Empiricism Journal
https://journal-center.litpam.com/index.php/empiricism
email: empiric.journal@gmail.com

Vol. 5, No 2, Dec. 2024
e-ISSN: 2745-7613
pp. 441-451

The Effect of Reflective Thinking on Critical Thinking Skills: A Predictive Analysis

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Abstract

University students must possess reflective and critical thinking skills to effectively navigate various life situations and contexts. This study aims to explain the effect of reflective thinking skills (RTS) on critical thinking skills (CTS). In this study, 71 prospective biology teacher students voluntarily participated. The RTS instrument developed by Kember et al. (2000) was adopted to collect data on RTS, and 20 CTS items to collect data on CTS. RTS had a significant impact on CTS, but not all RTS subscales; the habitual action subscale did not have a significant impact on CTS. Additionally, semester differences did not influence RTS and CTS. Finally, the recommendations based on these findings can be found in the conclusions and recommendations section.

Keywords: *Reflective Thinking Skills, Critical Thinking Skills, Semester Differences.*

How to Cite: Firdaus, L., Samsuri, T., & Mirawati, B. (2024). The Effect of Reflective Thinking on Critical Thinking Skills: A Predictive Analysis. *Empiricism Journal*, *5*(2), 341–451. https://doi.org/10.36312/ej.v5i2.2381

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INTRODUCTION

In its most basic form, thinking is a cognitive process that humans use to interpret information and make decisions (Demir, 2022). It is the essence of human cognition. However, the effectiveness and productivity of this process are crucial. Therefore, higher education institutions aim to cultivate graduates who can think effectively and productively. Through such thinking, they are expected to contribute significantly to society (Sargent, 2015). To support this goal, reflective and critical thinking skills are essential for college graduates (Gogus et al., 2020).

Critical thinking skills (CTS) as an entity in the world of education (Talebinejad & Matou, 2012) are conceptualized as basic elements in innovative thinking (Ho et al., 2023). They are conceptualized as the cognitive capacity to convey meaning, spread ideas, and engage in meaningful dialogue with others (da Silva Almeida & Helena Rodrigues Franco, 2011). Additionally, CTS involves purposeful judgment and self-regulation in conducting analysis, interpretation, inference, evaluation, application, and explanation, which are the basis of judgment (García-Moro et al., 2021; Tan et al., 2023; Zhang et al., 2017). As such, CTS is a type of thinking related to problem-solving, formulating conclusions, and making decisions (Halpern & Dunn, 2021). When university students acquire CTS, they are better equipped to examine new information and ideas, consider alternative perspectives and ways of life, and assess their acceptability and desirability (Lombardi et al., 2021). Moreover, these skills can be applied in various contexts and situations (Halpern & Dunn, 2021).

Meanwhile, the term reflective thinking skills (RTS) is sometimes also referred to as reflective practice (Phan, 2007; Yu, 2018; Yu & Chiu, 2019), usually associated with the problem-solving process (Choy, 2012; Kember et al., 2000). According to Schon, RTS refers to careful consideration and assessment of actions taken by someone towards developing expertise (Choy, Yim, et al., 2019; Ersözlü & Arslan, 2009). In other words, RTS is rooted in the understanding of knowledge development through consideration of what they learn and do (Yu, 2018), or efforts to reflect back on what we do either after completing a task or while doing it (Ghanizadeh, 2017; Ünver & Yurdakul, 2020). Therefore, learners who think reflectively become aware and take control of their learning by actively accessing what they know, what they need to know and how they bridge the gap (Choy, 2012).

