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Critical Inquiry Based Learning: A Model of Learning to Promote Critical Thinking Among Prospective Teachers of Physic

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ABSTRACT

Teaching critical thinking (CT) to prospective teachers has been a concern for a long time, and prospective teacher training becomes an appropriate period for interventions that promote CT ability. Therefore, it is necessary to develop a model of learning that accommodates aspects of prior knowledge, motivation, and CT. This study aims to develop *Critical-Inquiry-Based-Learning* (CIBL) model to promote the CT ability of prospective teachers of physic (PTP). This study is based on Nieveen's theory about the criteria of rich product quality (valid, practice, and effective) and the theory of Borg and Gall about development research. The CIBL model embraced three criteria, namely validity, practicality, and effectiveness. The CIBL model was validated by experts through the mechanism of the focus group discussion (FGD) (for validity aspect), the implementation of the model in the class were observed by a number of observers (for practicality aspect), and the assessment of CT ability is done after the learning process (for effectiveness aspects) and then analyzed. The findings of the research showed that the CIBL model is feasible because of its validity, practicality, and effectiveness. This means that the CIBL model was able to promote CT ability of PTP.

Keywords: CIBL model, critical thinking ability.

INTRODUCTION

Critical thinking is one of the essential skills that must learner possess in the 21st century (Partnership for 21st century, 2011), and it is one of the goals of science education (Bailin, 2002). The development of critical thinking skills is often listed as the most important reason for formal education because the ability to think critically is essential for success in the contemporary world where the rate at which new knowledge is created is rapidly accelerating (Marin & Halpern, 2011). Wasis (2016) explain that CT as one of the higher order thinking skills, supposed to be center of learning development, because it made people have life skills, creativity, and innovation so that can finish various real-life problems which are more complex in 21st century.

Teaching CT to the prospective teacher has garnered attention for a while, and the role of future teachers seems more crucial than ever before for educational systems in terms of seeking improvement in critical thinking (Sendag et al., 2015). Ashton (1988) stated that

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teacher educators have to teach and give cognitive skills to prospective teacher before they train them to students in the classroom. Warburton (2008) proposed that education before becoming a teacher is proper time to intervention activities which promote their critical thinking. Therefore, school or educational institution has to improve critical thinking ability to the prospective teachers (Innabi & Elsheikh, 2007).

CT is reasonable and reflective thinking focused on deciding what to believe or do (Ennis, 1996), its detailed description of some characteristic including the process of interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2011). CT is one of the higher-order thinking skills element, that can be taught (Woolfolk, 2009). The educators believe that improving learner's critical thinking is very important (Albrecht & Sack, 2000), however few of them have an idea how to teach it (Duron et al., 2006). Although one of the goals of university education is to improve students' critical thinking, courses are generally taught by the lecturing method and the content presents little chance for students to discuss topics so as to enhance their critical thinking (Demirhan, Önder & Beşoluk, 2014). 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 (Thompson, 2011).

Several previous studies (e.g., Fine & Desmond, 2015; Hamlin & Wisneski, 2012; Wasis, 2016) recommend inquiry activity as teaching foundation to promote 21st century needs, including critical thinking. Through inquiry activities, students construct their knowledge actively so that desired learning outcomes can be achieved (Samarapungavan et al., 2008). Inquiry process cannot be separated from critical thinking (Sriarunrasmee et al., 2015), inquiry have an effect toward on students' critical-thinking skills in science courses (Duran & Dökme, 2016). Inquiry-based learning activities also can improve student's critical thinking skills (Thaiposri & Wannapiroon, 2015). Learning occurs when learners have direct experience on learning activities that they are doing (Sriarunrasmee et al., 2015). When learner train to investigate, it could help them to develop their critical thinking ability and scientific reasoning (Barrow, 2006). Through investigating and discovering process, learner will collaborate to create new knowledge and will learn how to think critically and creatively, and also how to make discovery through investigation, reflection, exploration, experiment, and "trial and error" (Alberta Education, 2010).

Friesen and Scott (2013) reviewed literature about inquiry-based learning and identified inquiry learning with several learning approaches, where investigating and discovering activities are the basic of learning activity, such as; Authentic Intellectual Work (Newmann et al., 2001), Discipline-based Inquiry (Galileo Educational Network Association, 2008), Problem-based Learning (Barrow, 2006), Design-based Learning (Hmelo et al., 2000), Challenge-based Learning (Johnson & Adams, 2011), and Project-based Learning (Thomas, 2000; Sumarni et al., 2013). Along with the time, inquiry learning has been expanded and modified with integrated it into computerized system as simulation form (virtual laboratory) (Sriarunrasmee et al., 2015; Thaiposri & Wannapiroon, 2015). However, virtual laboratory cannot face learner on real situation and environment, because the inquiry basically is conduction between learned topics and real context (Hofstein et al., 2001), so that virtual laboratory cannot replace real laboratory (Cassady et al., 2008).

