Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 6, 2478-2493

PROJECT BASED LEARNING-COMPUTATIONAL THINKING (PBL-CT) PRODUCT DEVELOPMENT IN MOBILE PROGRAMMING COURSES

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Abstract

Learning in the Industrial Revolution 5.0 era, especially vocational education, must change fundamentally in the learning process. To achieve the goal of Vocational Education which produces students who have applied skills, are able to think critically and solve problems, have communication and collaboration skills, have creativity and innovation, and are ready to enter the world of work. Problems in the learning process at this time the learning process is still centered on the lecturer, and the lack of problem solving, collaboration, collaboration, and critical thinking skills possessed by graduates. Therefore, this study aims to develop a project-based learning model that integrates computational thinking concepts into mobile programming courses. This research is a development research that aims to develop a project based learning model by adding the concept of computational thinking. The model development uses the Borg & Gall concept. Testing the validity using Aiken's V and Confirmatory Factor Analysis. Research produces several products such as 1). Project Based Learning Computational Thinking (PjBL-CT) model book in Mobile programming course, 2). Lecturer's manual, 3). Student Guidebook, and 4). Project Based Learning Computational Thinking (PjBL-CT) teaching module book in the Mobile programming course. The syntax of the Project Based Learning-Computational Thinking (PjBL-CT) model in the Mobile programming course consists of 1). Formulating the focus of the problem, 2). Organization and analyze data in a logical way, 3). Algorithmic thinking, 4). Create a project schedule. 5). Monitor and evaluate project progress. And 6). Evaluation. This study shows that the Project Based Learning-Computational Thinking (PjBL-CT) model in the Mobile programming course is valid, has been tested so that it is suitable for use in the mobile programming course. The implications of research as an alternative for optimizing face-to-face and online learning, improving students' creativity, critical thinking, communication, and collaboration skills.

Keywords: System Apps, Web-based, Junior high school, System Development, Life Cycle, Use-Case Diagram.

1. INTRODUCTION

The development of technology and information in the twenty-first century continues to accelerate, with the potential to change the pattern of human life and have an impact on the world of education. Learning that makes use of information and communication technology (ICT) aligns with the needs of 21st century vocational technology education learning skills. To improve quality, current learning in vocational education necessitates the use of technology (Kamdi, 2011). (Ulansari, 2015). Furthermore, the needs of the twenty-first century necessitate the acquisition of 4C soft skills. (Cooperation, communication, critical thinking, and creativity) Arnyana (2019) (Hidayatullah, 2021). The significance of 4C skills for the needs of the workplace The lecturer is still at the center of problems that arise during the ongoing learning process (Teacher Center) (Wibawa, & Agustina, 2019); (Launchette, 2009). (Kurniawan, et, al, 2018) Students and graduates continue to lack competence in learning mobile programming. This is consistent with the findings of a survey conducted in April 2019 among 150,000 Information Technology (IT) graduates by Dicoding, a startup provider of computer programming learning platforms, which revealed that 56 percent of respondents had a career in the company, while the remaining 44 percent did not have a permanent job. When it comes to entering the workforce, student competence remains low (Nurhidayati, & Khasanah, 2021). Students' and graduates' soft skills are still lacking. (Hulu, 2020); (Yulhendri, & Sofya, 2021).

Medan State Polytechnic is a campus that organizes Vocational Education in North Sumatra. The Information Management Study Program, offered by the Department of Computer Engineering and Information Technology, is one of the existing study programs. This program aspires to be a professional study program in web and mobile application development. To achieve the vision in this study program, the vision has been reduced to a curriculum in the form of courses that will be implemented over a three-year period (6 semesters).

So far, the learning process has been centered on the lecturer (Teacher Center); the lecturer is the center of the learning process. Students are positioned as learning objects, and they are viewed as passive organisms who receive information from the lecturer. Learning activities take place at a specific location and time. New students learn in a classroom that has been designed as a learning environment. In fact, the primary goal of teaching is for students to master the subject matter in both theory and practice. The extent to which students master and absorb the lecturer's subject matter is a measure of the teaching process's success.

