

Development of Evaluative-Process Learning Tools Integrated with Conceptual-Problem-Based Learning Models: Study of Its Validity and Effectiveness to Train Critical Thinking

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Article Info	Abstract
<p>Article History Received: March 2022; Revised: May 2022; Published: June 2022</p> <p>Keywords Learning tools; Evaluative-process; Conceptual-problem-based learning; Validity; Effectiveness; Critical thinking skills</p>	<p>This study aimed to develop an evaluative-process learning tool integrated with the conceptual-problem-based learning (CPBL) model to train students' critical thinking skills. The learning tools developed (lesson plans, textbooks, worksheets, and critical thinking test instruments) were evaluated for validity and effectiveness in training students' critical thinking skills at the higher education level. Validity evaluation is carried out on content and construct validity aspects. This is done through a focus group discussion (FGD) mechanism involving four expert validators. Furthermore, the Effectiveness of the developed learning tools is evaluated by implementing them in the classroom. The experimental design (intact-group comparison) involved a sample group from the State Islamic University of Mataram. The experimental group was taught by evaluative-process learning tools integrated with the CPBL model, while lectures and discussions taught the control group. Critical thinking data were collected using a valid essay test instrument, and the results were analyzed. The validity test results show that all the elements that make up the learning tools in the aspect of content and construct validity have been declared valid. Furthermore, at the implementation stage in the classroom, evaluative-process learning tools integrated with the CPBL model have been effective in training students' critical thinking skills compared to teaching that relies on lectures and discussion. The Effectiveness is based on two aspects, (1) the conceptual framework of the CPBL model, which is constructed and arranged from a problem-based learning model with five learning steps, namely prior knowledge, organize, investigate, analyze, and evaluation; (2) the concept of evaluative-process which is integrated with the CPBL model. These two aspects support capacity in training students to think critically.</p> <p> https://doi.org/10.36312/ijece.v1i1.736 Copyright© 2022, Fitriani et al. This is an open-access article under the CC-BY-SA License.</p> 
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INTRODUCTION

Improving the quality of human resources is a challenge for universities. Ideally, university-level learning can develop students' hard and soft skills (Fakhriyah, 2014). Hard

skills are theoretically related to mastery of lecture material, while soft skills strengthen specific skills such as critical thinking (Jones et al., 2018). Critical thinking as a 21st-century skill in recent decades is seen as an essential outcome of learning at the university level and has become one of the competencies that students must achieve (Prayogi et al., 2019). Students face significant changes in all aspects of life, digital literacy and technological advances, multicultural society, global communication, innovation, and others in the 21st century (Saleh, 2019). In this context, the role of universities in helping students deal with these changes using critical thinking (Chalkiadaki, 2018).

Some developed countries such as the United States, Europe, Canada, Australia, and New Zealand set critical thinking as their standard of educational competence (Verawati et al., 2019). Likewise, in developing countries such as Indonesia, critical thinking has been established as the goal of achieving competence in learning, as stated in the Indonesian National Qualifications Framework (Prayogi et al., 2018). Critical thinking is reflective thinking that aims to decide what to believe and do (R. Ennis, 2018). Facione & Facione (1994) states that critical thinking is a cognitive skill with six aspects: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Critical thinking skills are divided into two dimensions, namely, ability and disposition, if it is focused on the ability aspect in several recent studies using critical thinking indicators such as analysis, inference, evaluation, and decision making (Wahyudi et al., 2019).

Practicing critical thinking requires a set of appropriate learning modes, one of which is developing learning tools based on a particular model. In this study, the conceptual-problem-based learning (CPBL) model. The conceptual framework of the CPBL model is built and arranged from a problem-based learning model with five learning steps: prior knowledge, organize, investigate, analyze, and evaluate (Karmana & Samsuri, 2018). In its implementation to train critical thinking, this model has weaknesses, including the indicators of critical thinking in the evaluation and inference aspects are still relatively low. The findings are almost the same as previous researchers that teachers still have difficulty improving students' critical thinking skills in inference and evaluation aspects (Miri et al., 2007; Qing et al., 2010). This problem is undoubtedly very worrying because critical thinking can be taught and trained (Woolfolk, 2000). Problems related to implementing the CPBL model can be solved through an evaluative process integrated into learning using the CPBL model. Previous research (Choy & Cheah, 2009) proves that students do not progress in critical thinking because teachers do not integrate the process of gaining critical thinking with learning practices that require several reflections and evaluations.

