Critical-Inquiry-Based-Learning: Model of Learning to Promote Critical Thinking Ability of Pre-service Teachers

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Abstract. This study aimed to develop Critical-Inquiry-Based-Learning (CIBL) learning model to promote critical thinking (CT) ability of preservice teachers. The CIBL learning model was developed by meeting the criteria of validity, practicality, and effectiveness. Validation of the model involves 4 expert validators through the mechanism of the focus group discussion (FGD). CIBL learning model declared valid to promote CT ability, with the validity level (Va) of 4.20 and reliability (r) of 90.1% (very reliable). The practicality of the model was evaluated when it was implemented that involving 17 of preservice teachers. The CIBL learning model had been declared practice, its measuring from learning feasibility (LF) with very good criteria (LF-score = 4.75). The effectiveness of the model was evaluated from the improvement CT ability after the implementation of the model. CT ability were evaluated using the scoring technique adapted from Ennis-Weir Critical Thinking Essay Test. The average score of CT ability on pretest is -1.53 (uncritical criteria), whereas on posttest is 8.76 (critical criteria), with N-gain score of 0.76 (high criteria). Based on the results of this study, it can be concluded that developed CIBL learning model is feasible to promote CT ability of preservice teachers.

1. Introduction

Critical thinking (CT) is one of the essential skills that must learner possess in 21st century [1], and become trend and center of attention in learning, even curriculum authority in several advanced country has mentioned CT skills in their curriculum as learning objectives [2], moreover its has become a major focus and competency in learning at all levels of their education [3]. CT is reasonable and reflective thinking focused on deciding what to believe or do [4], its detailed description of some characteristic including the process of interpretation, analysis, evaluation, inference, explanation, and self-regulation [5]. CT is one of the higher-order thinking skills element, that can be taught [6]. The educators believe that improving learner’s critical thinking is very important [7], however few of them have an idea how to teach it [8]. Teaching critical thinking requires holistic approach and should involve a set of appropriate learning models oriented on purpose that can to make learner manipulated their cognitive skills [9].

Several previous study recommended inquiry activity as teaching foundation to promote 21st century needs, including critical thinking [10]. Through inquiry activities, learners construct their knowledge actively so that desired learning outcomes can be achieved [11]. Inquiry process cannot be separated from critical thinking [12], thinking development and inquiry-teaching process can improve critical
thinking skills [13]. When learner trains to investigate, it could help them to develop their critical thinking ability and scientific reasoning [14].

Teaching critical thinking skills to the prospective teacher has become attention for a while. Teacher educators have to teach a cognitive skills to prospective teacher before they trained to their students in the classroom [15]. When the teachers and prospective teachers are trained and able to think critically, they will be able to improve student’s analyzing ability [16]. Education before becoming a teacher is proper time to intervention activities which promote their critical thinking [17]. Therefore, school or educational institution has to improve critical thinking ability to the prospective teachers [18].

This study aims to develop a specific learning model that promotes critical thinking ability of preservice teachers. The learning model in question is the Critical-Inquiry-Based-Learning (CIBL) learning model. The CIBL learning model were developed based on study about inquiry learning which is then attributed to the aspects of critical thinking into it. Inquiry has become a learning model which aim to make learner thinking [19]. It can be foundation and opportunities to develop critical thinking based on inquiry activities. Aspects of prior knowledge, advance organizer and motivation in learning reinforce the CIBL learning model. The learning steps in the CIBL model are orientation, exploration, analysis, inference, evaluation, and reflection. The results of model development and implementation in the class are described in this article.

2. Methods
This research is a development research that paired theory of Borg and Gall [20], and theory of Nieveen and Plomp [21]. The process of validating the CIBL learning model is done through a focus group discussion (FGD) mechanism involving 5 experts. After the CIBL model is declared valid, it will validate the learning tools as a supported of CIBL model, and instrument of critical thinking ability test (CTAT) by 2 validators. The reliability of the learning model is calculated using the percentage of agreement equation by Emmer and Millett in [22], they are reliable if the percentage of agreement is ≥ 75%. The subjects implementation of model are 17 preservice teachers (PT) of physics in Institute Teacher Training and Education Mataram, West Nusa Tenggara, Indonesia. Practicality of the model evaluated from the learning feasibility (LF). The effectiveness of the model was evaluated from the improvement CT ability after the implementation of the model. CT ability are evaluated using the scoring technique adapted from Ennis-Weir Critical Thinking Essay Test, where the highest score is +3 and the lowest score is -1. The indicators of CT ability in this study are analysis, inference, evaluation, and decision making. While to know the score change of CT ability, its analyzed using n-gain equation [23]. Criteria of validity, learning feasibility and critical thinking ability shown as Table 1.

