JPII 10 (4) (2021) 505-514

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

REFLECTIVE PRACTICES IN INQUIRY LEARNING: ITS EFFECTIVENESS IN TRAINING PRE-SERVICE TEACHERS' CRITICAL THINKING VIEWED FROM COGNITIVE STYLES

N. N. S. P. Verawati*[1], Hikmawati[2], S. Prayogi[3], M. R. Bilad[4]

[1,2]Physics Education Department, University of Mataram, Indonesia
[3]Physics Education Department, Mandalika University of Education, Indonesia
[4]Faculty of Integrated Technologies, Universiti Brunei Darussalam, Brunei Darussalam

DOI: 10.15294/jpii.v10i4.31814

Accepted: August 30th 2021. Approved: December 27th 2021. Published: December 31st 2021

ABSTRACT

This study aims to evaluate the effectiveness of reflective practices in inquiry learning to train pre-service teachers' critical thinking skills viewed from cognitive styles. The quasi-experimental design was conducted with two sample groups given the same treatment at the pretest, reflective-inquiry practice learning, and posttest. Before the pretest, each sample was given GEFT (Group Embedded Figures Test) to determine the sample of the FI (field-independent) or FD (field dependent) cognitive style. Two sample groups were pre-service physics teachers (PPT) at two different universities in Mataram, Indonesia. The measurement of critical thinking employed essay tests. Critical thinking skills data were analyzed descriptively (mean difference scores of pretest-posttest and N-gain analysis) and statistically (independent sample t-test) employing SPSS software. The effectiveness of reflective inquiry learning is measured by increasing critical thinking scores where the minimum posttest has the "critical" criteria. The study results indicated that the tendency of cognitive style FI was more dominant than FD. The critical thinking measurement showed that each FD/FI group was categorized as "critical," and the increase of critical thinking scores in the two groups was categorized as a "moderate" category. In line with this, statistical analysis (hypothesis testing at a significance level of 0.05) showed no difference in the increase of critical thinking scores between PPT belonging to FD and FI. This study showed that the reflective practice in inquiry learning effectively improved the pre-service teachers' critical thinking skills with the FD and FI cognitive styles. Reflective practices are a new way of inquiry learning to train critical thinking and can be used as a reference for its structured implementation in regular lectures.

Keywords: reflective-inquiry learning; critical thinking skills; cognitive style

INTRODUCTION

The fundamental task of the modern education system is to develop students' critical thinking (Gilmanshina et al., 2021). Critical thinking is a particular generic skill (Liang & Fung, 2021) and is known as a "core graduate attribute" in the modern education system (Moore, 2013; Szenes et al., 2015). In the current higher education system, it is widely agreed that higher education should train students' critical thinking as a provision for their competencies in personal and professional life in the 21st-century (Erikson & Erikson, 2019; Verawati et al., 2019). For this reason, higher education has to intervene critical thinking into classroom learning activities (Bezanilla et al., 2019). However, this is not easy because, in practice, teachers are not competent enough to teach critical thinking (Gilmanshina et al., 2021). Teaching and learning about critical thinking is also a complex problem (Cargas et al., 2017). As a result, the university's positive perception of critical thinking is not followed by pre-service teachers' exemplary performance in critical thinking (Din, 2020).

***Correspondence Address**
E-mail: veyra@unram.ac.id

Pre-service teachers' poor critical thinking skills were also identified in advanced countries. In Sweden, the essay assessment from 38 pre-service teachers showed poor analysis and deductive reasoning performance, and thus, it needs improvement (Trostek, 2020). Critical thinking training is an essential variable in pre-service teachers' education in China. Nevertheless, pre-service teachers respondents (senior undergraduate candidates) from five universities had inadequate performance in critical thinking skills (Ma & Luo, 2021). The limited learning experience that does not emphasize critical thinking was a factor in pre-service teachers' low performance in critical thinking (Ma & Luo, 2021). In Indonesia, elementary and secondary students' critical thinking performance was also low (Lestari et al., 2021), attributed to teachers' low training skills using effective pedagogical strategies (Kristiyanto et al., 2020). Teachers have vital roles in training students' critical thinking in real classrooms. Unfortunately, the importance of pre-service science teachers' critical thinking was evaluated with worrisome results (Prayogi & Verawati, 2020). A descriptive assessment of 100 pre-service science teachers resulted in underdeveloped critical thinking skills; hence, serious and planned treatments are required to overcome this condition (Fitriani et al., 2019).

