



## Research Article

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Received: 18 March 2021 / Accepted: 21 May 2021 / Published: 8 July 2021

# The Collaborative Problem Based Learning Model Innovation

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DOI: <https://doi.org/10.36941/jesr-2021-0080>

### Abstract

*Learning models that can specifically support 21st-century skills which are fundamentals and global in nature, especially in higher education, are still not available. The Problem Based Learning (PBL) model and the Collaborative Learning (CL) model have characteristics that have the potential to support these skills. The purpose of the study is to develop a collaborative problem-based learning (CPBL) model. The study's results are five model syntaxes consisting of problem orientation, organization, collaborative problem solving, presentation and discussion, and evaluation. Besides, a model matrix was produced to guide lecturer and student learning activities to achieve fundamental and global 21st-century skills, namely problem solving, critical thinking, and collaboration. The syntaxes and matrix of the model produced are feasible, valid, and practically implemented to produce graduates who have ready and competitive skills. Thus, the developed CPBL model can become an innovative initial role model for learning to support learning at various levels, especially higher education, to produce graduates who have skills that are ready and competitive in the current era, maybe even in the future.*

**Keywords:** Collaborative Learning, Problem-Based Learning, Innovation Model Learning, 21st-Century Skills

## 1. Introduction

### 1.1 Background of the Study

Various international organizations and projects (for example, the Assessment and Teaching of 21st-Century Skills project, the Partnership for 21st-Century Skills, the OECD's Definition and Selection of

Competencies, and the European Union's Key Competences for Lifelong Learning) emphasized education to make graduate students having 21st-century skills to be successful in life and career in the era of the industrial revolution 4.0 (Ananiadou & Claro, 2009; Binkley et al., 2012). According to Voogt & Roblin (2012), 21st-century skills include problem-solving, critical thinking, collaboration, communication, information technology literacy, creativity, and socio-cultural competence (Meyer & Norman, 2020; Voogt & Roblin, 2012). Likewise, in Indonesia, students are prepared to acquire 21 different skills which focus on problem-solving, critical thinking, and collaboration skills (Afandi, Sajidan, & Akhyar, 2019).

Previous studies reported that students' problem-solving and critical thinking skills were obtained through intervention and habituation of implementing the problem-based learning (PBL) model (Ahlam & Gaber, 2014; Chiang & Lee, 2016). When implementing PBL, lecturers usually assign students in groups, but they do not automatically develop problem-solving and critical thinking skills (Nookhong & Wannapiroon, 2015). Besides, students tend to think individually in solving the problems given during the PBL model (Yew & Goh, 2016). In other words, the implementation of the PBL model has not specifically accommodated collaborative skills. On the other hand, implementing the collaborative learning model (CL) makes student collaboration and interaction effective by placing students with diverse backgrounds and abilities in a small group to achieve common goals. Also, classes that are managed collaboratively get more motivation, have a curious nature, have a higher sense of helping, have the motivation to compete healthily, and have the urge to work individually with more focus (Handayani, Mantra, & Suwandi, 2019). PBL and CL models are considered student-centered learning strategies, where students solve problems collaboratively and reflect on their learning experiences through group collaboration. In particular, the collaboration that occurs in CL encourages multi-directional interactions, namely between students and students in groups, students with students outside the group, and all students with teachers (Huang & Chuang, 2008). Besides, PBL and CL also result in students experiencing personal and social cognitive conflicts in the discussion context. As an effect, students will try to resolve this conflict collectively by explaining the reasons behind their thinking (Lee & Kim, 2005). In other words, the process formed through PBL and CL is a product of social interaction constructed through negotiation and mutual understanding. This process can help students develop problem-solving abilities and collaborative skills (Ram, Ram, & Sprague, 2004). The characteristics of collaborative and problem-solving learning can be combined to produce high, complex, and realistic cognitive processes and products (Palincsar, 1998).