| Table 1. Criteria of validity, learning feasibility and critical thinking ability |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Validity        | Learning Feasibility | Critical Thinking Ability |
| Va > 4,21       | Very valid       | Very good       | CT > 8,8        | Very critical   |
| 3,40 < Va ≤ 4,21| Valid            | 3,40 < LF ≤ 4,21| Good            | 5,6 < CT ≤ 8,8 | Critical        |
| 2,60 < Va ≤ 3,40| Quite valid      | 2,60 < LF ≤ 3,40| Adequate        | 3,6 < CT ≤ 5,6 | Critical enough |
| 1,79 < Va ≤ 2,60| Less valid       | 1,79 < LF ≤ 2,60| Less            | 0,8 < CT ≤ 3,6 | Less critical   |
| Va ≤ 1,79       | Invalid          | LF ≤ 1,79       | Poor            | CT ≤ 0,8       | Not critical    |

3. Results and Discussion
The validity results show that CIBL learning model which is developed was declared valid. The validity level (Va) of CIBL model is 4.20 (its valid if: 3.40 < Va < 4.20) with the percentage of reliability is 90.1% (reliable). The recommendation from validators in FGD are are CIBL model is valid with some revision. The content validity in this study has two main components as the basic development of CIBL model, which are needs and state-of-the-art knowledge.

Supporting in need aspects is very important because it is the main basis of the development of a model, also if there is need aspect that cause the model has to be developed. Need aspects of the CIBL model development got an average validity score 4.25 from four validators with very valid criteria.
Besides need aspects, state-of-the-art knowledge aspect become very important of content validity to measure as a basic development of model. Strengthening in state-of-the-art of knowledge aspect as a support of development of a model got an average validity score 4.31 with very valid criteria.

Construct validity as an aspect of CIBL model development were focused on theoretical and empirical review that support the model. The syntax of the CIBL model as validation material that model phase shows logical, related, and mutual order of learning activity. The score of this aspect is 4.13 from four validators with valid criteria.

The average score of validation of learning tools is 4.24 with very valid criteria and the percentage of reliability is 90.2% (reliable). Then, the instrument of CTAT in this study is developed to assessing preservice teachers CT ability. The average validity result of instrument is 4.75 for each component of content validity and 3.13 for language and question-writing aspect. The final validity result of the instrument is 3.94 with valid criteria, while the reliability of the instrument is 79.37% with reliable criteria. Norris argued that the facts about the uniqueness level of CT is not finished yet because of many theories in different view, so making measurement and assessment of CT is difficult. Assessing CT distractor with another subject, because transferring to other context may be different with uniqueness of knowledge in CT [24]. In this study, we made simplification with developing the instrument of CT test based on 4 of CT ability indicators that are, analysis, inference, evaluation, and decision making.

In the implementation step, the practicality of the model was measured from learning feasibility. Observation result of learning feasibility using CIBL learning model were done very good (LF = 4.75). Its cause of the supports, especially the availability of the learning tools, including handsbook (module) and worksheet. When learning tools are designed well, it can give information which help learner more effective to accomplish learning objectives [25]. Learning tools that are good designed are functioned as communication tool, tool of learning plan, learning plan for students, learning resources, and tool for learning evaluation [26]. The support from module is also very important in this study. The material in the book is arranged systematically so it can condition students to learn [27]. The worksheet in this study were designed as the guidelines of learning feasibility in inquiry activity according to CIBL model to train student’s CT ability. Scientific process skill is able to be tools that can develop thinking skills including critical thinking skill, efficient learning feasibility, and correct problem solving [12]. Scientific process skill has a great effect in learning because it helps learner to improve higher mental skill, such as critical thinking, decision making, and problem solving ([28], [29]).

The assessment result of preservice teachers CT ability showed that average score of critical thinking of 17 PT in the pretest was -1.53 with not critical criteria (not critical, if X ≤ 0.8). The assessment of CT ability after the implementation of CIBL model (posttest) showed that average score of 17 PT was 8.76 with critical criteria (critical, if 5.6 < X ≤ 8.8), also the N-gain was 0.76 with high criteria (results are shown in Table 2). The study results showed preservice teachers CT ability tend to increase from not critical to critical criteria, so it can be state that CIBL model development is effective to improve CT ability. This result is also inseparable from the validity of CIBL model that aims to promote CT ability. CIBL model has accommodated several recommendations in learning which is the main idea in developing CIBL model, such as training critical thinking by presenting contextual or real life case in learning, motivating to openly discuss, and encouraging experimental activity oriented by inquiry activity ([30], [31]). CIBL model based on inquiry activity was integrated with worksheet oriented scientific process skill.