Some experts, such as Benade (2015), Dekker (2020), and Erikson & Erikson (2019), argue that the critical thinking training for pre-service teachers starts from modernizing the higher education system and implementing innovative educational models. A learning environment where pre-service teachers can develop critical thinking skills and demonstrate them effectively must also be prepared (Liyanage et al., 2021). This statement is based on a belief that the quality of the educational process impacts the development of students' critical thinking (Gilmanshina et al., 2021). Critical thinking explains the performance of competency achievement in each student and often becomes a critical issue if the expectations are not achieved (Liyanage et al., 2021) because critical thinking is directly related to academic achievement (Jacob, 2012; Leon et al., 2015; Ghanizadeh, 2017; D'Alessio et al., 2019; Siburian et al., 2019). Students with good critical thinking performance have better academic achievements than those with low critical thinking (D'Alessio et al., 2019). The quality of the educational process is measured by pedagogical practice in the classroom, which is very important for developing critical thinking (Polat & Aydın, 2020). One of the key factors that encourage critical thinking is student-centered pedagogy (Dekker, 2020). For this purpose, pedagogical practices apply appropriate learning methods or models because there is a significant relationship between the learning methods applied and the effective critical thinking improvement (Bezanilla et al., 2019).

Along with the needs of 21st-century learning in achieving critical thinking, the priority of science learning leads to inquiry activities identified as a promising approach (Sergis et al., 2019), as an innovative learning approach (Orhan & Sahin, 2018), even as the best teaching practice of critical thinking (Cleovoulou & Beach, 2019). The inquiry positively impacts critical thinking skills in science learning (Duran & Dökme, 2016; Naezak et al., 2021). The goals in scientific inquiry activities pay attention to critical thinking skills (Prayogi et al., 2018). Inquiry provides opportunities for students to create new knowledge based on experiences by exploring various information and surrounding phenomena. It follows the principles of constructivism (Vogt & Schmiemann, 2020). Inquiry learning places learners as active learners (Pedaste et al., 2015; Verawati, et al., 2020) with several benefits, including stimulating interest in science, understanding of the nature of science (Gaigher et al., 2014), increasing understanding of concepts (Laksana et al., 2019), practicing experimental skills (van Riesen et al., 2018), and facilitating collaboration among students (Walker et al., 2021).

However, the weaknesses of the inquiry learning model are also discussed. Students had difficulties with challenging logic (Lederman & Abell, 2014). Our initial study confirms the difficulty of teaching inquiry directly to train critical thinking if it is not accompanied by sufficient prior knowledge from pre-service teachers about the context of the material that is the focus of inquiry (Prayogi et al., 2018). Improvements in this aspect were made, where the cognitive conflict strategy was integrated with inquiry and implemented by 18 pre-service physics teachers, but the improvement in pre-service physics teachers' critical thinking skills did not show satisfactory performance (Verawati et al., 2019). The latest study results are pretty surprising, where there is almost no relationship between the teachers' inquiry approach and students' critical thinking habits. However, both can be linked if there is a powerful intervention method in inquiry activities to train critical thinking habits (Uiterwijk-Luijk et al., 2019). Therefore, modifying the inquiry learning process is necessary to achieve specific goals (Inoue et al., 2019). In this study, the goal is to train critical thinking skills. One of

the modifications of inquiry learning is to involve the reflection process in inquiry learning. The adoption of the reflection process seems to have become a tradition in inquiry learning. It can be evaluated from several inquiry teaching models. For example, the inquiry-base-instruction model places the reflective process at the end of the learning phase (Arends, 2012). It is just that it has not been as expected for the specific purpose of critical thinking training (Verawati et al., 2021).

A recent study modifies the inquiry process by intervening in the reflective process from the beginning to the end of the learning phase, which is a new model in inquiry practice and differs from previous studies. The latest model development is the reflective-inquiry learning model (Verawati & Hikmawati, 2019). The forms of inquiry teaching reflection that characterize this model are the presentation of anomalous phenomena, monitoring, performance evaluation, and continuous reflection to improve learners' critical thinking training (Verawati, et al., 2020; Verawati et al., 2021). It is widely recognized that critical and reflective thinking and the relationship between them originate from the work of John Dewey (Dewey, 1910). Even Ennis (2018) defines critical thinking as reflective thinking. In practice, the reflective process assumes a proactive cognitive activity directed by the individual (Benade, 2015).

In contrast, cognitive activity and critical thinking result from a reflective process (Dwyer et al., 2014). Reflective actions in the learning process allow systematic reconsideration and clarification, supporting learning ways to achieve critical thinking (Procter, 2020). Stimulation of reflection processes in learning is related to students' critical thinking (Ryan, 2013). Recommendations for using reflective practices for pre-service teachers were found in previous studies. Ma & Luo (2021) stated that inviting reflective and inquiry thinking trains critical thinking. Trostek (2020) suggested mobilizing important critical thinking through self-reflection from pre-service teachers. In the current study, researchers apply the reflective practice in inquiry learning and evaluate the pre-service teachers' critical thinking skills viewed from cognitive styles.