This integration will be more complex and realistic if mobile learning products are added to the learning process. Mobile learning activities have been designed in a striking way for learning that is different from the classroom (Frohberg, Göth, & Schwabe, 2009). Their low cost and ease of use of mobile devices make their integration into everyday classroom routines an attractive option. According to Parsons, Ryu, & Cranshaw (2007), the most promising feature of the context of mobile learning is able to carry out activities collaboratively. In fact, research in instructional technologies for the classroom, and in particular, developments in the field of mobile computer-supported collaborative learning, have provided evidence of mobile-enabled collaborative learning activities being effective in classrooms (Sharples & Roschelle, 2010).

Learning outcomes from collaborative activities depend on the extent to which the group is actually involved in productive interactions, such as explanations, arguments or negotiations, and joint regulation (Dillenbourg & Crivelli, 2009). In addition, it has been proven that collaboration is a skill that must be learned and requires practice (Weinberger & Fischer, 2006). Therefore, to be successful, collaborative learning needs to be supported by adequate scaffolding, no matter whether it is a face-to-face experience (e.g. in a classroom) or a distance learning setting (Dillenbourg & Crivelli, 2009).

## 1.2 Problem of Research

Based on these explanations, skills in problem-solving, critical thinking, and collaborative thinking in digital competencies are fundamental skills in the 21st-century that must be achieved through an appropriate learning model, especially in Indonesia. Besides, based on the evaluation of the Program

Internationale for Student Assessment (PISA) 2021, it shows that these skills have decreased cognitive development to produce students as superior human resources (PISA, 2021). In other words, enhancement of problem-solving, critical thinking, and collaborative skills are global and fundamental problems that must be achieved through an appropriate learning model. However, until now, the available learning models do not specifically accommodate these skills.

### 1.3 Research Focus

A new innovation model is needed to support lecturer activities and student activities in achieving skills in problem-solving, critical thinking, and student collaboration to answer the problems. In this study, researchers integrated the PBL and CL model syntaxes into a collaborative problem-based learning (CPBL) model. Besides, CPBL is also developed to pay attention to problem-solving, critical thinking, and collaborative skills. Therefore, this study aims to develop a CPBL model in the form of a learning activity syntaxes and matrix for lecturers and students based on PBL and CL syntaxes and components of problem-solving, critical thinking, and collaborative skills.

## 2. Research Methods

### 2.1 Research Methods and Participants

This study used a development research method. The CPBL model was developed in the Learning Strategy course. The CPBL model development is carried out by constructing analysis theoretically and empirically, with the following steps: (1) analyzing PBL and CL syntaxes theoretically; (2) analyzing the components of problem-solving, critical thinking, and collaborative skills theoretically; (3) compiling the syntaxes framework for the CPBL model; (4) compiling the CPBL model framework; (5) testing the CPBL model empirically.

### 2.2 Instrument and Procedures

The instrument for testing the CPBL model framework was adopted from the model development components by (Joyce, Weil, & Calhoun, 2003) (See Table 1). Meanwhile, the study procedure for developing the CPBL model was carried out by adapting the development stages by van den Akker (2013). Further details regarding the procedures for this study are provided in the Research Results section.

**Table 1.** Instrument Components for Developing the CPBL Model

Components	Descriptions
Supporting theory	a. Constructivism theory <ul style="list-style-type: none"><li>• PBL syntaxes</li><li>• CL syntaxes</li></ul> b. Cognitive Theory <ul style="list-style-type: none"><li>• Components of problem-solving skills</li><li>• Critical thinking skills components</li><li>• Collaborative skills component</li></ul>
Model concept	Syntaxes integration of PBL and CL models is conducted by paying attention to the components of problem-solving, critical thinking, and collaborative skills.
Principle of the model	a. Problem Investigation b. Collaborative learning c. Mobile learning
Syntaxes	a. Problem orientation b. Organizing c. Collaborative problem solving d. Presentation and discussion e. Evaluation