| CTs interval | Criteria          | Pre test Mean | F | %  | Post test Mean | F | %  | N-gain | N-gain criteria |
|--------------|-------------------|---------------|---|----|----------------|---|----|-------|-----------------|
| X > 8.8      | Very critical     | -1.53         | 0 | 0  | 72.34          | 12| 70.59| 0.76  | High            |
| 5.6 < X ≤ 8.8| Critical          | 0             | 0 | 0  | 17.65          | 3 | 5.88|       |                 |
| 3.6 < X ≤ 5.6| Critical enough   | 0             | 0 | 0  | 1              | 1 | 5.88|       |                 |
| 0.8 < X ≤ 3.6| Less critical     | 2             | 11.76 | 1 | 5.88          | 1 | 5.88|       |                 |
| X ≤ 0.8      | Not critical      | 15            | 88.24 | 0 | 0             | 0 | 0  |       |                 |
| Amount       | 17               | 100           |     |    | 17             | 100|    |       |                 |

Table 2. The results of PT critical thinking ability
Learning feasibility has become effectiveness factor of CIBL model. Learning steps (syntax) in CIBL model, that are orientation, exploration, analysis, inference, evaluation, and reflection are designed consistently to train intact PT critical thinking throughout the learning process. Learning activity based on inquiry can improve critical thinking skills of the student [32]. Learning orientation was done by facing learner with contradictive information (anomalous data) and then by presenting advance organizer. Presenting contradictive information or anomalous data is viewed as a solution that can attract interest, ensuring the prior knowledge emerges ([33], [34]), and helping learners to reflect their ideas to give explanation about learned phenomena [35]. Giving explanation based on ideas or phenomena is one of the study and become main indicator of critical thinking.

Exploration is the second phase in CIBL model after orientation phase. When learners train to investigate, it will help them to improve their critical thinking and scientific reasoning. Through investigating process, learner will collaborate to create new knowledge and learn to think critically. After exploration phase, then learner do analyze, inference, and evaluate. Analysis, inference, and evaluation processes are main indicators of critical thinking. Those indicators were adopted into syntax or phases of CIBL model. This is appropriate with researcher’s previous recommendations or findings that several indicators of critical thinking are in low category [36]. According to [30], integrating critical thinking indicators into learning can train them more to critical thinking.

The result of this study is also supported by valid learning tools of CIBL model, such as syllabus, lesson plan, module and worksheets, that help learner to train their critical thinking ability. The learning tools is supporting factor which help the students to organize CIBL model that used in learning, so that they can train their critical thinking ability. Constructivism learning theory of Vygotsky said that well-organized learning can produces the mental development. Critical thinking is mental processes [37]. The good designed learning tools can give information that help learners are more effective to achieve learning objectives. The module also supported the improvement of student’s CT ability. Module is equipped with attributions to achieve critical thinking objectives. The module as a part of learning tools contains information, tools, and text that are required by teacher in presenting materials and skills that have to be learned by students, those skills are critical thinking in this context.

The test of CT ability showed that the N-gain score is 0.76 (high criteria), but there are five of PT with medium N-gain score (the range score, 0.30-0.70), and one of five of PT is less critical at the posttest. These results are affected by motivation of the PT in learning. When the contradictive information is presented in the beginning of the learning, there are several PT that shows less attention and do not give responses, even though this learning activities mean to motivate PT in learning besides to think critically. This is shown from observation result of PT activity in learning. Motivation factors toward content and context learning material are very important in learning. Interest and motivation factors can affect the process of believe establishment that occur when learners get new knowledge or are faced on new situation in learning even when they are presented with new information that is contradictive with their prior conception [38]. Someone’s motivation to engage in cognitive activity can determine impact of delivered information [39]. High motivation in learning showed high level of cognitive necessity, this become learner’s predictor to engage in the intellectual challenging activity [40], which is critical thinking. Students with high cognitive activity and motivation will be better in elaborating information, showing performance which are better in cognitive assignments, and more effective on complex problem solving [24].

4. Conclusion
The CIBL learning model was developed based on inquiry processes in learning by accommodating the aspects of prior knowledge, motivation, and thinking ability in learning. The results show that the CIBL learning model has been valid, practice, and effective to promote the critical thinking ability of preservice teachers, including aspects of analysis, inference, evaluation and decision making. These results are very important as empirical evidence of CIBL model development to promote the critical
thinking ability of preservice teachers. The wide-scale implementation and dissemination of CIBL model are needed to evaluate the implementation of models in different places.

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