Evaluative-process is an approach to determine the impact of the conditioned learning process and is based on evidence of empirical achievement of the induced learning process (Chong et al., 2015). In this context, students are conditioned through a series of learning activities by conducting the CPBL model to achieve specific learning outcomes, namely critical thinking skills. Evaluative-process intervenes in the learning process as a form of feedback information that students can use to improve the quality of the desired learning outcomes and their performance in the learning process (Ross et al., 2002). The study results show that the feedback mode as a form of evaluative process positively impacts student success in learning (Agricola et al., 2020). Evaluative-process is identified with a reflective process which is a form of regulation of cognitive processes that can support successful learning according to the expected goals, one of which is critical thinking (Verawati, Hikmawati, & Prayogi, 2021).

Learning using the CPBL model, which intervened with the evaluative process, is planned by developing learning tools. The design of learning tools is crucial as the foundation for implementing learning in the field. When learning tools are appropriately designed, they

can provide information that helps learners more effectively achieve learning goals (Pozzi et al., 2020). In addition, well-designed learning tools serve as communication tools, lesson plan tools, learning resources, and tools for learning evaluation (Rusznyak & Walton, 2011). Learning tools are one of the factors that play an essential role in learning activities. The development of learning tools in accordance with the learning model's characteristics tends to impact a directed learning process so that the learning objectives to optimize students' skills can be achieved. An evaluative-process learning tool integrated with the conceptual-problem-based learning (CPBL) model was developed in the current study to achieve the goal of critical thinking. The learning tools developed were tested for validity and Effectiveness in training students' critical thinking skills.

METHOD

This study aims to develop an evaluative-process learning tool integrated with a conceptual-problem-based learning (CPBL) model. Learning tools were developed in Basic Biology lectures at the University. Furthermore, the learning tools developed were evaluated for validity and Effectiveness in training students' critical thinking skills at the higher education level. This research and development study produces a product, namely evaluative-process learning tools integrated with the CPBL model. According to Borg & Gall (1983), the development stage is research and information gathering, planning, developing the initial product form, initial trial, initial product revision, main trial, operational product revision, operational trial, final product revision, and dissemination. In accordance with the needs of this research, adaptation and modification were carried out in six stages of research, namely: 1) information collection, which includes literature review and preparation of the subject matter; 2) planning includes defining and formulating goals; 3) develop the initial product form; 4) conduct an initial trial (expert validation); 5) revision of the initial product in accordance with the suggestions in the initial trial; and 6) the main trial in the relevant groups.

Focusing on the validation process, the learning tools developed were validated by 4 validators through a focus group discussion (FGD) mechanism. Suggestions and inputs from the validator are followed up to improve the developed learning tools. The data from the validation of learning tools were analyzed descriptively qualitatively, namely by averaging the scores obtained from the validators. The validity assessment uses a five-point scale (highest score 5, lowest score 1). The scores obtained from the validator's assessment were converted into intervals and categorized in Table 1 (Prayogi et al., 2018).

Table 1. The level of validity of learning tools

Intervals	Category
$V_a > 4.21$	Very valid
$3.40 < V_a \leq 4.21$	Valid
$2.60 < V_a \leq 3.40$	Enough valid
$1.79 < V_a \leq 2.60$	Less valid
$V_a \leq 1.79$	Not valid

Learning tools are declared to have a good degree of validity, if the minimum level is valid. If the level of attainment of validity is below valid, it is necessary to revise it. The valid learning tools are then tested for their Effectiveness on the relevant subject (main trial on the relevant group). What is meant by relevant subjects are students at the level of higher education.

Test the Effectiveness of the learning tools using an experimental design by employing an "intact-group comparison design" (Fraenkel et al., 2012). In the intact-group comparison design, one group is used for research, but is divided into two, namely half the experimental group (which is treated) and half the control group. The final results of the learning treatment objectives were then observed.

Table 2. The intact-group comparison design

Group	Treatment	Observation
Experimental	X ₁	O ₁
Control	X ₂	O ₂

The experimental group was given learning treatment (X₁) with evaluative-process learning tools integrated with the CPBL model, while the control group (X₂) with regular learning relied on lectures and discussions. O₁ and O₂ are observations in both groups (experimental and control). Observations are on aspects of the critical thinking skills of the two groups after the learning treatment. The test of the Effectiveness of the learning tools was carried out on the material "Structure and Function of Cells." Learning is carried out in four meetings, each meeting taking about ninety minutes.