Received: November 2024 **Revised: December 2024** **Published: December 2024**

The study of reflective thinking skills (RTS) is not a new concept (Ersözlü & Arslan, 2009; Yuen Lie Lim, 2011), starting from Dewey's work (Phan, 2007, 2009) defined RTS as an active and continuous process of considering beliefs or knowledge, involving stages like suggestion, problem-naming, interpretation, explanation generation, experimentation, and ramification (Phan, 2007; Yu & Chiu, 2019), consisting of several stages namely suggestion of an experience, naming the problem, spontaneous interpretation, generating explanations, experimenting on selected hypotheses, and ramifying explanations (Yu & Chiu, 2019). Mezirow's thinking further divided RTS into non-reflective (including habitual action, understanding, and reflection) and reflective actions (namely critical reflection) (Kember et al., 2000; Leung & Kember, 2003; Phan, 2009), with the latter being crucial for teaching and learning (Phan, 2009). Research in psychology and education has shown that RTS is a predictor of critical thinking skills (CTS) and academic performance (Choy, al., 2019; Phan, 2009). Therefore, fostering RTS can enhance CTS, improve understanding through reflective learning processes (Choy, Lee, et al., 2019; Phan, 2007, 2009; Yaacob et al., 2021), and develop effective learning strategies (Hafiz et al., 2023; Phan, 2007).

RTS has been extensively studied by researchers, who have explored various aspects such as gender, culture, year of study, and level of education. Loka et al. (2019) found a significant relationship between RTS subscales (habitual action, reflection, understanding, and critical reflection) and the academic performance of undergraduate dental students, noting differences in RTS subscales based on year of study but not gender. Kablan and Günen (2021) investigated the relationship between RTS and problem-solving skills in eighth-grade science students, discovering a positive correlation between RTS subscales (questioning, reasoning, and evaluating) and the ability to solve science problems. Ersözlü and Arslan (2009) examined the impact of RTS on metacognitive awareness in elementary school students, finding that reflection activities significantly increased metacognitive awareness in the experimental group. Aghaei et al. (2022) explored the relationship between RTS and self-regulated learning (SRL) in medical science students, identifying a connection between the two. Similarly, Zhang et al. (2017) studied the effect of RTS on critical thinking disposition in nursing students, revealing a relationship between the two constructs.

Several studies have examined the relationship between RTS and various dependent variables. Some studies have focused on the overall effect of RTS, while others have delved into the specific impact of RTS subscales. However, no existing research has explored the relationship between RTS and CTS in prospective biology teacher students. Therefore, the influence of RTS subscales on CTS in this specific population remains unclear. To address this gap, this study aims to: (1) to explain the effect of RTS on CTS; (2) to examine the relationship between RTS and semester differences; (3) to examine the relationship between CTS and semester differences. And the research questions will be addressed: (1) does RTS have a significant impact on CTS? (2) does semester difference have a significant impact on RTS? (3) does semester difference have a significant impact on CTS?

METHODS

Respondents and instruments

This research is a correlational study. This research was conducted at Universitas Pendidikan Mandalika in the odd semester of the 2023/2024 academic year. A total of 71 prospective biology teacher students as voluntary respondents, consisting of 35 (semester 1), 14 (semester 3), 12 (semester 5), and 10 (semester 7). The number of respondents is explained in the next section. The instrument used to obtain data on RTS was adopted from a questionnaire developed by Kember et al. (2000), consisting of four subscales (habitual action, reflection, understanding, and critical reflection). Each subscale is composed of 4 items, so that the total number of items is 16. The use of this instrument is because it has been widely validated and used by researchers. Therefore, the level of validity and reliability is not a problem. Then, we compiled CTS questions in the form of multiple choices of 20 items, including logical inference, verbal and analytical reasoning.

Measures

Both instruments (RTS and CTS) were distributed to all prospective biology teacher students to be answered—which could be done on campus or at home. For the reflective thinking skills instrument, each subscale was responded to with a four-option Likert scale (1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree) by giving a check mark, and for the CTS questions, answered by circling or crossing one of the most correct answers from the four answer options. Each respondent was given two weeks to return the instruments that had been answered. Of the total prospective biology teacher students, 71 students returned the instruments that had been answered from the total number of prospective biology teacher (95).

Data Analysis

The data that has been obtained, then analyzed using SPSS with several methods. *First*, to determine the relationship between the subscale of reflective and critical thinking, the multiple regression method is used at a significance level of 5% (α = 0.05). To obtain a good multiple linear regression model, several classical assumptions are first tested, such as testing the normality of residual variables, linearity, multicollinearity, and heteroscedasticity. *Second*, one-way ANOVA is used to determine whether there are differences in reflective and critical thinking skills based on semester differences.