Cognitive style is a crucial aspect of learning as it affects (weakens or strengthens) an individual's success in learning (Arifin et al., 2020). Cognitive style is identified with the level of individual consistency in paying attention, understanding, organizing, retaining, processing, and reproducing information in learning (Rayner & Cools, 2011), which affects individual performance in learning and thinking (Armstrong et al., 2012). Previous studies found that students' information processing is related to their cognitive style (George et al., 2018). Cognitive style is a mediator of students' cognitive skills to receive information (Viator et al., 2020). For this reason, students' critical thinking skills are related to their cognitive style (Susandi et al., 2019).

In a specific context, this study aims to evaluate the effectiveness of reflective practices in inquiry learning to train pre-service teachers' critical thinking skills viewed from cognitive styles. The specific question of this study confirms the research objective, how is the effectiveness of reflective practice in inquiry learning to train the pre-service teachers' critical thinking skills viewed from cognitive styles?

METHODS

A quasi-experimental design was applied in this study using two groups given the same treatment, and no control group was used. The simple design is as follows.

$$O_1 \qquad X \qquad O_2$$

The treatments given for each group include a pretest, learning with reflective inquiry practice (carried out in four meetings on fluid mechanics material), and a posttest. Before the pretest, each group was given GEFT (Group Embedded Figures Test). The two groups are pre-service physics teachers (PPT) at Mandalika University of Education (UNDIKMA) and the University of Mataram (UNRAM). A purposive sampling technique was used, with pre-service physics teachers studying fundamental physics as criteria. The research was conducted at sample locations (universities) as regular lectures. The demographics of the sample are presented in Table 1.

Table 1. Demographics of Samples

Group	N	Gender		Age
		Male	Female	
UNDIKMA	16	7	9	18-19 years
UNRAM	18	10	8	18-19 years

Research data were collected using the GEFT instrument and critical thinking skills tests. The GEFT instrument was used to assess the cognitive style of the PPT and identify it into the FD (field dependent) or FI (field independent) cognitive style. This instrument was adopted from the GEFT instrument developed by Witkin et al. (1977). The scoring technique is classified as the FD category if the individual score is in the 0-11 range and the FI category if the score is in the 12-18 range. The test instrument is used to measure PPT's critical thinking skills. The evaluation of critical thinking applied an essay test consisting of eight questions to see aspects or indicators of critical thinking from analysis, inference, evaluation, and decision making. This study's scoring technique and critical thinking criteria were adopted from several previous studies considering similar indicators and the number of test items (Verawati et al., 2020).

The learning tools used in the classroom were in the form of lesson plans, scenarios, and learning modules previously validated by two validators (experts) on content and construct validity. The validity criteria (Va) of learning tools and critical thinking skills test instruments were adopted from previous studies of Prayogi et al. (2018), where each learning tool and instrument was stated as very valid (Va > 4.21), valid (3.40 < Va < 4.21), quite valid (2.60 < Va < 3.40), less valid (1.79 < Va < 2.60), and invalid (Va < 1.79). The validation results of learning tools and instruments are presented in Table 2.

Table 2. The Validation Results of Learning Tools and Instruments

Learning Tools and Instruments	The Average Validity of the Two Validators			
	Content Validity	Criteria	Construct Validity	Criteria
Lesson plan and scenario	3.88	Valid	3.98	Valid
Learning module	4.10	Valid	4.00	Valid
Critical thinking skills test	4.00	Valid	4.12	Valid
Average	3.99	Valid	4.03	Valid

Furthermore, descriptive and statistic analyses were used to evaluate the difference in critical thinking scores between the sample groups (UNDIKMA and UNRAM) and the cognitive style groups (FI and FD). The effectiveness of reflective-inquiry learning for each group is measured by the increase in critical thinking scores (N-gain analysis). The criteria for effectiveness are if the minimum N-gain score has the criteria of "moderate" (N-gain score range, 0.30 to 0.70) (Hairida, 2016), and the minimum score of posttest has the criteria of "critical" (critical thinking score range, 11.20 to 17.60) (Wahyudi et al., 2019a). Analysis of increasing scores used N-gain (Hake, 1999), and the statistical analysis of the difference in critical thinking scores for the FI and FD groups employed t-test (preceded by homogeneity and normality tests). In the hypothesis test, Ha (a significant difference in critical thinking ability between groups with FI and FD cognitive styles) was tested at a significance level of 0.05 with SPSS 23.0 software.

RESULTS AND DISCUSSION

The results of cognitive style measurement applied the GEFT instrument for each sample group. It can be presented in Table 3. The data in Table 3 showed that the tendency of the FI cognitive style was more dominant than FD. It can be seen from 16 PPT from the UNDIKMA group. There were 9 PPT (56.25%) in the FI category and 7 PPT (43.75%) in the FD category. Likewise with the UNRAM group. There were 12 PPT (66.67%) in the FI category and 6 PPT (33.33%) in the FD category.

