

Critical Thinking Embedded Essay Test

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ABSTRACT

Critical thinking (CT) is one of the essential twenty-first-century competencies that need to be empowered. The development of students' critical thinking (CT) can be assessed using the Illinois Critical Thinking Essay Test (ICTE Test). However, due to the constant use of multiple evaluation items at one time, Indonesian teachers consider ICTE Test less applicable. Therefore, by adding some modifications to the ICTE Test, a more practical rubric for assessing students' critical thinking, namely critical thinking embedded essay test (CTEE Test), was developed. The difference between the ICTE and CTEE Tests results was also investigated in this study. The participants of this study consisted of 300 students who were enrolled in the natural science program at senior high schools in Malang, Indonesia. A 5-item essay test was administered to the students. Their answers were assessed using both the ICTE Test and CTEE Test rubrics. The results of the paired sample t-test showed that there was no significant difference between the ICTE Test and CTEE Test rubrics in evaluating the participants' critical thinking. Therefore, the use of the CTEE Test rubric is highly recommended.

Keywords: *critical thinking, critical thinking skills assessment, ICTE Test, CTEE Test*

1. INTRODUCTION

People from the current era need to acquire various competencies to compete with others in the real world [1]. In regards to this matter, every individual needs to think critically towards every opportunity that comes their way [2]. Flexibility allows people to be competent in facing a world which keeps changing into an unpredictable direction [3]. As an educational institution, schools are responsible for producing graduates who are equipped with 21st century competencies [4]–[6], including critical thinking [5], [7].

Critical thinking (CT) is the ability to think clearly and rationally about what needs to be done [8]. John Dewey defines critical thinking as active, persistent, and thorough consideration of a belief or knowledge that is accepted as what it is and viewed from the standpoint of reasons that support it and the conclusions that follow as a tendency [9]. Besides, Dr. Richard Paul from the Foundation for Critical Thinking describes critical thinking as an art of analyzing and evaluating thinking with a developing perspective. To think critically is to be independent and discipline in monitoring self and correcting one's mind. Critical thinking, to a certain extent, consists of logical and reflective thinking skills that focus on deciding what to do or what to believe [10]. Schools are expected to be able to produce critical thinkers [11] who are ready to face a new era of globalization [12]. Individuals with critical thinking will be able to evaluate, analyze, and interpret information [13]. These individuals are capable of dealing with various challenges and problems [14] as well as adjusting themselves into diverse situations [3]. They can handle not only simple but also complex or unusual problems [15]. Critical thinkers can

make a constructive decision when faced with everyday conflicts and provide arguments which are organized in such a way to support their decision [16]. Given such benefits of critical thinking in life, CT is thus considered as a key to interdisciplinary problem-solving [15].

In attempting to empower students' critical thinking, the development of an appropriate assessment tool is indispensable. A wide array of critical thinking tests have been developed. Unfortunately, the majority of the tests are formulated as multiple-choice tests, while according to Ennis, multiple-choice tests are less reliable than open-ended tests in measuring students' critical thinking [17]. Tests containing open-ended questions are also more comprehensive [18]. Besides the tests, methods used to assess students' critical thinking should also be able to determine the students' thinking processes [19].

Tests that consist of multiple-choice questions or short-answer questions are thought to be less effective in assessing students' thinking processes because the answers are already provided by the tests' makers [20]. As a result, the test takers are not allowed to provide their alternative answers [21], [22]. Furthermore, short-answer tests are generally managed to save time and cost; therefore, the relevance and the objective of the tests are sometimes not in line with the learning purpose. Also, these types of tests cannot be used to evaluate individuals' 21st century skills [23], [24].

Illinois Critical Thinking Essay Test (ICTE Test) is designed by Finken and Ennis to assess critical thinking [25]. This test contains open-ended questions which are considered quite useful in measuring critical thinking, yet less practical when used as an evaluation tool of every subject matter in schools, such as Biology. Since biological science includes many complex concepts, a Biology essay test in Indonesia is comprised of more than

one questions, reducing the applicability of the ICTE Test. Therefore, by adding some modifications to the ICTE Test, a more practical rubric for assessing critical thinking was developed in this study. The modified ICTE test rubric, namely Critical Thinking Embedded Essay Test (CTEE Test), was tested to ensure its validity. The result of the validity test would provide a solid foundation for product use. Besides, the difference between the ICTE Test and CTEE Test rubrics in assessing critical thinking was also investigated.

2. MATERIALS AND METHODS

2.1. Participants of the Study

This study involved 300 students who were enrolled in the natural science program at senior high schools in Malang, Indonesia.