REULTS AND DISCUSSION

Results

In this study, the effects of RTS on CTS have been analyzed. Furthermore, as a general description, it is also necessary to convey descriptive information about reflective thinking and critical thinking skills—where the habitual action subscale has the highest average, and the critical reflection subscale has the lowest average. For more details, see Table 1.

Table 1. Descriptive information about RTS and CTS

Variables	Mean	Std. Deviation	N
Habitual Action	12.58	1.618	71
Understanding	11.82	1.150	71
Reflection	11.73	1.041	71
Critical Reflection	11.54	1.402	71
Critical thinking score	10.79	1.133	71

Table 2 shows the results of the normality test of the residual variables of all variables (habitual action, understanding, reflection, critical reflection, and critical thinking skills). From the analysis results obtained the value of *Sig* Kolomogorov-Smirnov = .200, and *Sig* Shapiro-Wilk = .760. Thus, it is stated that the residual variables are normally distributed.

Table 2. Results of the normality test of residual variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	.078	71	.200*	.988	71	.760

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

a. Lilliefors Significance Correction

Figure 1 illustrates several key assumptions for regression analysis, including normality, linearity, and homoscedasticity. Linearity assumes a linear relationship between the reflective thinking skills subscale (habitual action, reflection, understanding, and critical reflection) and the critical thinking skills. Homoscedasticity assumes that the variance of the residuals is constant across all levels of the predictor variables. In other words, homoscedasticity refers to the homogeneity of the variance of the residual variables (Salkind, 2006). Based on Figure 1, the residual variables are normally distributed, the relationship between the predictor and regressor variables is linear, and there is no evidence of heteroscedasticity. This indicates that the variance of the residual variables is homogeneous

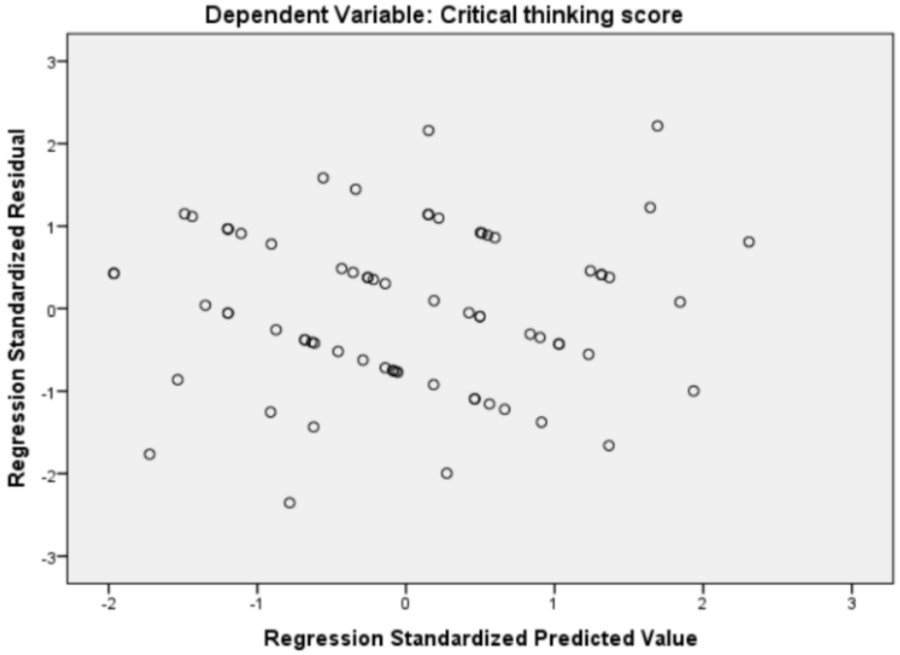

Figure 1. Scatterplot of linearity and homoscedasticity test results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-1.405	2.990		-.470	.640					
	Habitual Action	.178	.095	.254	1.872	.066	-.166	.224	.194	.581	1.721
	Understanding	.324	.127	.329	2.557	.013	.386	.300	.264	.647	1.546
	Reflection	.326	.133	.299	2.451	.017	.363	.289	.253	.717	1.394
	Critical Reflection	.200	.097	.248	2.062	.043	.405	.246	.213	.740	1.352

a. Dependent Variable: Critical thining score

Figure 2. Results of multicollinearity test

A multicollinearity test is conducted to determine whether a strong correlation exists between predictor variables (subscale of RTS). This test is crucial because multiple linear regression analysis cannot be performed if multicollinearity is present. Checking for multicollinearity can be done by examining the VIF and Tolerance values, with the criteria of Tolerance values > 0.10 and VIF values < 10. Figure 2 indicates that no multicollinearity exists between the predictor variables.