Table 3. The Results of Cognitive Style Measurement

Group	N	Cognitive Style	
		FI (%)	FD (%)
UNDIKMA	16	9 (56.25)	7 (43.75)
UNRAM	18	12 (66.67)	6 (33.33)
Total	34	21	13

Cognitive style distinguishes the way pre-service teachers acquire and process information, and this can be an information source for teachers in developing effective learning materials. Furthermore, the results of critical thinking measurements between the two sample groups are presented in Table 4.

Table 4. The Results of Pre-service Physics Teachers' Critical Thinking Skills Measurement

Group	N	Pretest		Posttest		N-gain	Category
		$\bar{x}$	Category	$\bar{x}$	Category		
UNDIKMA	16	-2.37	Not critical	15.13	Critical	0.66	Moderate
UNRAM	18	-0.58	Less critical	17.29	Critical	0.73	High

Annotation: N (number of PPT), $\bar{x}$ (critical thinking score averages)

Table 4 indicates the results of critical thinking measurement from two sample groups. Pretest of UNDIKMA was categorized as not critical, while UNRAM was categorized as less critical. However, after treatment (reflective-inquiry learning), both sample groups were categorized as critical. The improvement category of critical thinking score (N-gain) differed from the two sample groups. In UNDIKMA, the score was moderate (N-gain of 0.66), while UNRAM was high (N-gain of 0.73). The results of critical thinking measurement based on the FD/FI cognitive style are presented in Figure 1.

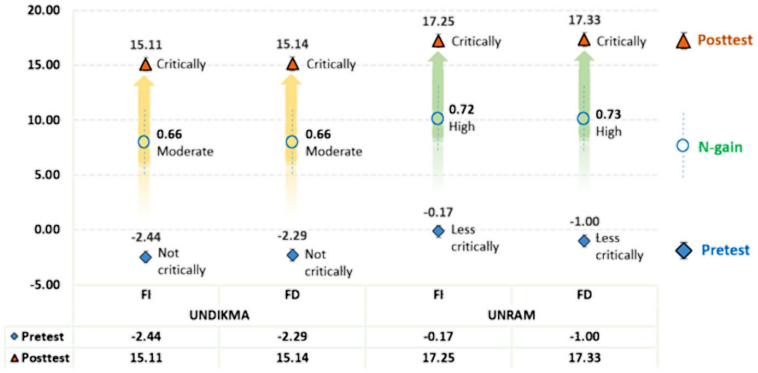

Figure 1. Critical Thinking Skills of PPT from Two Sample Groups (UNDIKMA and UNRAM) and FD/FI Cognitive Styles

Figure 1 illustrates the average variation of critical thinking skills and N-gain for each sample group belonging to the FD/FI category. Although in the posttest, the two-sample groups were categorized as critical, there were differences in the score improvement of each group with the FD/FI cognitive style. The N-gain in the UNDIKMA group was categorized as moderate for the FD and FI cognitive styles, while the UNRAM group was high for the FD and FI cognitive styles. If each FD/FI cognitive style is combined from the two sample groups (UNDIKMA and UNRAM), where N_{FI} = 21 and N_{FD} = 13 (see Table 3), the results are presented in Figure 2.

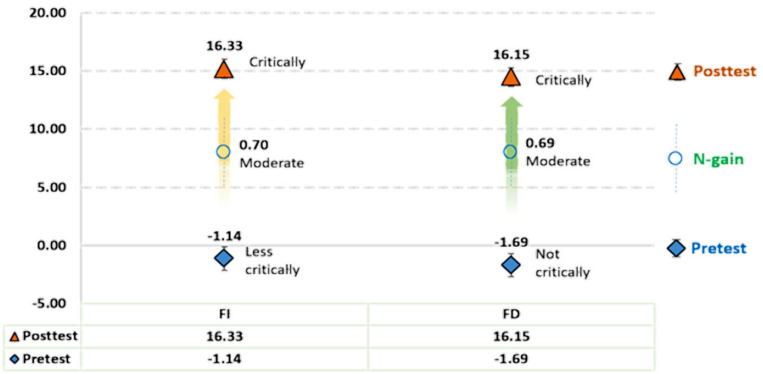

Figure 2. Critical Thinking Ability from PPT Based on FD/FI Category

The increase of critical thinking scores between FD and FI is moderate. It means that there is no significant difference in the improvement of critical thinking scores between PPT of FD and FI, with an N-gain score of 0.69 (FD) and 0.70 (FI). In addition, both are also categorized as critical in line with the posttest score. This result can be proven by statistical analysis as presented in Table 5 for homogeneity and normality test and Table 6 for the t-test.