2.2. Instruments for Data Collection

The data on the students' critical thinking was collected using a test containing five essay questions. The test was developed in such a way so that the students were allowed to freely express themselves, allowing them to provide more various and argumentative answers supported by relevant evidence. The students' answers were evaluated using two critical thinking rubrics: 1) Illinois Critical Thinking Essay Test (ICTE Test) rubric; and 2) modified ICTE Test rubric, that is Critical Thinking Embedded Essay Test (CTEE Test) rubric.

2.3. Data Analysis

Data analysis was performed using paired sample t-test to investigate the difference between the ICTE Test (IGAP-LIKE Scoring Sheet) and CTEE Test rubrics in assessing critical thinking. Before conducting the analysis, prerequisite tests (i.e., normality and homogeneity tests) were run. The normality and homogeneity tests were performed using Z-test from Skewness and Kurtosis and Levene's test, respectively

3. RESULT AND DISCUSSION

The students' average critical thinking scores assessed using the ICTE Test and CTEE Test rubrics were presented in Table 1. Based on the table, it was found that there was a slight difference between the students' average critical thinking score assessed using the ICTE Test rubric and that assessed using the CTEE Test rubric. Also, the standard deviations of both groups showed no significant difference.

Table 1. Average Scores and Standard Deviations Measured Using the ICTE Test and CTEE Test Rubrics

| Instrument | Mean | Standard Deviation |
|------------|-------|--------------------|
| ICTE | 60.04 | 20.504 |
| CTEET | 60.27 | 21.388 |

The results of the normality and homogeneity tests performed were summarized in Table 2 and 3, respectively. The results of the Z-test were presented in Table 2. Skewness and Kurtosis values were 0.217 and 1.757, respectively. Since this study involved a medium-sized sample and the Z-values from Skewness and Kurtosis < 3.29 [26], the critical thinking scores collected in this study were considered to be distributed normally. The result of the homogeneity test showed a significance value of >0.05. Therefore, the CT scores obtained from the ICTE Test and CTEE Test rubrics were homogeneous.

Table 2. The Result of the Normality Test

| Measure | Value | Standard Error | Z-test |
|----------|-------|----------------|--------|
| Skewness | 0.031 | 0.140 | 0.217 |
| Kurtosis | 0.493 | 0.280 | 1.757 |

Table 3. The Result of the Homogeneity Test

| F | Sig. |
|-------|-------|
| 0.025 | 0.874 |

T-test was run after ensuring the normality and homogeneity of the data. The result of the paired sample t-test was summarized in Table 4. Table 4 showed that there was no significant difference between the students' average critical thinking score assessed using the ICTE Test rubric and that assessed using the CTEE Test rubric ($t(598) = 0.131$, $p = 0.896$). Therefore, it can be said that the ICTE Test and CTEE Test rubric produced similar scores when used to assess critical thinking (CT).

Table 4. The Result of the Paired Sample T-test

| t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
|-------|-----|-----------------|-----------------|-----------------------|
| 0.131 | 598 | 0.896 | 0.223 | 1.711 |

Critical thinking is one of the key 21st century competencies [4], [27]–[31]. Students need to develop this competency to solve distinctive problems in life [15]. Critical thinking is a capital required more than ever by someone to thrive in this information age [3]. Not surprisingly, the empowerment of critical thinking is considered as an essential element of education today [32]. To help teachers evaluate their students' critical thinking, an appropriate assessment tool should be developed. Illinois Critical Thinking Essay Test (ICTE Test) is one of the most common critical thinking evaluation tools used in Indonesia. This test was developed by Finken & Ennis [25]. The test rubric contains detailed information about

how to manage and measure students' ability in providing critical written or oral arguments. Six critical thinking components can be assessed using the rubric, including 1) focus, 2) supporting reasons, 3) reasoning, 4) organization, 5) conventions, and 6) integration (FRISCO).

The ICTE Test rubric is very effective in evaluating critical thinking. Even, the majority of research on critical thinking conducted in Indonesia used this assessment tool as the instrument to collect the data, for example, research carried out in Karanganyar [33] and Lombok Tengah [34]. However, when examined further, the rubric seems to be less practical when applied for every subject matter in schools. Tests designed by the Indonesian teachers or practitioners mostly contain more than one essay questions, while the ICTE Test rubric is mainly designed to evaluate a single essay or interview question only.

