategies and learning experiences that promote CT skills among teacher education students.

Disclosure Statement

No potential conflicts of interest were reported by the authors.

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