Components	Descriptions
Social system	Students: <ul style="list-style-type: none"><li>• Students share roles actively during learning</li><li>• Students Collaborate in multi directions</li></ul> Lecturer: <ul style="list-style-type: none"><li>• Lecturers guide, facilitate, provide consultation and bridge the learning process</li><li>• Lecturers motivate students</li></ul>
Reaction principle	There are rewards and opportunities to play an active role as a whole
Support system	Learning design, student worksheets, evaluation instruments
Instructional impact	Improve problem-solving, critical, and collaborative thinking skills

### 2.3 Data Analysis

The data analyzed in this study consisted of quantitative and qualitative data. Analysis of quantitative data was carried out on experts' validation score results based on filling in the instrument items. Meanwhile, qualitative data analysis was carried out on data in criticism and suggestions from experts. The validity test of the CPBL model was carried out internally by three teaching and learning design experts. The validation results are calculated by the average score of each instrument component. The grading scale uses the conversion of scores: 4 is very good, 3 is good, 2 is not good, and 1 is very bad. The CPBL model is deemed feasible and practical to use in this study, which has a "good" conversion based on the average validator score.

## 3. Research Results

### 3.1 Preliminary investigation and theoretical embedding

A preliminary investigation was carried out by identifying the existing skills problems of the 21st-century, especially for universities. Besides, identify deficiencies in existing learning models and identify the availability of relevant models for solving 21st-century skills-related problems. This stage's result is that problem-solving, critical thinking, and collaborative skills become fundamental and global problems that must be achieved. Meanwhile, a relevant model's availability is the integration between the syntaxes in the PBL model and the CL model into the CPBL model. Thus, theoretical embedding is also required for the developed CPBL model. The CPBL model's construction is carried out by analyzing the relevance and suitability of PBL and CL syntaxes. The theoretical study of PBL syntaxes consists of problem orientation, organizing for learning, providing guidance individually or in groups, creating and presenting work, and analyzing and evaluating (Arends, 2012; Barrows, 2002; De Graff & Kolmos, 2003; Hicks, 1991; Ibrahim & Nur, 2004). Meanwhile, the CL model syntaxes consist of basic concepts, problem definition, independent learning, knowledge exchange, and assessment (Barkley, Cross, & Major, 2005; McCahon & Lavelle, 1998; Mustaji, 2017). The results of this analysis indicate that the five syntaxes of the CPBL model consist of problem orientation, organizing, collaborative problem solving, presentation and discussion, and evaluation (see Appendix 1).

#### 3.1.1 Problem Orientation

In this stage, the lecturer introduces the skills development strategy previously developed from the integrated PBL syntax by adding basic concepts to CL. Lecturers provide motivation, real problem orientation, explain the learning process and learning strategies to students. So, it is hoped that students can assess the problems that occur and bring out students' inductive knowledge.

#### 3.1.2 Organization

This syntax is the result of the integration of organizing learning with problem recognition. Students in groups heterogeneously understand the problems presented on the student worksheets. The lecturer

observes the student's social behavior shortly after being divided into several groups.

### 3.1.3 Collaborative Problem-Solving

This syntax is the result of the integration of guiding with independent learning. Lecturers provide direction to students in completing inductive-deductive problem-based worksheets to improve problem-solving skills and collaborative critical thinking with multiple sharing and peer instruction representation. The collaborative activities carried out can produce an interaction between students and mutually supportive behavior and facilitate multi-directional interaction between students and lecturers by completing worksheets, compiling problem formulations, and gathering information.

### 3.1.4 Discussion and Presentation

This syntax is the result of the integration of the presentation with the exchange of information. Lecturers guide students in presenting the results of activities. Students present the results of the discussion and conduct investigative questions and answers to exchange information from each group's results.

### 3.1.5 Evaluation

This syntax is the result of the integration of analyzing and evaluating by assessment. Lecturers guide students to evaluate processes and results. In this phase, students can organize and assess their friends' abilities. After conducting the evaluation, the lecturer gave a reward for the collaborative group presentation.