The research sample was Biology education students at Mataram State Islamic University, Indonesia. One test class with 40 students was divided into two groups, each 20 students as the experimental group and 20 in the control group. Demographically, the gender of the two sample groups was relatively balanced between male and female, while the ages of the members of the sample group were between 17-19 years old. Ethical approval of research sample involvement has received official permission from the university where the research is carried out.

The test instrument was employed to measure students' critical thinking skills. The essay test is a commonly used instrument to measure critical thinking (Verawati, Hikmawati, Prayogi, et al., 2021). Methods of measurement and indicators of critical thinking are adapted from previous studies (Prayogi et al., 2018), where four essay questions were employed and each item was scored using a multilevel stage with five scoring criteria (-1 to +3). In the final calculation, each student is then categorized into criteria, the lowest criterion is not critical, and the highest criterion is very critical. Criteria or categories for critical thinking skills based on calculating critical thinking scores (CTs) were adopted from Prayogi et al. (2018).

Table 3. Category for critical thinking skills

Intervals	Category
CTs > 8.8	Very critical
5.6 < CTs ≤ 8.8	Critical
3.6 < CTs ≤ 5.6	Enough critical
0.8 < CTs ≤ 3.6	Less critical
CTs ≤ 0.8	Not Critical

Each critical thinking data was analyzed descriptively statistically using the SPSS 25.00 software. Considering the normality of the data between the two groups being compared is the most essential for statistical tests. Each statistical test uses a reference level of significance of 0.05. The research hypothesis tested was the difference in students' critical thinking skills between the experimental and control groups.

RESULTS AND DISCUSSION

Information gathering includes literature review, initial observation, and determination of the subject matter. This is done to find out the learning needs related to the plan for developing learning tools. The results of collecting information indicate that urgent learning needs lead to the achievement of critical thinking. The achievement of critical thinking in students has an impact on many aspects of competence, in this education system, it is directly related to academic achievement (D'Alessio et al., 2019; Ghanizadeh, 2017; Siburian et al., 2019). In addition to learning needs, critical thinking is also considered a very valuable generic skill (Liang & Fung, 2021).

Previous studies saw a very good opportunity to build students' critical thinking, namely through an evaluative process integrated with the CPBL model (Karmana & Samsuri, 2018). Furthermore, it is necessary to develop learning tools to support evaluative-process learning integrated with the CPBL model so that this can be realized and implemented in the field. The learning tools developed are in Biology lectures. Learning tools consist of lesson plans, textbooks, worksheets, and critical thinking test instruments. The lesson plan consists of the identity of the lecture material and the lecture planning strategy with an evaluative-process approach integrated with the CPBL model. The textbook contains biology teaching materials that are attributable to the evaluative-process, and attributions that emphasize critical thinking training and student motivation in learning. The textbook has a worksheet (in the form of a minilab) and a critical thinking skill test instrument at the end of each chapter (sub-material). The developed textbook is presented in Figure 1.

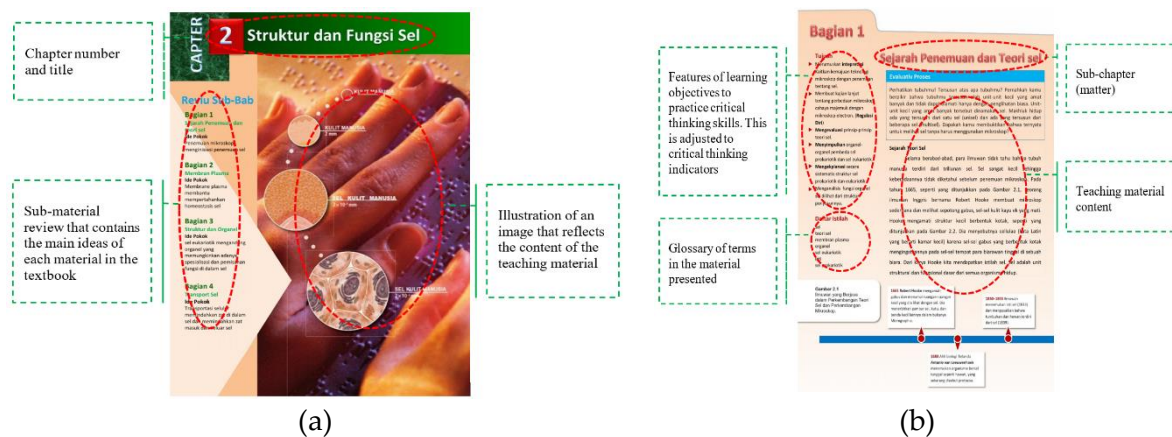


Figure 1. Textbook as part of a learning tool from the evaluative process integrated with the CPBL model