Focusing on implementation of inquiry, based on a study conducted by Verawati (2013) there are several problems on conducting inquiry for the purpose to improve CT skills of prospective teachers, one of them has difficulty to conduct inquiry directly without the prior knowledge about the concept that will be taught with inquiry. This is in accordance with the previous findings that learners experience problems with relating new content with prior knowledge (Blumenfield et al., 1991; Gulbahar & Tinmaz, 2006; Marx et al., 1997; Lee & Tsai, 2004). Prior knowledge is one of the most influential factors in learning because it is processed by what learner has known, believe, and done (Ambrose & Lovett, 2014). When prior knowledge is accurate, enough, active, and correct, learners can construct their knowledge on that foundation, relating new knowledge with prior knowledge which is possible for them to learn, take, and use it when they need it (Ambrose et al., 2010). When prior knowledge is wrong (for example the ideas, models, theories, or facts are inaccurate), learner tend to be restricted because they may ignore or decline new evidence and information which inappropriate with their prior knowledge (Dunbar et al., 2007; Chinn & Malhotra, 2002).

There is a fact that before the implementation of inquiry, students have prior knowledge about the concept of teaching material, so generally in learning process there will be a conflict between their prior knowledge and inquiry process itself called conflict cognitive because there are conception changes in learner (Limon, 2001). Conflict cognitive has a big role in conceptual changes (Lee, 1998), but this does not always consistently cause conceptual changes (Vosniadou & Ioannides, 1998), which means although learners are faced with new contradictive information in learning, they often do not recognize the conflict. Piaget also stated that several learners have not adapted response in learning task where learners are unaware of any conflict (Lee et al., 2003; Limon, 2001). Therefore, some things can be done to facilitate learners in recognizing conflict and to bring up student's interest to learn, like presenting contradictive information or anomalous data (Chinn & Malhotra, 2002; Thagard, 1992). According to Limon & Carretero (1997) presenting contradictive information or anomalous data on the other hand helps learners to reflect more about their ideas to bring explanation of learned phenomena, and may be able to activate their curiosity of learned phenomena. In critical thinking study, giving explanation based on learned ideas or phenomena is one of the studies and become main indicator of critical thinking (Facione, 2011; Paul & Elder, 2006; Fisher, 2003). Which means by presenting contradictive information or anomalous data in learning, it can train critical thinking ability to learners indirectly.

Furthermore, so that the information at the beginning is more meaningful, it is used advance organizer. Advance organizer is one of the form of cognitive thinking stimulation in learning which can support learning motivation (Dolezal et al., 2003). Advance organizer is information presentation that bridging new learning materials with related ideas (Shah, 2004; Zaman, 1996). Advance organizer can be used by learners to organize and interpretation information which can be used by them for next learning (Shafdar et al., 2014; Mayer, 2003). On the other side, advance organizer encourages the usage of critical thinking skills, like analyzing abstract concept besides making understanding deeper and expanding the relations of ideas (Kwaku et al., 2014).

This study aims to develop a specific learning model for promoting the critical thinking ability of prospective teachers of physic. Model development is based on inquiry processes in learning, and accommodates aspects of prior knowledge, motivation, and critical thinking in learning. Then the learning model in question is the Critical Inquiry Based Learning (CIBL) 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.

METHODS

This research is a development research that will produce a product which is CIBL model. The research that based on Nieveen's theory about the criteria of rich product quality (valid, practice, and effective) (Nieveen, 1999) and the theory of Borg and Gall (1983) about development research. CIBL model embraced three criteria, namely the validity, practicality, and effectiveness. The plot of development of CIBL learning model is explained at Figure 1.

Pre-development of the model was done by conducting a preliminary study of model development needs, planning of model development, and develop preliminary form of product (composing a CIBL model hypothetical framework).