## 3.2 Empirical Testing

Based on the validator's opinion, the CPBL model has a suitable syntaxes construction based on the PBL and CL models' syntaxes. The CPBL model syntaxes provide students with a higher education experience through more collaborative problem solving and problem-solving. That is, student knowledge is constructed collectively through multi-directional interactions. This is characterized by good sharing of multiple representations and peer-in-instruction between students in groups, students outside the group, and students and lecturers in the classroom as a teaching and learning environment. Therefore, the CPBL model strongly supports the construction of problem-solving, critical thinking, and collaborative skills as fundamental and global skills in the 21st-century. The validators provide suggestions to improve the form of problems given to students to involve real problematic analysis. This is so that the formation of student knowledge collaboratively is formed from deductive thinking and prioritizing inductive thinking. The validation of the CPBL model on each component of the model development research shows that the CPBL model has a very good value, so it is suitable for use in learning.

**Table 1.** Results of the Validation of the CPBL Model by Learning Design Experts

No	Validation Components	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	Average	Criteria
1	Supporting theories	3,5	4	4	3,83	Good
2	Model concepts and principles	4	4	4	4	Very good
3	Learning Syntaxes	4	4	4	4	Very good
4	Social system	4	4	4	4	Very good
5	Principle of Reaction	4	4	4	4	Very good
6	Support System	4	3,5	4	3,83	Good
7	Instructional Impact	4	4	4	4	Very good

### 3.3 Documentation and Analysis

The CPBL model has the capacity as a learning guide to accommodate lecturers and students' activities to achieve problem-solving, critical thinking, and collaborative skills in higher education. Optimization of the achievement of these skills is carried out by presenting real and inductive-deductive problems. At this development stage, the researcher produces a syntaxes matrix of the CPBL model for lecturers and students by analyzing its syntaxes construction based on the components of problem-solving, critical thinking, and collaborative skills (see Appendix 2). The researchers analyze these components from the perspective of experts. The components of problem-solving skills are identifying the problem, defining and representing the problem, exploring possible strategies, acting on the strategy, looking and back, and evaluating the effect of activities (Bransford, Brown, & Cocking, 2000; Robertson, 2005). Meanwhile, critical thinking skills consist of formulating problems, formulating hypotheses, making observations, analyzing, making arguments, concluding, and taking action (Hesse, Care, Buder, Sassenberg, & Griffin, 2015; Mason, 2007). Furthermore, collaborative skills consist of participation, perspective-taking, social regulation, learning and knowledge building, and task regulation (Hesse et al., 2015).

### 3.4 Reflection on process and outcome

To reflect on the results of the application of the Mobile in CPBL model, the results of students' critical thinking skills, problem-solving and collaborative abilities were analyzed through critical thinking tests, problem-solving tests, and a collaborative ability questionnaire. To determine the significance of the increase in student ability, homogeneity test, normality test and independent-sample t-test were carried out with a significance level of 0.05 which is described in Table 2 to Table 6.

**Table 2.** Homogeneity test

		Levene statistic	df1	df2	Sig.
CTAT	Based on Mean	0.195	1	42	.661
	Based on Median	.200	1	42	.657
	Based on median and with adjusted df	.200	1	41.742	.657
	Based on trimmed mean	.190	1	42	.665
PSAT	Based on Mean	.404	1	42	.529
	Based on Median	.385	1	42	.539
	Based on median and with adjusted df	.385	1	41.979	.539
	Based on trimmed mean	.409	1	42	.526
CAQ	Based on Mean	.145	1	42	.705
	Based on Median	.112	1	42	.740
	Based on median and with adjusted df	.112	1	40.728	.740
	Based on trimmed mean	.141	1	42	.709

**Table 3.** Normality test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CTAT	.098	44	.200	.957	44	.099
PSAT	.095	44	.200	.980	44	.639
CAQ	.114	44	.180	.958	44	.107