Computational Thinking (CT) refers to the use of structured thinking or algorithmic thinking to generate outputs that match the inputs (Denning, 2017). CT seeks to democratize computational knowledge as an important body of learner knowledge for addressing 21st-century challenges (Angeli, & Giannakos, 2020). According to the findings (Pérez-Marn et al, 2020), student-centered use of CT can improve understanding and learning. However, the gap that occurs in the CT environment, according to (Wing, 2006), is still weak, even as countries around the world launch reforms to include the integration of computational thinking into education (Bocconi, 2016). Computational thinking, according to Jeannette Wing, is a way of thinking that involves information processing, such as algorithmic thinking, reasoning, models, procedural thinking, and recursive thinking (Wing, 2011). According to Grover and Pea, computational thinking is a skill that underpins analytical activity. Computational thinking entails specific problem-solving abilities such as abstraction, decomposition, evaluation, modeling, recognition, logic, and algorithm design (Grover & Pea, 2018). overcoming difficulties in learning the program (Yadav, et, al 2016). While CT can help with learning programming problems. (Ketelhut and colleagues, 2020); (Pérez-Marn, 2020); (Nouri, 2020). As a result, overcoming these learning problems requires a combination of CT and the PJBL learning model.

Researchers in this study present a solution for developing a project-based learning-computational thinking model to manifest earthquake applications in mobile programming courses in order to improve students' competence and 4C in vocational education, so that the resulting model is valid, practical, and effective. Project-based learning (PBL) is a project-based learning model that results in products (Lucas, 2005). (Denning, 2017). The presence of projects in learning can motivate students to become skilled (Jalinus, & Nabawi, 2018). The project has the potential to improve student learning outcomes (Jalinus, & Nabawi, 2018). Based on the findings (Kuswandi, et al, 2018). The outcomes of project-based learning improve. Alacapnar (2008) emphasizes contextual learning through complex activities in PJBL.

Because it is still difficult for lecturers to develop and implement PjBL learning with technological elements, and their achievements have not yet had a maximum impact on 4C, researchers provide solutions to improve and integrate PjBL models with computational thinking elements, which are still relatively new in Indonesia. In the course of mobile programmers, this research has produced a model with the concept of PJBL learning model, which combines the concept of Computational Thinking. There are project elements and computational thinking, advanced technology, 4C elements, and learning to improve student competence in mobile programming courses as learning concepts. Model books, mobile applications, application guidelines, and learning tools are among the products created (modules, lesson plans, syllabus). The developed model has the following syntax: The syntax of the developed model is as follows: produces 6 (syntax) syntax consisting of: 1) Formulate the problem's focus, 2) Organize and analyze the data logically. 3. Algorithmic Thinking 4).Make a project schedule. 5).Project monitoring and evaluation. 6).Evaluation. The model of project-based learning-computational thinking (PjBL-CT) has been demonstrated to be valid, practical, and effective.

2. RESEARCH METHOD

This research employs research and development. Research and development is a type of research that is used to test, develop, and create specific products. In terms of methods, however, research and development methods employ a combination method (Sugiono, 2017: 51). According to Gay, Mills, and Airasian (2009: 18), the primary goal of R&D research is to develop effective products for use in schools rather than to formulate or test theories. R&D produces teacher training materials, teaching materials, media materials, and management systems. The research and development model used in this study is the Borg and Gall model. The Borg and Gall development model includes a step-by-step guide for researchers to follow to ensure that the products they design meet a standard of feasibility. So, in this development, a reference to the product procedure to be developed is required.

The research procedures used in this development were adapted with limitations from the stages of development developed by Borg and Gall. According to Borg and Gall (in Emzir, 2013: 271), research can be limited on a small scale by limiting research steps. The implementation of the development stage is tailored to the researcher's requirements. Given the researcher's limited time and resources, these steps were simplified into four development steps: 1) data collection phase with preliminary studies, needs analysis. 2) Models and other supporting products are designed during the planning and design stages. 3). It is carried out during the Development phase by creating models and other supporting products, as well as implementing FGDs. Expert validation, practical testing, model implementation, and effectiveness testing are the four stages of validation and testing.

3. RESULT AND DISCUSSION

The development process and results of the PjBL-CT model, which uses the Borg & Gall stages, will be explained in this section by reducing the development stage to four stages (Emzir, 2007), namely 1). Stage of data collection with preliminary studies and needs analysis 2) Models and other supporting products are designed during the planning and design stages. 3). During the Development phase, he creates models and other supporting products and conducts focus groups. 4). Expert validation, practical testing, model implementation, and effectiveness testing are the validation and testing stages.

3.1 Data collection stage

The researcher conducts a preliminary study of the reference model to be developed during the data collection stage. Furthermore, an analysis of learning needs was performed at this stage, which was given to 30 students from the Medan State Polytechnic Information Management Study Program who had taken the Mobile Application Programming course.