Table 5. Results of Homogeneity and Normality Tests

Homogeneity (Levene's test)			Normality (Shapiro-Wilk test)	
Levene's score	**df**	**Sig.**	**N**	**Sig.**
0.585	32	0.450	34	0.040

The homogeneity test results showed homogeneous data variance, sig (0.450) > 0.05. However, the normality test results showed a sig value (0.040) < 0.05. These results indicated that the data were not normally distributed. Because the number of samples was not the same ($N_{FD} \neq N_{FI}$), and the data were not normally distributed. Because of this, non-parametric statistical tests were applied. The Mann-Whitney independent sample t-test was carried out on the FD/FI group posttest. The results are presented in Table 6.

Table 6. Results of Mann-Whitney Independent Sample t-test

	Group	N	Mean rank	Sum of ranks	Sig.
Critical Thinking Skills	FI	21	17.88	375.50	0.774
	FD	13	16.88	219.50	
	Total	34			

Table 6 illustrates the value of sig. 0.774 was higher than 0.05. It indicated that the Ha hypothesis was rejected. It means there is no significant difference in critical thinking ability between groups with FI and FD cognitive styles. This result showed in Figure 2, where the practice of learning with reflective inquiry has improved the PPT's critical thinking skills with FD and FI cognitive styles, and both are categorized as critical.

This study clearly showed that reflective practice in inquiry learning effectively improved pre-service teachers' critical thinking skills for the two experimental groups UNDIKMA and UNRAM (see Table 4 and Fig. 1), and the FI/FD cognitive style groups (see Fig. 2). This result is inseparable from the reflective practice in inquiry learning. Critical thinking skills are developed through inquiry in exploring, discovering, and interpreting (Ernita et al., 2021). On the one hand, the process of reflection has demanded that learners think openly, have curiosity, and be responsible for their knowledge. The argument of previous studies states that the practice of reflection is identified with a systematic self-evaluation cycle process, and it is achieved through open discussion and analysis during learning (Choy et al., 2017). The practice of self-evaluation and analysis is an indicator of critical thinking (Facione, 2020). It means that the process of reflection in teaching inquiry has directly trained learners' critical thinking. These results follow previous studies that the practice of reflection has improved PPT critical thinking ability (Verawati et al., 2020; Verawati et al., 2021). In addition, the reflection process in learning activities has been investigated for better learning outcomes and academic achievement (Akpur, 2020) and more meaningful learning (Griggs et al., 2018).

The study results answered problems related to pre-service teachers' low critical thinking performance, where they showed excellent critical thinking performance in this study. The essence of the success of this study lies in reflective practices in inquiry learning. We conduct six steps of reflective-inquiry learning based on the prepared framework (Verawati & Hikmawati, 2019): orientation, problem presentation, hypothesis formulation, hypothesis testing, explanation formulation, and reflection. The reflection process is also carried out on reflective-inquiry learning with several steps: presenting anomalous phenomena, monitoring, performance evaluation, and continuous reflection. Reflection requires strategic and explicit pedagogic interventions to be carried out well (Ryan & Ryan, 2013).

The first reflection process is carried out in the problem presentation step by conducting anomalous phenomena. This step was found to be the best reflection process in inquiry activities (Kahan, 2013). Anomalous phenomena are part

of cognitive conflict strategies that help students reflect on concepts and explanations of phenomena that can encourage them to think critically (Akmam et al., 2018). The second reflection process is carried out in the hypothesis testing step by monitoring and carrying out performance evaluation processes. It has been studied as the core of the reflection process (Choy & Oo, 2012). When PPT conducts the investigation process, they conduct self-monitoring and self-evaluation on their performance. Through this, they can decide the best ways to test hypotheses. In previous studies, the process of evaluating and making decisions was part of critical thinking training (Wahyudi et al., 2019b). The third reflection process, namely continuous reflection carried out at the end of the learning phase, where PPT checks the learning process that has been passed and identifies errors for further improvement. This process is known as critical reflection, which supports critical thinking development (Procter, 2020).

CONCLUSION

The current study results indicated that the tendency of the cognitive style of FI is more dominant than FD in both sample groups (UNDIKMA and UNRAM). The PPT's critical thinking measurement shows that the UNDIKMA pretest is categorized as "not critical," while UNRAM is "less critical." However, after treatment (Reflective-Inquiry Learning), both sample groups were categorized as "critical." The N-gain for UNDIKMA was categorized as moderate, while UNRAM was high. If each FD/FI cognitive style is combined from the two sample groups, each FD/FI group is categorized as critical, and the increase of critical thinking scores is categorized as moderate. In line with this, statistical analysis showed no difference in the increase of critical thinking scores between PPT of FD and FI. The present study results have shown that reflective practice in inquiry learning effectively improved PPT's critical thinking skills with FD and FI cognitive styles. Based on these results, the reflective practice in inquiry learning can be a reference in its structured implementation in regular lectures, aiming to improve the pre-service teachers' critical thinking skills.