The learning tools developed were then validated through the FGD mechanism. Validation contains two elements of validity, namely content validity and construct validity. Content validity refers to the extent to which the test measures the content domain to be measured. In this context, the content domain in question is learning tools. There are three aspects of content validity: domain definition, domain representation, and domain relevance (Sireci & Faulkner-Bond, 2014). At the same time, construct validity refers to the extent to which the operationalization of the construct is defined by a theory (Cronbach & Meehl, 1955). The results of the validation of learning tools are presented in Table 4.

Table 4. The results of the validation of learning tools

Learning tools	Content validity				Criteria	CV	Criteria
	D.def	D.rep	D.rel	Average			
Lesson plan	3.75	4.00	3.75	3.83	Valid	4.00	Valid
Textbook	3.50	3.75	3.75	3.67	Valid	3.50	Valid
Worksheet	3.50	3.75	3.50	3.58	Valid	3.75	Valid
Critical thinking test	3.50	3.50	3.50	3.50	Valid	3.50	Valid

Note: D.def = domain definition; D.rep = domain representation; D.rel = domain relevance; CV = Construct validity

The results in Table 4 show that all of the components that make up the learning tools have valid criteria. The content validity aspect shows that learning tools have been operationally defined in terms of content (domain definition), learning tools have a match between content and cognitive specifications (domain representation), and the relevance of each content domain of learning tools already exists (domain relevance). These three domains are essential aspects of content validity (Sireci & Faulkner-Bond, 2014) and have been declared valid in this study. Likewise, with construct validity, where all aspects of the learning tools have been declared constructively valid. Construct validity refers to the extent to which a theory defines a construct or concept's operationalization (Cronbach & Meehl, 1955). From a more specific perspective, this is identified with a conceptual framework built on a theory (McGrath, 2005). The validation results, which show that all aspects of learning tools are declared valid, are inseparable from the integration and consistency of content in each aspect of learning tools, where learning tools already contain evaluative-process aspects integrated with the CPBL model.

Testing the Effectiveness of evaluative-process learning tools integrated with the CPBL model was carried out by employing an intact-group comparison design. The results of the analysis of critical thinking skills after learning treatment using essay test instruments are presented in Table 5.

Table 5. The results of the analysis of students' critical thinking skills

Group	N	Range	Min.	Max.	Mean	Criteria
Experimental	20	5.00	6.00	11.00	9.30	Very critical
Control	20	5.00	0.00	5.00	2.30	Critical

The results in Table 5 indicate differences in critical thinking skills scores between the treatment groups. In the experimental group with the conduction of evaluative-process learning integrated with the CPBL model, the final critical thinking score in this group was 9.30 with very critical criteria. On the one hand, the control group (learning with lectures and discussions) got a final score of 2.30 with critical criteria. The results in table 5 show that evaluative-process learning integrated with the CPBL model effectively trains students' critical thinking skills. Statistical tests were carried out on the two learning treatment groups to confirm the significance of the difference in the final score of students' critical thinking skills. Before this is realized, a normality test is carried out. The results of the data normality test and the different tests are summarized in Tables 6 and 7.