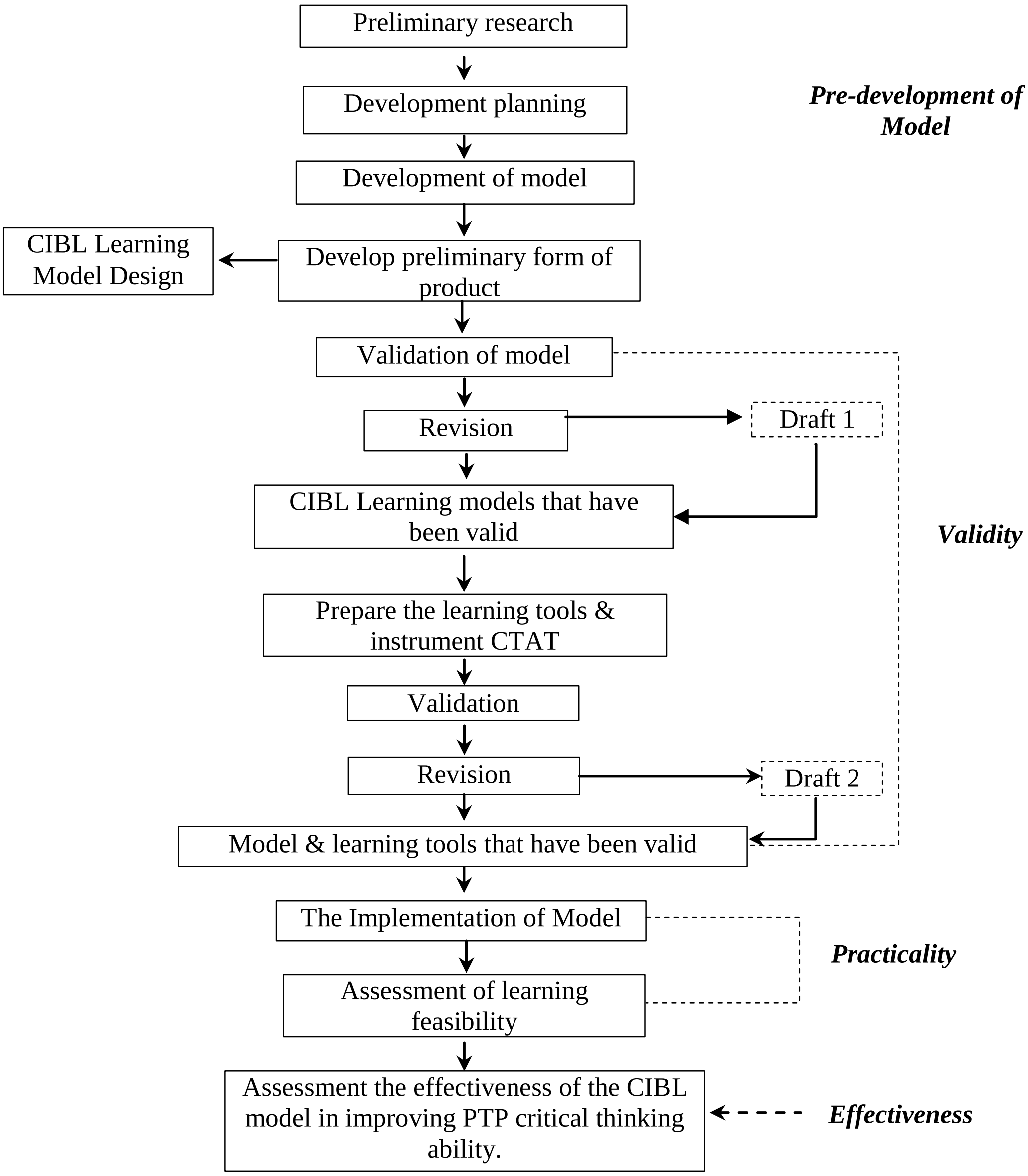

Figure 1. The plot of development of CIBL model

Validity of CIBL Model

The hypothetical framework of the CIBL model that has been arranged is further validated. The validation has been done with containing two elements of validity, which are content validity and construct validity. Content validity is all components that form the model should be based on state-of-the-art knowledge, and construct validity is all components should be consistently linked to each other (Nieveen, 1999). The CIBL model was validated by the experts. Technically validating CIBL model was done with Focus Group Discussion (FGD) mechanism. FGD is followed by researcher, and four experts as validator. Suggestions and feedback from validators would be followed-up to fixed CIBL model. After the CIBL model were declared valid, then compiled learning tools and instrument of critical thinking ability test (CTAT) as a supported model. Learning tools include lesson plans, learning module, and worksheets. Learning tools and instrument of CTAT are further validated by two validators. Suggestions from the validators are further followed up for the improvement of learning tools and instruments. Learning tools are operationalization of CIBL model when implemented in the classroom.