ACKNOWLEDGMENTS

This study is part of the decentralization research of the University of Mataram on the Higher Education Excellence Applied Research scheme, with contract number 3966/UN18/PP/2021. The research is fully funded by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia.

REFERENCES

Akmam, A., Anshari, R., Amir, H., Jalinus, N., & Amran, A. (2018). Influence of Learning Strategy of Cognitive Conflict on Student Misconception in Computational Physics Course. *IOP Conference Series: Materials Science and Engineering*, *335*, 012074.

Akpur, U. (2020). Critical, Reflective, Creative Thinking and Their Reflections on Academic Achievement. *Thinking Skills and Creativity*, *37*, 100683.

Arends, R. (2012). *Learning to teach* (9th ed). McGraw-Hill.

Arifin, S., Setyosari, P., Sa'dijah, C., & Kuswandi, D. (2020). The effect of problem based learning by cognitive style on critical thinking skills and student retention. *Journal of Technology and Science Education*, *10*(2), 271–281.

Armstrong, S. J., Cools, E., & Sadler-Smith, E. (2012). Role of Cognitive Styles in Business and Management: Reviewing 40 Years of Research. *International Journal of Management Reviews*, *14*(3), 238–262.

Benade, L. (2015). Teachers' Critical Reflective Practice in the Context of Twenty-first Century Learning. *Open Review of Educational Research*, *2*(1), 42–54.

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity*, *33*, 100584.

Cargas, S., Williams, S., & Rosenberg, M. (2017). An approach to teaching critical thinking across disciplines using performance tasks with a common rubric. *Thinking Skills and Creativity*, *26*, 24–37.

Choy, S. C., & Oo, P. S. (2012). Reflective thinking and teaching practices: A precursor for incorporating critical thinking into the classroom? *International Journal of Instruction*, *5*(1), 167–182.

Choy, S. C., Yim, J. S. C., & Tan, P. L. (2017). Reflective thinking among preservice teachers: A Malaysian perspective. *Issues in Educational Research*, *27*(2), 234–251.

Cleovoulou, Y., & Beach, P. (2019). Teaching critical literacy in inquiry-based classrooms: Teachers' understanding of practice and pedagogy in elementary schools. *Teaching and Teacher Education*, *83*, 188–198.

D'Alessio, F. A., Avolio, B. E., & Charles, V. (2019). Studying the impact of critical thinking on the academic performance of executive MBA students. *Thinking Skills and Creativity*, *31*, 275–283.

Dekker, T. J. (2020). Teaching critical thinking through engagement with multiplicity. *Thinking Skills and Creativity*, *37*, 100701.

Dewey, J. (1910). *How we think*. Boston : D.C. Heath & Co.

Din, M. (2020). Evaluating university students' critical thinking ability as reflected in their critical reading skill: A study at bachelor level in Pakistan. *Thinking Skills and Creativity*, *35*, 100627.

Duran, M., & Dökme, I. (2016). The Effect of the Inquiry-Based Learning Approach on Student's Critical-Thinking Skills. *EURASIA Journal of Mathematics, Science & Technology Education*, *12*(12), 2887–2908.

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*, *12*, 43–52.

Ennis, R. (2018). Critical Thinking Across the Curriculum: A Vision. *Topoi*, *37*(1), 165–184.

Erikson, M. G., & Erikson, M. (2019). Learning outcomes and critical thinking – good intentions in conflict. *Studies in Higher Education*, *44*(12), 2293–2303.

Ernita, N., Muin, A., Verawati, N. N. S. P., & Prayogi, S. (2021). The effect of inquiry learning model based on laboratory and achievement motivation toward students' physics learning outcomes. *Journal of Physics: Conference Series*, *1816*(1), 012090.

Facione, P. A. (2020). *Critical Thinking: What It Is and Why It Counts*. Measured Reasons LCC. https://www.insightassessment.com/wp-content/uploads/ia/pdf/whatwhy.pdf

Fitriani, H., Asy'ari, M., Zubaidah, S., & Mahanal, S. (2019). Exploring the Prospective Teachersâ€™ Critical Thinking and Critical Analysis Skills. *Jurnal Pendidikan IPA Indonesia*, *8*(3), 379–390.

Gaigher, E., Lederman, N., & Lederman, J. (2014). Knowledge about Inquiry: A study in South African high schools. *International Journal of Science Education*, *36*(18), 3125–3147.

George, B., Desmidt, S., Cools, E., & Prinzie, A. (2018). Cognitive styles, user acceptance and commitment to strategic plans in public organizations: An empirical analysis. *Public Management Review*, *20*(3), 340–359.

Ghanizadeh, A. (2017). The interplay between reflective thinking, critical thinking, self-monitoring, and academic achievement in higher education. *Higher Education*, *74*(1), 101–114.