Table 6. Summary of normality test results

Data group	Kolmogorov-Smirnov			Shapiro-Wilk			Data distribution
	Statistic	df	Sig.	Statistic	df	Sig.	
Experimental	0.223	20	0.010	0.877	20	0.015	Not normally distributed
Control	0.176	20	0.104	0.915	20	0.079	Normally distributed

Table 7. Summary of Mann-Whitney test results

Group	N	Mean Rank	Sum of Ranks	Asymp. Sig. (2-tailed)
Experimental	20	30.50	610.00	0.000
Control	20	10.50	210.00	
Total	40			

The results in Table 6 indicate that one of the groups does not meet the assumption of normality (experimental group data), where the p-value ($0.015 < 0.05$). Finally, hypothesis testing (difference test) using the Mann-Whitney test. The results of the Mann-Whitney test are presented in Table 7, the mean rank for the experimental and control groups is 30.50 and 10.50, respectively. At the same time, the rank sum for both is 610.00 and 210.00, asymp. sig. (2-tailed) ($0.000 < 0.05$). Refers to the result of asymp. sig. (2-tailed) it can be stated that there is a significant difference in students' critical thinking skills between the experimental group (evaluative-process learning integrated with the CPBL model) and the control group (lecture and discussion learning).

In our current findings, evaluative-process learning tools integrated with the CPBL model are more effective in training critical thinking than lectures and discussions. Conceptual change and the involvement of cognitive roles directly affect problem-based learning (Loyens et al., 2015), not only in self-study instruction but also in a study group (Loyens et al., 2015). This then gives impetus to the optimal performance of students' critical thinking skills (Evendi et al., 2022). In a previous study (Evendi et al., 2022), process control is needed in every problem-based learning management to achieve the goal of training thinking. On the one hand, process control is one of the evaluative-process indicators in reflection learning, which is identical to critical thinking (Verawati, Hikmawati, & Prayogi, 2021).

Two main factors impact the Effectiveness of evaluative-process learning integrated with the CPBL model in training critical thinking. First, the conceptual framework of the CPBL model is constructed and arranged from a problem-based learning model with five learning steps: prior knowledge, organization, investigation, analysis, and evaluation (Karmana & Samsuri, 2018). Second is the evaluative process concept integrated with the CPBL model. Let us describe in detail the power of CPBL learning steps in supporting critical thinking. Prior knowledge directly impacts critical thinking training, as found by Fausan et al. (2021). Learning that begins with good organization guarantees achieving teaching goals, and in principle, critical thinking skills enable students to organize their learning (da Silva Almeida & Helena Rodrigues Franco, 2011). The investigative phase is a way to achieve critical thinking, this has been claimed for a long time as a way to train how students think (Arends, 2012), and even broadly underlies the ways of acquisition of critical thinking in problem-based learning (Birgili, 2015; Liu & Pásztor, 2022; Osman & Kriek, 2021; Seibert, 2021; Suyatman et al., 2021). The last two phases in the CPBL model are analyze and evaluate, both of which are core indicators of critical thinking skills (R. H. Ennis, 2011; Facione, 2020), which if taught directly in a learning model, can have an impact on increasing students' critical thinking skills. (Prayogi et al., 2018). Furthermore, the evaluative-process concept integrated with the CPBL model impacts the optimality of students' critical thinking skills. As recognized in previous studies, the evaluative process is the hallmark of reflective learning to support deep thinking in critical thinking (Akpur, 2020; Ghanizadeh, 2017; Verawati, Hikmawati, & Prayogi, 2021; Verawati, Hikmawati, Prayogi, et al., 2021), and even support efforts to achieve learning competence in the 21st century (Benade, 2015).

Finally, the findings in this study become an essential foothold in implementing evaluative-process learning tools integrated with the CPBL model, especially in classroom learning routines. Furthermore, this finding becomes a reference for every educator interested and concerned in educating students to achieve critical thinking.

CONCLUSION

An evaluative-process learning tool has been developed that is integrated with the CPBL model to train critical thinking skills. The learning tools developed are lesson plans, textbooks, worksheets, and critical thinking test instruments. In the aspect of content and construct validity, all the elements that make up the tools have been declared valid. Furthermore, at the implementation stage in the classroom, evaluative-process learning tools integrated with the CPBL model have been effective in training critical thinking skills compared to teaching that relies on lectures and question and answer. This Effectiveness is based on two aspects. First, the conceptual framework of the CPBL model is constructed and arranged from the problem-based learning model with five learning steps: prior knowledge, organize, investigate, analyze, and evaluate. Second is the concept of the evaluative process, which is integrated with the CPBL model. These two aspects are the main support in training students to think critically.

RECOMMENDATION

The effects of critical thinking skills training will be more visible if the learning tools developed can be implemented on more participants and different subject matter. This is our work in future studies.

Author Contributions

The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

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Declaration of Interest

The authors declare no conflict of interest.

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