In Table 3, the Summary Model of multiple linear regression shows an R-square value of .294 (around 29%). This value represents the coefficient of determination of the relationship between variables. In other words, it shows the combined effect of RTS subscales on CTS, excluding the habitual action subscale, which has no or negative effect on CTS. Figure 2 indicates that the understanding subscale contributes 13%, the reflection subscale 11%, and the critical reflection subscale 10% to the effect on CTS. Thus, the understanding subscale has the highest effect on CTS. Meanwhile, the Adjusted R-Square value of .251 (around 25%) indicates the magnitude of the effect of the predictor variables together on the regressant variables according to the multiple linear regression model.

Table 3. Summary model of multiple linear regression on the effect of RTS on CTS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.542[a]	.294	.251	.980

a. Predictors: (Constant), Critical Reflection, Understanding, Reflection, Habitual Action

The ANOVA table (**Table 4**) shows an *F* value of 6.870 with a significance level of .000, indicating that the predictor variables (RTS subscales) significantly predict CTS. Figure 2 shows that only the habitual action subscale does not have a significant impact on CTS (*Sig* > .05).

Table 4. Multiple linear regression Anova model on the effect of RTS on CTS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.407	4	6.602	6.870	.000[b]
	Residual	63.424	66	.961		
	Total	89.831	70			

a. Dependent Variable: Critical thinking score
b. Predictors: (Constant), Critical Reflection, Understanding, Reflection, Habitual Action

The results of the analysis shown in **Table 5** show that semester differences have a significant effect on RTS. This is partially shown in **Table 6**.

Table 5. Results of RTS analysis based on semester differences

		Sum of Squares	df	Mean Square	F	Sig.
Habitual Action	Between Groups	108.257	3	36.086	32.208	.000
	Within Groups	75.067	67	1.120		
	Total	183.324	70			
Understanding	Between Groups	40.870	3	13.623	17.638	.000
	Within Groups	51.750	67	.772		
	Total	92.620	70			
Reflection	Between Groups	27.527	3	9.176	12.705	.000
	Within Groups	48.388	67	.722		
	Total	75.915	70			
Critical Reflection	Between Groups	40.433	3	13.478	9.288	.000
	Within Groups	97.229	67	1.451		
	Total	137.662	70			

Table 6. Post-hoc results of RTS analysis based on semester differences

Subscales	(I) Semester	(J) Semester	Sig.
Habitual Action	Semester 1	Semester 3	.229
		Semester 5	.000
		Semester 7	.000
	Semester 3	Semester 5	.000
		Semester 7	.000
	Semester 5	Semester 7	.955
Understanding	Semester 1	Semester 3	.000
		Semester 5	.000
		Semester 7	.000
	Semester 3	Semester 5	.669
		Semester 7	.909
	Semester 5	Semester 7	.978

Continued

Subscales	(I) Semester	(J) Semester	Sig.
Reflection	Semester 1	Semester 3	.951
		Semester 5	.001
		Semester 7	.000
	Semester 3	Semester 5	.022
		Semester 7	.000
	Semester 5	Semester 7	.548
Critical Reflection	Semester 1	Semester 3	.103
		Semester 5	.001
		Semester 7	.001
	Semester 3	Semester 5	.354
		Semester 7	.294
	Semester 5	Semester 7	.997

*. The mean difference is significant at the 0.05 level.

Then, based on the results of the analysis as shown in **Table 7** and the post-hock analysis (Tukey with α = .05) in **Table 8**, it is stated that the semester differences do not have a significant effect on CTS.