In this study, a more effective rubric was developed by adding some modifications into the original ICTE Test rubric and testing the validity of the newly modified version. The modifications included adding the score range (from 1-6 to 0-5) and reducing the indicators (from six indicators to five indicators) of the original rubric. As a result, indicators "supporting reasons" and "reasoning" will not be found in the new version since they have been merged into one aspect. The descriptors presented in the newly modified version of the rubric have included the six primary components of critical thinking suggested by Ennis [25], that consist of focus, reason, inference, situation, clarity, and overview (FRISCO). The results of the modifications of the ICTE Test rubric can be seen in Table 5.

Table 5. CTEE Test Rubric, Modified version of the ICTE Test rubric by Finken and Ennis [25]

| Score/Point | Descriptor |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | <ul style="list-style-type: none"> • Covers correct, clear, and specific concepts • Provides accurate, clear, and precise answers, and supports them by strong, right, and clear arguments • Shows a smooth flow of thinking, all of the concepts are interrelated and integrated • Uses correct and appropriate language and grammar • Presents perceptible aspects and provides fair and accurate evidence |
| 4 | <ul style="list-style-type: none"> • Most of the concepts covered are exact, clear, and specific • The descriptions of the answers are mostly correct and clear, but less specific • Shows a smooth flow of thinking, most of the concepts are interrelated and integrated • The majority of sentences are error-free, makes only occasional errors • All of the aspects are perceptible, but the evidence is not yet fair and accurate |
| 3 | <ul style="list-style-type: none"> • Some of the concepts covered are correct, clear, and specific • Some of the descriptions of the answers are correct, but supporting arguments are sometimes irrelevant • The flow of thinking is quite smooth, only small parts of the concepts are interrelated and integrated • Uses appropriate grammar, but errors in spelling predominate • Most of the aspects are perceptible |
| 2 | <ul style="list-style-type: none"> • Covers unclear, sometimes exaggerated or confusing concepts • Provides irrelevant arguments to support answers • Shows the poor flow of thinking, unrelated concepts • Uses incomplete sentences • Only small parts of aspects are correct |
| 1 | <ul style="list-style-type: none"> • Covers incorrect or insufficient concepts • Provides false arguments • Shows inferior flow of thinking • Cannot write proper sentences • All of the elements are imperceptible |
| 0 | No answer or incorrect answer |

ICTE Test rubric scores range from 1 to 6. In the range between 1-3, critical thinking is categorized “less apparent or less developed”, while scores ranged between 4-6 indicate “well developed” critical thinking. CTEE Test rubric, on the other hand, uses scores ranged between 0-5 instead of 1-6. Since score 2 and score 3 in the ICTE Test rubric seemingly measure the same level of critical thinking, they are merged into one score range in the CTEE Test rubric. Besides, score 0 for no answer or incorrect answer has been added to the ICTE Test rubric. This scoring range (0-5) has been adjusted to the common assessment standard used in Indonesia.

The result of the t-test showed no significant difference between the ICTE Test and CTEE Test rubrics in assessing

critical thinking. This finding suggests that the CTEE Test rubric can be used as an alternative tool to assess students’ critical thinking in Biology in Indonesia. Besides, essay questions formulated in the CTEE Test rubric also cover high-cognitive ability questions which, according to Bloom Taxonomy consist of analyzing (C4), evaluating (C5), and creating (C6). Questions with cognitive levels C4-C6 will encourage students to process provided information before making a decision [35], [36]. Unlike the low-cognitive ability questions, questions that require students to think at higher cognitive levels will encourage them to provide logical arguments to support answers or solve problems [19]. The arguments provided by the

students are used as a basis for assessing their critical thinking level in the CTEE Test rubric.

Critical thinking, along with creative thinking and metacognitive skills, is categorized into higher-order thinking skills [37], [38]. Therefore, tests used to assess critical thinking should include high-cognitive ability questions and open-ended questions that can discuss authentic problems in real life [19] and encourage solutions from multiple perspectives. By always promoting the ability of Indonesian teachers to construct high-cognitive tests, schools can improve the quality of their poor low-cognitive assessment which is still prevalent in some areas of this country [39], [40]. In addition to increasing the quality of the assessment tool, the students can also be accustomed to thinking critically [41].

Despite the challenges faced by the teachers, it is expected that the CTEE Test rubric developed in this study can be

4. CONCLUSION

The results of this study showed that there was no significant difference between the Illinois Critical Thinking Essay Test (ICTE Test) and Critical Thinking Embedded Essay Test (CTEETest) rubrics in assessing critical thinking. Therefore, the CTEE Test rubric can be implemented by biology teachers as an effective and efficient tool to measure students' critical thinking in biology. The effectiveness of the CTEETest rubric in assessing students' critical thinking in other subjects should be investigated in the future.