Validity assessment of CIBL model, learning tools, and instrument of CTAT using the validation sheet base on Likert scales consist of five scoring scale for each item of declarations, there are 5 = very valid, 4 = valid, 3 = quite valid, 2 = less valid, 1 = invalid. Obtained score from the validators are converted into five-scale qualitative data (Bahtiar & Prayogi, 2012) as shown in Table 1.

Table 1. *The validity criteria of CIBL model, learning tools, and the instrument of CTAT*

Interval (Va = validity level)	Criteria
Va > 4,21	Very valid
3,40 < Va ≤ 4,21	Valid
2,60 < Va ≤ 3,40	Quite valid
1,79 < Va ≤ 2,60	Less valid
Va ≤ 1,79	Invalid

Learning model, learning tools, and instrument of CTAT have good validity degree if the minimum of validity degree is valid. If the validity degree is less than valid, they have to be revised. The reliability is counted with the equation of percentage of agreement by Emmer and Millet (in Borich, 1994), they are reliable if the *Percentage of Agreement (PA)* is ≥ 75%.

Practicality of CIBL model

The practicality of the CIBL model is evaluated upon being implemented in the classroom. The practicality of the model will be evaluated from the learning feasibility (LF) using the learning tools as supported of CIBL model. It was observed by two observers by means of providing a score from 1 to 5 using the observation sheet. Observers are also asked to give advice (if any) toward the implementation of the model. The scores given are then analyzed to determine the average scores. From the average scores, their category can be established, as presented in Table 2. CIBL model is practice when the minimum category of LF are good criteria. The subjects of model implementation are 17 of prospective teachers of physic (PTP) in Institute Teacher Training and Education Mataram, West Nusa Tenggara Province, Indonesia. The number of meetings of learning at the implementation of the model as much as four meetings on the subject matter of fluid mechanics.

Table 2. *The assessment category of learning feasibility using CIBL model*

Interval	Criteria
LF > 4,21	Very good
3,40 < *LF* ≤ 4,21	Good
2,60 < *LF* ≤ 3,40	Adequate
1,79 < *LF* ≤ 2,60	Less
LF ≤ 1,79	Poor

Effectiveness of CIBL model

The effectiveness of the model was evaluated from the improvement CT ability after the implementation of the model using the instrument of CTAT. 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 (Hake, 1999). The conversion of critical thinking score (CTs) refers to Table 3.

Table 3. *The score criteria of CT ability*

CTs Interval	Criteria
$X > 8,8$	Very critical
$5,6 < X \leq 8,8$	Critical
$3,6 < X \leq 5,6$	Critical enough
$0,8 < X \leq 3,6$	Less critical
$X \leq 0,8$	Not critical

FINDINGS

The hypothetical framework of CIBL model were arranged as a preliminary form of model, it is based on the empirical and theoretical study supported the model which are accommodates inquiry process, aspects of prior knowledge, motivation, and critical thinking in learning. Sintax of the CIBL model consist of orientation, exploration, analysis, inference, evaluation, and reflection. Learning steps of CIBL Model are explained in Table 4.

Table 4. *Learning steps of CIBL Model*

Sintax of CIBL	Learner behavior
1. *Orientation*	• *Establishing set* and giving learning objectives. • Presenting or demonstrating contradictive information (anomalous data) to generate student's motivation in learning. • Presenting advance organizer as the follow-up of the presented anomalous data.
2. *Exploration*	• Guiding students to experiment/investigate. • Guiding students to propose problem formulation and hypothesis based on objectives of experiment, identify variables in experimental activities, and define operational of variables. • Guiding students to plan experimental procedure.
3. *Analysis*	• Guiding students to analyze the data of experiment result to test the proposed hypothesis by reviewing various reference sources.
4. *Inference*	• Asking students to make inference based on data analyzing of experiment result.
5. *Evaluation*	• Asking students to make evaluation about experiment which is done.
6. *Reflection*	• Asking student to do advanced investigation by presenting the problem of anomalous data which is related with the experiment.

The hypothetical framework of the CIBL model that has been arranged was further validated. The results of the validator assessment of the CIBL Model are shown in Table 5.