Table 7. Results of CTS analysis based on semester differences

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.481	3	3.160	2.635	.057
Within Groups	80.350	67	1.199		
Total	89.831	70			

Table 8. Post-hoc analysis of CTS based on semantic differences

(I) Semester	(J) Semester	Sig.
Semester 1	Semester 3	.126
	Semester 5	.195
	Semester 7	1.000
Semester 3	Semester 5	1.000
	Semester 7	.315
Semester 5	Semester 7	.386

Discussion

After presenting the research results, we next examine how the RTS subscales influence CTS. Figure 2 reveals that only the habitual action subscale has no significant impact on CTS. In other words, habitual action cannot predict CTS. This finding aligns with Loka et al. (2019), who reported the highest average habitual action score among interns and found no significant differences in the total reflection scale based on gender, year of study, and academic performance. Similarly, Ghanizadeh (2017), reported the lowest average for the habitual action subscale compared to the other three subscales (reflection, understanding, and critical reflection). Each RTS subscale is positively correlated with CTS, with the reflection subscale exerting the strongest influence on learning outcomes, followed by the understanding subscale. Sargent (2015) also found that the habitual action subscale has the weakest effect compared to the other three subscales.

The inability of the habitual action subscale to predict CTS, strengthens Meziro's RTS hierarchy, about the habitual action subscale which is based on actions that are carried out automatically, without thought or awareness (Kember et al., 2000; Leung & Kember, 2003), or actions without an attempt to fully understand what will be obtained (Ghanizadeh, 2017). While habitual action, understanding, and reflection are all non-reflective actions, they differ significantly. Understanding involves a thinking process without considering its broader implications (Kember et al., 2000; Leung & Kember, 2003). Learners on the understanding subscale engage in cognitive processes to comprehend information but do not relate it to other contexts or evaluate its significance (Yuen Lie Lim, 2011).

In addition, the understanding subscale is a key objective of science learning, particularly in higher education (Azevedo, 2005; Duit & Treagust, 2003; Flaig et al., 2018). To effectively solve complex problems, students must possess a deep understanding of the subject matter and be able to critically analyze different solutions (Hong & Choi, 2011). It's no surprise, then, that students often associate lectures with understanding and reflection. This is evident in the higher understanding subscale scores compared to other subscale scores (Sargent, 2015). Then, the reflection subscale involves intellectual and affective processes that help individuals explore their experiences, gain new insights, and make informed decisions (Kember et al., 2000; Phan, 2007, 2009). It entails continuous consideration and careful evaluation of assumptions and beliefs. Reflection is also seen as a developmental precursor to critical reflection (Yuen Lie Lim, 2011). Critical reflection involves a deeper level of thinking, as it requires individuals to be aware of their own thought processes and the underlying assumptions that shape their beliefs and actions (Kember et al., 2000; Yuen Lie Lim, 2011). All three reflective thinking skill subscales—understanding, reflection, and critical reflection—are closely linked to deep learning strategies and a focus on course objectives (Loka et al., 2019; Phan, 2007).

Table 5 indicates that semester differences impact on RTS. The habitual action subscale shows no significant difference between semesters 1 and 3 (*Sig* > .05), but significant differences between semesters 1, 3, and 5 (*Sig* < .05). The understanding subscale significantly differs between semesters 1, 3, 5, and 7, but not between semesters 3, 5, and 7. The reflection subscale significantly differs between semesters 1, 5, and 7, but not between semesters 1 and 3 or 5 and 7. Similarly, the critical reflection subscale significantly differs between semesters 1, 5, and 7, but not between semesters 1 and 3 or 3, 5, and 7. These findings align with Loka et al. (2019), who reported significant differences in all four RTS subscales based on year of study, with fourth-year students scoring highest in reflection and critical reflection. Yuen Lie Lim (2011) also found significant differences in habitual action, reflection, and critical reflection subscales based on year of study. While some research suggests that senior university students, with their longer study periods, may exhibit higher levels of RTS than their newer counterparts (Sargent, 2015), but other studies have yielded different results. Kaya and Öz (2021) found no significant difference in RTS between different grade levels. Similarly, Eğmir et al. (2020) reported no significant difference in RTS between first-year and fourth-year prospective teachers.