REFERENCES

- [1] B. Johnson and Sessions, *What schools don't teach: 20 ways to help students excel in school and life*. New York: Routledge, 2015.
- [2] T. Wrahatnolo and Munoto, "21st centuries skill implication on educational system," in *IOP Conference Series: Materials Science and Engineering*, 2018, pp. 1–7.
- [3] C. P. Dwyer, M. J. Hogan, and I. Stewart, "An integrated critical thinking framework for the 21st century," *Think. Ski. Creat.*, vol. 12, pp. 43–52, 2014.
- [4] C. L. Scott, "The futures of learning 2: What kind of learning for the 21st century?" Paris, 2015.
- [5] A. Chalkiadaki, "A systematic literature review of 21st century skills and competencies in primary education," *Int. J. Instr.*, vol. 11, no. 3, pp. 1–16, Jul. 2018.
- [6] B. Trilling and C. Fadel, *21st century skills: Learning for life in our times*. San Francisco: Jossey-Bass, 2009.
- [7] P. C. Abrami, R. M. Bernard, E. Borokhovski, D. I. Waddington, C. A. Wade, and T. Persson, "Strategies for teaching students to think critically: A meta-analysis," *Rev. Educ. Res.*, vol. 85, no. 2, pp. 275–314, 2015.
- [8] J. M. Sharples et al., "Critical thinking in healthcare and education," *BMJ*, vol. 357, pp. 16–18, 2017.
- [9] A. Fisher, *Critical thinking: An introduction*. London: Cambridge University Press, 2011.
- [10] R. H. Ennis, "A logical basis for measuring critical thinking skills," *Educ. Leadersh.*, vol. 43, no. 2, pp. 44–48, 1985.
- [11] O. L. Uribe, D. S. Uribe, and M. del P. Vargas, "Critical thinking and its importance in education: Some reflections," *Rastros Rostros*, vol. 19, no. 34, pp. 1–17, 2017.
- [12] M. J. Durib, "Challenges of globalization to school curricula from the point of view of faculty members with suggestions of how to deal with it," in *Procedia - Social and Behavioral Sciences*, 2014, vol. 112, no. Iceptsy, 2013, pp. 1196–1206.
- [13] S. A. Ali, "Critical thinking in the information age: helping students find and evaluate scientific information," *Teach. Innov. Proj.*, vol. 6, no. 1, 2016.
- [14] M. Evens, A. Verburgh, and J. Elen, "Critical thinking in college freshmen: The impact of secondary and higher education," *Int. J. High. Educ.*, vol. 2, no. 3, pp. 139–151, 2013.
- [15] B. Sundell, "Critical thinking and interdisciplinary development fostering critical thinking in an interdisciplinary wellness coaching academic program," *Eur. Sci. J.* vol. 11, no. 8, pp. 46–59, 2015.