Table 5. *The experts validation results on the CIBL Model*

Aspects of validation		Average score	Category
Content validity	• The need for development of model.	4.25	Very valid
	• The model designed base on state-of-the-art of knowledgement.	4.21	Very valid
Construct validity	• Consistency and logically of all arrangement components of model.	4.13	Valid
Va		*4.20*	*Valid*
PA (Percentage of Agreement)		*90.1%*	*Reliabel*, PA ≥ 75%

The validity results show that CIBL learning model which is developed was declared valid (Va= 4.20). The validation of learning tools and instrument of CTAT that compailed the CIBL model was done, the average score of validation of both consist of 4.24 (very valid criteria) and 3.94 (valid criteria).

In the implementation step, the practicality of the CIBL model was evaluated from the learning feasibility (LF) using the learning tools as supported of CIBL model. It was observed by two observers, and observation result of LF using CIBL model were done very good (*LF* = 4.75).

The effectiveness of the model was evaluated from the improvement CT ability after the implementation of the model using the instrument of CTAT. The results of CT ability of prospective teachers of physic (PTP) shown in Table 6.

Table 6. *The results of CT ability of PTP*

CTs interval	*Criteria*	*Pre test*			*Post test*			*N-gain*	*N-gain criteria*
		Mean	*F*	*%*	*Mean*	*F*	*%*		
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		3	17.65		
3,6 < X ≤ 5,6	Critical enough		0	0		1	5.88		
0,8 < X ≤ 3,6	Less critical		2	11.76		1	5.88		
X ≤ 0,8	Not critical		15	88.24		0	0		
Amount			*17*	*100*		*17*	*100*		

DISCUSSION and CONCLUSION

Sintax of the CIBL model consist of six phases of learning, that are *orientation, exploration, analysis, inference, evaluation*, and *reflection*. In the orientation phase learners are confronted with contradictive information (anomalous data) to generate their motivation in learning as well as to explore the prior knowledge of learners, and advance organizer conducted as the follow-up of the anomalous data presented as well as the bridging of prior knowledge for further exploration. Ausubel (in Arends, 2012) argued that the educator has to find ways to anchor the new learning materials to the learners' prior knowledge and ready the students' minds so that they can receive new information. Presenting the contradictive information or anomalous data is seen as a solution that can attract interest and ensure that prior knowledge emerges (Ambrose & Lovett, 2014; Chinn & Malhotra, 2002; Chinn & Brewer, 1998). After the learner were confronted with an information, fact or problem, the teacher encourages them to create and prove the hypothesis, and think of the means used to test the hypothesis through exploration (experiment) (Suchman, 1962). Construction of knowledge is done by formulating a new hypothesis and testing it through the exploration (Fine & Desmond, 2015). Guiding learner to analyze the data of experiment result to test the proposed hypothesis by reviewing various reference sources were conducting in this model. Conducting further analysis, compiling and communicating the results of data processing in the experiment are critical thinking activity (Sarwi et al., 2012). After the analysis, learner make inference based on data analyzing of experiment result. Involving inference processes in learning strategies leads to better learners' critical thinking skills (Miri, et al., 2007). The evaluation process becomes part of a very important learning phase after inference. Aside from being an indicator of critical thinking, according to Yenice (2011) evaluation is also a correct step in problem solving. Reflection into the last phase of the CIBL model. In this activity learner do advanced investigation by presenting the problem of anomalous data which is related with the experiment.

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 is that 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.

Strengthening 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 4.21 with very valid criteria.

Construct validity as an aspect of CIBL-model development is focused on theoretical and empirical review that support the model (Arends, 2012). 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 student's prospective teachers of physics 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 (1989) 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. In this study, researcher made simplification with developing the instrument of CT test based on 4 critical thinking indicators according to Ennis (1991) that similar to critical thinking indicators of experts and previous researchers, such as; a) analysis (Facione, 2011; Fisher, 2003), b) inference (Facione, 2011; Fisher, 2003; Scriven & Paul, 2009; Paul & Elder, 2006), c) evaluation (Facione, 2011; Scriven & Paul, 2009); Paul & Elder, 2006; Reid, 2006), and d) decision making (Rudinow & Barry, 2008; Fisher, 2003; Stenberg, 1986).

In the implementation step, the practicality of the model was measured from LF. Observation result of LF using CIBL model were done very good (LF = 4.75). Its cause of the supports, especially the availability of the learning tools, including handbook (module) and worksheet. When learning tools are designed well, it can give information which help learner more effective to accomplish learning objectives (Parkes & Harris, 2002). 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 (Fink, 2012). 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 (Levin, 2008). The worksheet in this study is designed as the guidelines of LF in in inquiry activity according to CIBL model to train student's CT ability. According to Sriarunrasmee et al (2015) scientific process skill is able to be tools that can develop thinking skills including critical thinking skill, efficient LF, and correct problem solving. 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 (Lee et al., 2002; Koray et al., 2007).