Gilmanshina, S., Smirnov, S., Ibatova, A., & Berechikidze, I. (2021). The assessment of critical thinking skills of gifted children before and after taking a critical thinking development course. *Thinking Skills and Creativity*, *39*, 100780.

Griggs, V., Holden, R., Lawless, A., & Rae, J. (2018). From reflective learning to reflective practice: Assessing transfer. *Studies in Higher Education*, *43*(7), 1172–1183.

Hairida, H. (2016). The Effectiveness Using Inquiry Based Natural Science Module with Authentic Assessment to Improve the Critical Thinking and Inquiry Skills of Junior High School Students. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 209–215.

Hake, R., R. (1999). *Analyzing change/gain scores*. Indiana University: Woodland Hills, CA - USA.

Inoue, N., Asada, T., Maeda, N., & Nakamura, S. (2019). Deconstructing teacher expertise for inquiry-based teaching: Looking into consensus building pedagogy in Japanese classrooms. *Teaching and Teacher Education*, *77*, 366–377.

Jacob, S. M. (2012). Mathematical achievement and critical thinking skills in asynchronous discussion forums. *Procedia - Social and Behavioral Sciences*, *31*, 800–804.

Kahan, D. M. (2013). Ideology, motivated reasoning, and cognitive reflection. *Judgment and Decision Making*, *8*(4), 407–424.

Kristiyanto, W., Gunarhadi, & Indriayu, M. (2020). The Effect of the Science Technology Society and the Quantum Teaching Models on Learning Outcomes of Students in the Natural Science Course in Relation with Their Critical Thinking Skills. *International Online Journal of Education and Teaching*, *7*(1), 177–191.

Laksana, D., Dasna, I. W., & Degeng, I. N. S. (2019). The effects of inquiry-based learning and learning styles on primary school students' conceptual understanding in multimedia learning environment. *Journal of Baltic Science Education*, *18*(1), 51–62.

Lederman, N. G., & Abell, S. K. (Eds.). (2014). *Handbook of Research on Science Education, Volume II* (0 ed.). Routledge.

Leon, J., Núñez, J. L., Ruiz-Alfonso, Z., & Bordón, B. (2015). Music academic performance: Effect of intrinsic motivation and critical thinking. *Revista de Psicodidactica / Journal of Psychodidactics*, *20*(2), 377–391.

Lestari, H., Sopandi, W., Sa'ud, U. S., Musthafa, B., Budimansyah, D., & Sukardi, R. R. (2021). The Impact of Online Mentoring in Implementing RADEC Learning to the Elementary School Teachers' Competence in Training Students' Critical Thinking Skills: A Case Study During COVID-19 Pandemic. *Jurnal Pendidikan IPA Indonesia*, *10*(3), 346–356.

Liang, W., & Fung, D. (2021). Fostering critical thinking in English-as-a-second-language classrooms: Challenges and opportunities. *Thinking Skills and Creativity*, *39*, 100769.

Liyanage, I., Walker, T., & Shokouhi, H. (2021). Are we thinking critically about critical thinking? Uncovering uncertainties in internationalised higher education. *Thinking Skills and Creativity*, *39*, 100762.

Ma, L., & Luo, H. (2021). Chinese pre-service teachers' cognitions about cultivating critical thinking in teaching English as a foreign language. *Asia Pacific Journal of Education*, *41*(3), 543–557.

Moore, T. (2013). Critical thinking: Seven definitions in search of a concept. *Studies in Higher Education*, *38*(4), 506–522.

Naezak, N., Savitri, E., & Fibriana, F. (2021). Simple Terrarium Teaching Aid for Guided Inquiry Learning Model: The Development of Learning Instruments to Students' Concept Understanding in Global Warming and Environmental Awareness. *Journal of Innovation in Educational and Cultural Research, 2*(2), 51-59.

Orhan, T., & Sahin, N. (2018). The Impact of Innovative Teaching Approaches on Biotechnology Knowledge and Laboratory Experiences of Science Teachers. *Education Sciences*, *8*(4), 213.

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61.

Polat, Ö., & Aydın, E. (2020). The effect of mind mapping on young children's critical thinking skills. *Thinking Skills and Creativity*, *38*, 100743.

Prayogi, S., & Verawati, N. N. S. P. (2020). The Effect of Conflict Cognitive Strategy in Inquiry-based Learning on Preservice Teachers' Critical Thinking Ability. *Journal of Educational, Cultural and Psychological Studies (ECPS Journal)*, *21*, 27–41.

Prayogi, S., Yuanita, L., & Wasis. (2018). Critical Inquiry Based Learning: A Model of Learning to Promote Critical Thinking Among Prospective Teachers of Physic. *Journal of Turkish Science Education*, *15*(1), 43–56.