- [16] N. A. Shukri and J. Mukundan, "A review on developing critical thinking skills through literary texts," *Adv. Lang. Lit. Stud.*, vol. 6, no. 2, pp. 2–7, 2015.
- [17] R. H. Ennis, "Critical thinking assessment," The Ohio State University, 2001. [Online]. Available: <http://www3.qcc.cuny.edu/WikiFiles/file/EnnisCriticalThinkingAssessment.pdf>. [Accessed: 23-Mar-2015].
- [18] S. Zubaidah, "Berpikir kritis: Kemampuan berpikir tingkat tinggi yang dapat dikembangkan melalui pembelajaran sains," in *Seminar Nasional Sains 2010 dengan Tema "Optimalisasi Sains untuk Memberdayakan Manusia"*, 2010, pp. 1–14.
- [19] E. R. Lai, "Critical thinking: A literature review," 2011.
- [20] Y. Attali and M. Bar-Hillel, "Guess where: The position of correct answers in multiple-choice test items as a psychometric variable," *J. Educ. Meas.*, vol. 40, no. 2, pp. 109–128, 2003.
- [21] N. L. Ibbett and B. J. Wheldon, "The incidence of clueing in multiple choice testbank questions in accounting: Some evidence from Australia," *J. Bus. Educ. Scholarsh. Teach.*, vol. 10, no. 1, pp. 20–35, 2016.
- [22] B. P. Foley, "Getting lucky: How guessing threatens the validity of performance classifications," *Pract. Assessment, Res. Eval.*, vol. 21, no. 3, pp. 1–23, 2016.
- [23] Y. Abosalem, "Assessment techniques and students' higher-order thinking skills," *Int. J. Second. Educ.*, vol. 4, no. 1, pp. 1–11, 2016.
- [24] A. Doganay and A. P. Bal, "The measurement of students' achievement in teaching primary school fifth-year mathematics classes," *Educ. Sci. Theory Pract.*, vol. 10, no. 1, pp. 199–215, 2010.
- [25] M. Finken and R. H. Ennis, "Illinois critical thinking essay test," Champaign, 1993.
- [26] H.-Y. Kim, "Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis," *Restor. Dent. Endod.*, vol. 38, no. 1, pp. 52–54, 2013.
- [27] R. H. Ennis, "The nature of critical thinking: An outline of critical thinking dispositions and abilities," 2011. [Online]. Available: http://faculty.education.illinois.edu/rhennis/documents/TheNatureofCriticalThinking_51711_000.pdf.
- [28] L. C. Garcia, "Environmental science issues for higher-order thinking skills (HOTS) development : A case study in the Philippines," in *Biology Education and Research in a Changing Planet*, E. G. S. Daniel, Ed. Singapore: Springer Science+Business Media, 2015, pp. 45–54.
- [29] B. P. Mainali, "Higher order thinking in education," *Acad. Voices A Multidiscip. J.* vol. 2, no. 1, pp. 5–10, 2012.
- [30] D. Strauss, "How critical is 'critical thinking'?" *South African J. Philos.*, vol. 35, no. 3, pp. 261–271, 2016.
- [31] S. Živković, "A Model of critical thinking as an important attribute for success in the 21st century," in *Procedia - Social and Behavioral Sciences*, 2016, vol. 232, pp. 102–108.
- [32] M. Karakoç, "The significance of critical thinking ability in terms of education," *Int. J. Humanit. Soc. Sci.*, vol. 6, no. 7, pp. 81–84, 2016.
- [33] S. A. Triyanto, H. Susilo, F. Rohman, and E. S. Lestari, "Kecakapan berpikir kritis dan literasi ilmiah siswa kelas XI IPA 7 SMAN 1 Karanganyar," in *Seminar Nasional Pendidikan dan Saintek*, 2016, vol. 2016, pp. 803–808.
- [34] S. Zohdi, "Pengaruh model pembelajaran IPA berbasis masalah (problem based learning) terhadap kemampuan berpikir kritis dan motivasi belajar kelas 5 MIN 2 Lombok Tengah NTB," Universitas Islam Negeri Maulana Malik Ibrahim Malang, 2018.
- [35] J. Stayanchi, "Higher order thinking: Bloom's taxonomy," *Kwansei Gakuin Univ. Humanit. Rev.*, vol. 22, pp. 117–124, 2017.
- [36] A. Salisbury and A. Salisbury, "High cognitive test item development and implementation," Utah State University, 2014.
- [37] N. Baharin, N. Kamarudin, U. K. Abdul, and A. Manaf, "Integrating STEM education approach in enhancing higher order thinking skills," *Int. J. Acad. Res. Bus. Soc. Sci.*, vol. 8, no. 7, pp. 810–821, 2018.
- [38] C. Jerome, J. A.-C. Lee, and S.-H. Ting, "What students really need : instructional strategies that enhance higher order thinking skills (HOTS) among UNIMAS undergraduates," *Int. J. Bus. Soc.*, vol. 18, no. 4, pp. 661–668, 2017.
- [39] N. Netri, B. Holiwarni, and Abdullah, "Development of test instruments based higher order thinking skill (HOTS) on chemical equilibrium at second grade in senior high school," *JOM*, vol. 5, no. 2, pp. 1–11, 2018.

- [40] S. Hadi, H. Retnawati, S. Munadi, E. Apino, and N. F. Wulandari, "The difficulties of high school students in solving higher-order thinking skills problems," *Probl. Educ. 21st Century*, vol. 76, no. 4, pp. 520–532, 2018.
- [41] I. W. Widana, "Higher order thinking skills assessment (HOTS)," *J. Indones. Student Assess. Eval.*, vol. 3, no. 1, pp. 32–44, 2017.
- [42] T. I. Permana, I. Hindun, N. L. Rofi'ah, and A. S. N. Azizah, "Critical thinking skills: The academic ability, mastering concepts and analytical skill of undergraduate students," *J. Pendidik. Biol. Indones.*, vol. 5, no. 1, pp. 1–8, 2019.
- [43] A. Fauzi, "Profile of junior high school students' critical thinking skills in answering questions related to biological concepts," *Sci. Educ. J. Pendidik. Sains*, vol. 8, no. 1, 2019.