**Table 4.** Independent sample t-test

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error difference	lower	upper
CTAT	Equal variances assumed	2.579	.116	17.95	42	.000	21.0227	1.171	18.66	23.38
	Equal variances not assumed			17.75	37.85	.000	21.0227	1.184	18.62	23.42
PSAT	Equal variances assumed	2.698	.108	17.43	42	.000	20.7639	1.191	18.36	23.16
	Equal variances not assumed			17.71	39.62	.000	20.7639	1.172	18.39	23.13
CAQ	Equal variances assumed	.145	.705	14.33	42	.000	22.0476	1.538	18.94	25.15
	Equal variances not assumed			14.25	40.19	.000	22.0476	1.546	18.92	25.17

Table 2 showed that the result of Lavene's homogeneity of critical thinking ability is 0.195 with a significance result of 0.661 so that students' critical thinking skills were a homogeneous group. Meanwhile, the result of Lavene homogeneity of problem-solving ability was 0.404 with a significance result of 0.529 so that the student's problem-solving ability was a homogeneous group. Meanwhile, the result of Lavene homogeneity of problem-solving ability was 0.145 with a significance result of 0.705 so that the student's problem-solving ability was a homogeneous group.

Table 3 showed that the results of the Kolmogorov-Smirnov calculation and the Shapiro-Wilk test for critical thinking skills are 0.099, which means that the data was normally distributed. While the results of the Kolmogorov-Smirnov calculation and the Shapiro-Wilk test of problem-solving ability were 0.639, which means the data was normally distributed. The results of the Kolmogorov-Smirnov count and the Shapiro-Wilk test for collaborative ability are 0.107, which means the data is normally distributed.

Table 5 showed that the independent sample t-test results of the ability to think critically in the equal variance assumed to show a result of 0.000 <0.05, which indicates that there was a significant difference before and after the application of the Mobile CPBL model. Meanwhile, the independent sample t-test result of the problem-solving ability in the equal variance assumed shows a result of 0.000 <0.05, which indicates that there is a significant difference before and after the application of the Mobile CPBL model. Meanwhile, the independent sample t-test result of collaborative ability in the equal variance assumed shows a result of 0.000 <0.05, which indicates that there was a significant difference before and after the application of the Mobile CPBL model.

#### 4. Discussion

The development of the CPBL model helps lecturers and students interact in a more multi-directional and constructivist manner. In addition, the innovation of combining PBL and CL syntaxes models is accommodative in learning, especially in higher education. At the problem orientation stage, learning activities show that students carry out several activities that support problem-solving, collaborative, and critical thinking abilities. Student activities that can understand and assess problems can help to plan or organize problem-solving.

At the organizing stage, students can plan problem-solving by collaborating with one group so that social interactions emerge. The experience provides the students' opportunities to work together and develop a sense of cooperation (Burn, Pierson, & Reddy, 2014; Davidson & Major, 2014). Lecturers facilitate and advise students to persuade them to learn to their full abilities. Goldie (2016) explained that lecturers are a supporter of learning and are instrumental in managing student learning.

The syntaxes of collaborative problem solving, presentation, and discussion show that in understanding a problem, a person investigates his / her environment by making direct interaction and social interaction to support cognitive growth. When there is an interaction between learners and between learners and lecturers, a cognitive conflict will occur and motivate students to resolve imbalances with individuals to reconstruct their knowledge structure. Thus, the CPBL model's syntaxes support previous studies that a structured and inductive-deductive problem-solving process helps

students achieve the demands of 21st-century skills (Huang & Chuang, 2008; Yeh, 2010).

In the evaluation syntax, students ask probing questions from students that start with solving complex problems or discovering (with the help of learners) the basic skills needed. The cognitive products produced at this syntax are classified as effective as stated Becker & Park (2011) that effective learning requires an understanding of how to make information easily accessible and evaluated by students to relate the constructed information and apply it outside of learning.