Existing research suggests that a person's level of RTS is not solely determined by the number of semesters or years of study. This indicates that even early-stage students can exhibit higher levels of RTS than their more advanced peers. In other words, RTS does not necessarily develop linearly with increased academic experience (Eğmir et al., 2020). Sargent (2015) explains that those who are not motivated will never develop their thinking potential. Furthermore, reflective thinking requires abstract thinking, which involves critically evaluating beliefs and knowledge based on underlying reasons (Hong & Choi, 2011).

Talking about thinking, including reflective thinking, is never straightforward. We must consider various factors in the formation and development of RTS. Experts have emphasized personal characteristics as a key factor in the formation and development of RTS (Kalk et al., 2014). In this context, weekly study hours can be considered a significant influence on RTS and CTS (Gogus et al., 2020). Additionally, students who dedicate more time to examining and solving problems are more adept at controlling and organizing problem-solving strategies (Wopereis et al., 2008).

Some experts also point out that factors such as education, training, and experience play an important role in shaping reflective thinking and decision-making skills (Hafiz et al., 2023). Related to this, several studies have shown that inquiry and problem-based learning models can help students develop their RTS and CTS (Al Mamun & Lawrie, 2023; Kablan & Günen, 2021; Saracoglu, 2022; Yuen Lie Lim, 2011). Inquiry-based learning (IBL) provides students with the opportunity to question their learning, build connections between concepts and problems, and reconstruct their learning experiences (Saracoglu, 2022). Likewise, problem-based learning (PBL) facilitates the development of outcome-oriented cognitive functions, such as reviewing decisions and evaluating the effectiveness of solutions (Kablan & Günen, 2021), ultimately helping students become reflective learners (Demirel et al., 2015).

Finally, regarding the effect of semester differences on CTS (Table 7), the results indicate that semester differences do not significantly impact CTS. This finding aligns with those of Shirazi and Heidari (2019), who reported no relationship between CTS subscales and academic level. Similarly, Azizi-Fini et al. (2015) found no difference in average CTS scores between freshmen and senior students. Therefore, it can be concluded that semesters do not directly influence CTS, but are rather influenced by factors such as teaching methods. CTS development is primarily driven by teaching practices, regardless of semester structure (Huber & Kuncel, 2016). Employing active learning methods like IBL or PBL can significantly contribute to the development of university students' CTS (Guamanga et al., 2024; Nielsen et al., 2022).

CONCLUSION

Before we arrive at our conclusion, we would like to acknowledge the limitations of this study, particularly the relatively small sample size. This limitation stems from our inability to coordinate with other study programs, resulting in the inclusion of only prospective biology teacher students. A more diverse participant pool, involving students from other programs, could potentially enhance the consistency of the prediction model. Therefore, future research should consider a larger sample size to further validate the findings of this study. Despite these limitations, several conclusions can be drawn. *First*, overall, RTS has a significant impact on CTS. However, the habitual action subscale does not significantly predict CTS, indicating that not all RTS subscales are significant predictors of CTS. *Second*, semester differences do not significantly impact either RTS or CTS.

RECOMENDATION

The study found that the three RTS subscales (understanding, reflection, and critical reflection) have a minimal effect on CTS. This result, unfortunately, indicates a low level of RTS among our respondents. Therefore, there is a need to improve the RTS of our respondents. The low level of RTS may be due to various factors. However, one possible explanation is that our current learning process may not be optimal in training our respondents to think reflectively. The findings of this study are highly significant for improving the quality of learning. Although this study involves CTS, the primary focus is on RTS itself. This does not imply neglecting CTS. Given RTS's predictive role in CTS and academic achievement, improving it should be prioritized. To enhance RTS, we prioritize training our respondents to become independent learners, potentially through IBL or PBL. This approach empowers them to plan, direct, and reflect on their learning experiences.

ACKNOWLEDGEMENT

This research was not funded by any party. However, it would be a shame not to express our gratitude to the biology teacher candidates who have been willing to be voluntary respondents in this research.

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