The assessment result on CT ability of PTP showed that average score of CT of 17 PTP in the pretest was −1.53 with not critical criteria (not critical, if $X \leq 0.8$). The assessment of CT ability after the implementation of CIBL model (posttest) showed that average score of 17 SPTP was 8.76 with critical criteria (critical, if $5.6 < X \leq 8.8$), also the N-gain was 0.76 with high criteria (results are shown in Table 6). The study results showed that CT ability tend to increase from not critical to critical criteria, so it can be state that CIBL model development is effective to promote 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 CT by presenting contextual or real-life case in learning, motivating to openly discuss, and encouraging experimental activity oriented by inquiry (Miri et al., 2007; Fine & Desmond, 2015; Samarapungavan et al., 2008). CIBL model based on inquiry activity was integrated with worksheet oriented scientific process skill. According to Sriarunrasmee et.al (2015), scientific process skill can be instrument that can improve critical thinking.

Learning feasibility (LF) 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 PTP critical thinking throughout the learning process. Theoretical and empirical review showed that CT can be taught and trained (Woolfolk, 2009), persistently (Fisher, 2003), and continuously (Miri et al., 2007; Qing et al., 2010). Learning activity based on inquiry can improve critical thinking skills (Thaiposri & Wannapiroon, 2015). 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 (Ambrose & Lovett, 2014; Chinn & Malhotra, 2002; Chinn & Brewer, 1998), and helping learners to reflect their ideas to give explanation about learned phenomena (Limon & Carretero, 1997). Giving explanation based on ideas or phenomena is one of the study and become main indicator of critical thinking (Facione, 2011; Paul & Elder, 2006; Fisher, 2003).

Exploration is the second phase in CIBL model after the orientation phase. When learners train to investigate, it will help them to improve their critical thinking and scientific reasoning (Barrow, 2006). Through investigating and discovering process, learner will collaborate to create new knowledge and learn to think critically (Alberta Education, 2010). Teaching strategy to develop higher order thinking skill include critical thinking can use inquiry-oriented experiment (Miri et.al, 2007). 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 given researchers' previous recommendations or findings that several indicators of CT (analysis, inference, and evaluation) are in low category (Prayogi, 2013; Qing et al., 2010; Miri et al., 2007). According to Miri et al (2007), integrating CT indicators into learning can train them more in CT.

The result of this study is also supported by valid learning tools of CIBL model, such as lesson plans, learning 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 CT ability. Constructivism learning theory of Vygotsky said that well-organized learning produces mental development (Woolfolk, 2009). Critical thinking is mental processes (Sternberg, 1986; Dwijananti & Yuliyanti, 2010). The strong designed learning tools can give information that help learners are more effective to achieve learning objectives (Parkes & Harris, 2002). The learning module also supported the improvement of learners 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 PTP with medium N-gain score (the range score, 0.30–0.70), and one of five of PTP is less critical at the posttest. These results are affected by motivation of the PTP in learning.

When the contradictive information is presented in the beginning of the learning, there are several PTP that shows less attention and do not give responses, even though this learning activities mean to motivate PTP in learning besides to think critically. This is shown from observation result of PTP activity in learning. Motivation factors toward content and context learning material are very important in learning (Pintrich, 1999; Pintrich et al., 1993). According to Pintrich (1999), 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. Someone's motivation to engage in cognitive activity can determine impact of delivered information (Cacioppo & Petty, 1982; Cacioppo et al., 1996). High motivation in learning showed high level of cognitive necessity, this become learner's predictor to engage in the intellectual challenging activity (Steinhart & Wyer, 2009), 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 (Luong et al., 2017).

Generally, the results of this study show that the CIBL model has been declared valid, practice, and effective to promote critical thinking ability of prospective teachers of physic, including aspects of analysis, inference, evaluation and decision making. The results of this study has become the important findings that the CIBL model can promote critical thinking ability of prospective teachers of physic, so that can be used as a reference and consideration of educators or prospective teachers' instructors in learning for the purpose of meeting prospective teachers learning needs in the direction of improving their critical thinking ability. However, further research by other researchers is needed to evaluate the impact of learning using the CIBL model to improve the critical thinking disposition which is not revealed in this article.

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