## 5. Conclusions

This study produces five CPBL syntaxes and a matrix for lecturer and student activities. The CPBL syntaxes consist of problem orientation, organizing, collaborative problem solving, presentation and discussion, and evaluation. Based on theoretical studies, empirical tests, and expert suggestions, the CPBL model's implementation constructs the fundamental and global skills needed in the 21st-century, namely problem solving, critical thinking, and collaborative skills. In implementing the CPBL model, students build knowledge inductively and deductively, as well as learning experiences in sharing multiple representations, peer instruction, and multi-directional interactions.

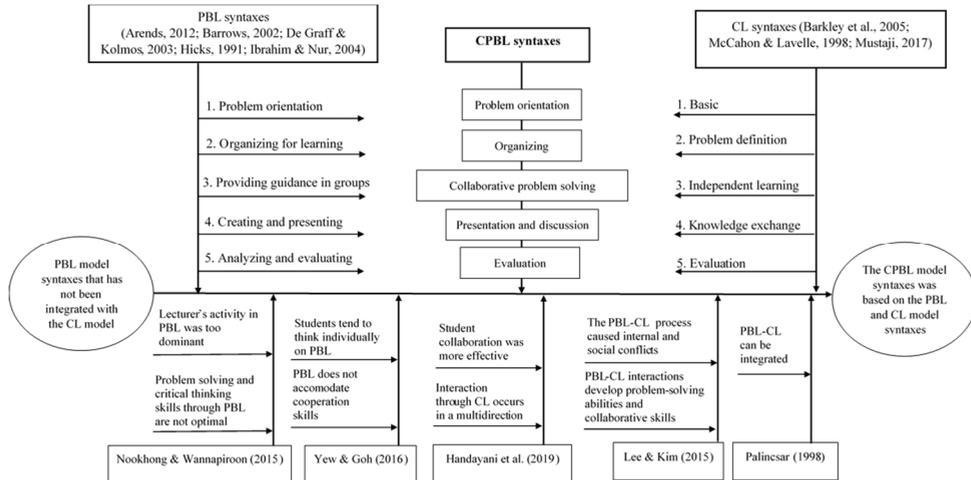
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Appendix 1:

Mapping the CPBL model syntaxes constructs



Appendix 2:

CPBL model matrix for lecturer and students activities

No Syntaxes	Actions		Problem Solving	Critical Thinking	Collaborative	Duration (Minutes)
	Lecturer	Students				
1 Problem orientation	Motivate and build student perceptions				Participation Perspective-taking	5
	Orient students in real problems	Understand the problem given	Identifying the problem	Formulating problems		5
	Describe the learning process				Learning and knowledge building	2
	Introducing critical thinking, problem-solving, and collaborative learning strategies	Assess the problems that occur	Defining and represent the problem	Formulating hypotheses		3
2 Organization	Divide students into heterogeneous groups	Heterogeneous group			Participation Social regulation	5
	Provide real and inductive-deductive worksheets to each group with the mobile application	Read the worksheet with the mobile application	Identifying the problem Explore	Making observations	Perspective-taking	10
3 Collaborative Problem-Solving	Provide advanced tasks with advanced problem solving to be completed in a collaborative and multi-directional interaction with mobile applications	Through peer instruction representation and collaborative groups, and multi-way interactions with mobile applications	Exploring possible strategies Act on strategies	Analyzing	Learning and knowledge building Task regulation	15
	Provide direction to students in completing student worksheets with the mobile application	Completing student worksheets constructively with the mobile application	Exploring possible strategies		Learning and knowledge building	
		Make a problem statement	Acting on strategies	Making arguments	Task regulation	10
		Actively participate in gathering information, analyzing and making conclusions with a mobile application		Analyzing	Participation Social regulation	15
4 Discussion and Presentation	Guide the course of presentations and discussions	Present the results of the discussion by presenting a powerpoint from the results of the discussion on the mobile application	Look and back	Concluding	Participation Social regulation	20
5 Evaluation	Guide students to evaluate processes and results	Evaluate learning processes and outcomes	Evaluating the effect of activities	Concluding Taking action	Task regulation	5
	At each syntaxes in the evaluation, lecturers need to provide rewards so that students become motivated	Get a reward			Participation Social regulation	5