Procter, L. (2020). Fostering critically reflective thinking with first-year university students: Early thoughts on implementing a reflective assessment task. *Reflective Practice*, *21*(4), 444–457.

Rayner, S., & Cools, E. (2011). *Style Differences in Cognition, Learning, and Management: Theory, Research and Practice*. Routledge.

Ryan, M. (2013). The pedagogical balancing act: Teaching reflection in higher education. *Teaching in Higher Education*, *18*(2), 144–155.

Ryan, M., & Ryan, M. (2013). Theorising a model for teaching and assessing reflective learning in higher education. *Higher Education Research & Development*, *32*(2), 244–257.

Sergis, S., Sampson, D. G., Rodríguez-Triana, M. J., Gillet, D., Pelliccione, L., & de Jong, T. (2019). Using educational data from teaching and learning to inform teachers' reflective educational design in inquiry-based STEM education. *Computers in Human Behavior*, *92*, 724–738.

Siburian, O., Corebima, A. D. I., & Saptasari, M. (2019). The Correlation Between Critical and Creative Thinking Skills on Cognitive Learning Results. *Eurasian Journal of Educational Research*, *19*(81), 1–16.

Susandi, A. D., Sa'dijah, C., As'ari, A. R., & Susiswo. (2019). Students' critical ability of mathematics based on cognitive styles. *Journal of Physics: Conference Series*, *1315*(1), 012018.

Szenes, E., Tilakaratna, N., & Maton, K. (2015). The Knowledge Practices of Critical Thinking. In M. Davies & R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education* (pp. 573–591). Palgrave Macmillan US.

Trostek, J. R. (2020). Between the modelling and the engineering of learning: Preservice teachers' performance in course essays. *Journal of Further and Higher Education*, *44*(6), 781–794.

Uiterwijk-Luijk, L., Krüger, M., Zijlstra, B., & Volman, M. (2019). Teachers' role in stimulating students' inquiry habit of mind in primary schools. *Teaching and Teacher Education*, *86*, 102894.

van Riesen, S. A. N., Gijlers, H., Anjewierden, A., & de Jong, T. (2018). The influence of prior knowledge on experiment design guidance in a science inquiry context. *International Journal of Science Education*, *40*(11), 1327–1344.

Verawati, N. N. S. P., & Hikmawati, H. (2019). Validitas Model Inkuiri yang Diintervensi Proses Reflektif untuk Melatih Kemampuan Berpikir Kritis Mahasiswa Calon Guru. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*.

Verawati, N. N. S. P., Hikmawati, H., & Prayogi, S. (2020). The Effectiveness of Inquiry Learning Models Intervened by Reflective Processes to Promote Critical Thinking Ability in Terms of Cognitive Style. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(16), 212.

Verawati, N. N. S. P., Hikmawati, & Prayogi, S. (2021). The Effectiveness of reflective-inquiry learning model to improve preservice-teachers' critical thinking ability viewed from cognitive style. *Journal of Physics: Conference Series*, *1747*(1), 012010.

Verawati, N. N. S. P., Prayogi, S., Gummah, S., Muliadi, A., & Yusup, M. Y. (2019). The Effect of Conflict-Cognitive Strategy in Inquiry Learning towards Pre-Service Teachers' Critical Thinking Ability. *Jurnal Pendidikan IPA Indonesia*, *8*(4).

Verawati, N. N. S. P., Wahyudi, W., & Ayub, S. (2020). Pengaruh Model Pembelajaran Inquiry-Creative-Process (ICP) terhadap Kemampuan Berpikir Kritis Mahasiswa Calon Guru. *Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika*, *4*(1), 7–15.

Viator, R. E., Harp, N. L., Rinaldo, S. B., & Marquardt, B. B. (2020). The mediating effect of reflective-analytic cognitive style on rational thought. *Thinking & Reasoning*, *26*(3), 381–413.

Vogt, F., & Schmiemann, P. (2020). Assessing Biology Pre-Service Teachers' Professional Vision of Teaching Scientific Inquiry. *Education Sciences*, *10*(11), 332.

Wahyudi, Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019a). Effectiveness of Inquiry-Creative-Process Learning Model to Promote Critical

Thinking Ability of Prospective Physics Teachers. *Journal of Physics: Conference Series*, *1417*, 012071.

Wahyudi, W., Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019b). The Effect of Scientific Creativity in Inquiry Learning to Promote Critical Thinking Ability of Prospective Teachers. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(14), 122.

Walker, C. L., Shore, B. M., & Tabatabai, D. (2021). On the Trail of Authentic Collaboration Over Extended Time in Inquiry Classrooms: Following the Footprints of Role Diversification as Indicators that Inquiry Occurred. *Scandinavian Journal of Educational Research*, *0*(0), 1–24.

Witkin, H. A., Moore, C. A., Goodenough, D., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research*, *47*(1), 1–64.