Meanwhile, the following graph depicts the results of student perceptions:

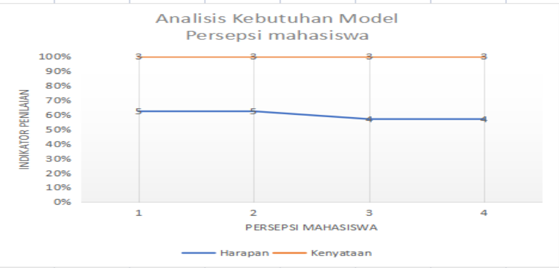

Figure 1 depicts the results of student questionnaires on learning perceptions.

Meanwhile, the following graph depicts the learning experience:

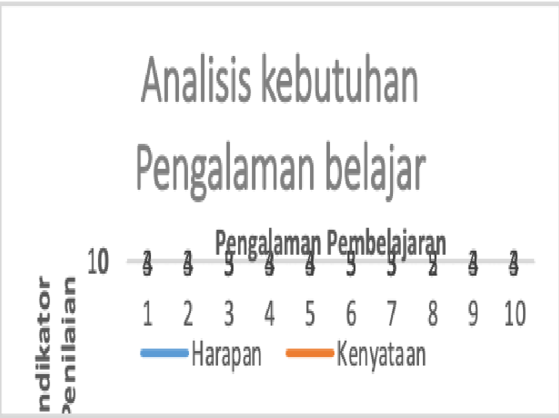

Figure 2 shows the results of student surveys on their learning experiences.

Meanwhile, the following graph depicts the results of student needs in developing learning models:

Figure 3: Student model needs analysis questionnaire results.

The results of the lecturer's perception are then depicted in the graph below:

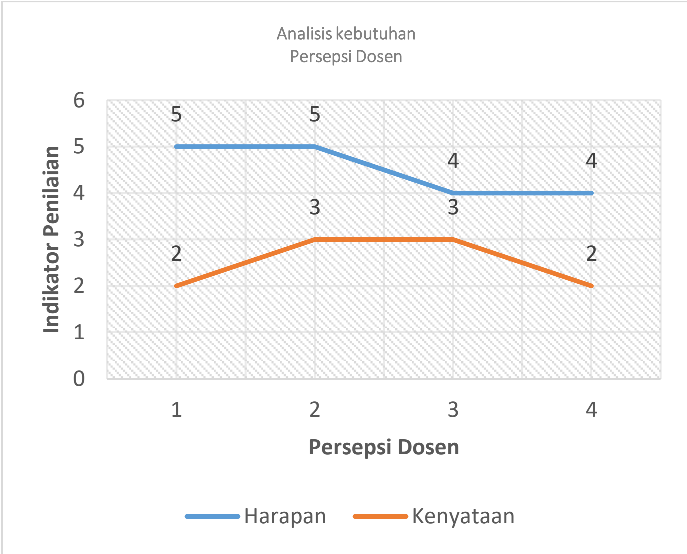

Figure 4 depicts the findings of the lecturer's perception questionnaire.

Meanwhile, the following graph depicts the teaching experience of lecturers:

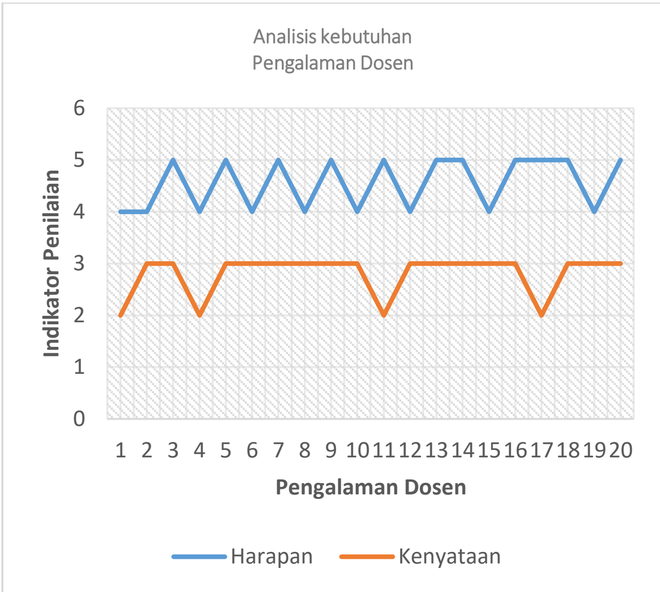

Figure 5: Experience questionnaire results for lecturers

These findings indicate that there is still a gap between expectations and reality. Meanwhile, the following graph depicts the results of lecturers' needs in developing learning models:

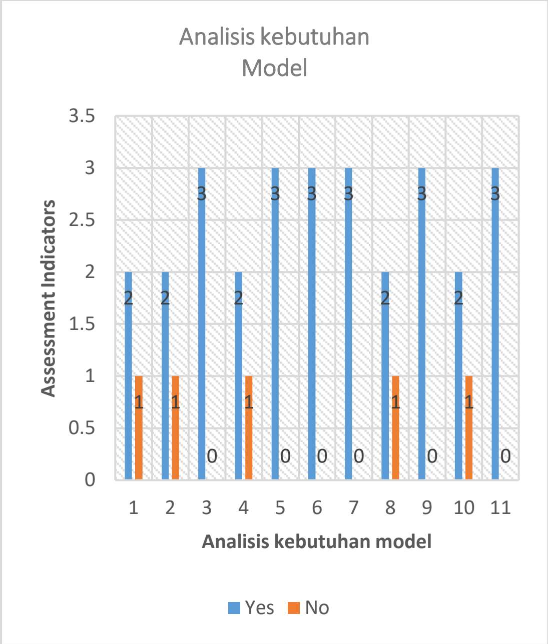

Figure 6: The lecturer's model needs analysis questionnaire results

This description leads to the conclusion that lecturers require a project-based learning model of computational thinking.

3.2 Planning and Design Stage

At this stage, the model is being designed, beginning with the creation of a grid of research instruments, followed by the creation of validation sheets, observation sheets, and interview guidelines, as well as the creation of instruments for cognitive, affective 4C, and psychomotor questions. Create lesson plans, a syllabus, learning tools, model books, manuals, and teaching modules. The PjBL-CT model's design, which includes the stages (syntax) of learning, social systems, reaction principles, support systems, and instructional impacts, as well as the PjBL-CT model's accompaniment.

3.3 Development Stage

This stage is the model's development, beginning with the conceptual framework of the model, moving on to the stages (syntax) of learning, the social system, the reaction principle, the support system, the model's impact, and the research product.

a. Model Construct Design

In the course of mobile programmers, this newly developed model develops the PjBL learning model, which incorporates the concept of Computational Thinking. There are project elements and computational thinking, advanced technology, 4C elements, and learning to improve student competence in mobile programming courses as learning concepts. Model books, mobile applications, application guidelines, and learning tools are among the products created (modules, lesson plans, syllabus).

Researchers add experiences and descriptions of an earthquake tool and application so that students are familiar with the tools and applications that will later be used in a student final project trial in retrieving data from tools and applications developed by previous researchers. Another improvement made to the PjBL-CT model is the addition of evaluations in the middle and end of the semester. The evaluation's goal is to determine students' cognitive abilities in the context of Mobile Application Programming using the applied learning model.

To learn syntax, you must first: 1) formulate the problem's focus, 2) organize and analyze data logically, 3) use Algorithmic Thinking, and 4) create a project schedule. 5). Keep track of and evaluate project progress. 6) Assessment. The study's novelty is that it offers a learning solution in which the concept adapts the PjBL model with project clarity, project monitoring, reporting, and other features. Furthermore, the model developed in the mobile programming course where students are required to learn how to create products. Using a combination of advanced technology, computer thinking, and 4C elements.

The implementation of the PjBL-CT model is detailed in the appendix image of the concept map for the PjBL-CT model of learning activities.

Table 1. Syntax of the PjBL-CT learning model

SINTAK	AKTIVITAS
Determine the problem's focal point.	a) Give students specific instructions by discussing the use of problem solving in the design of learning devices that will be used on web links and other support system devices. b) According to the guidelines, all students were given a verbal explanation for the use of device access rights. c) The lecturer notifies the learning system via a link, where the device contains lecture process rules such as the syllabus, RPS, and learning outcomes. d) d. The lecturer explained the main part of the learning outcomes in order to improve each student's ability to understand how to solve problems from the project plan design in order to use the software system in accordance with the planned project concept.
Data should be organized and analyzed logically.	a. The lecturer invites students to organize the formulations that have previously been discussed. b. Students collaborate to develop a formulation that addresses the project's central problem. As a result, being a unit does not detract from the overall goal of learning outcomes.
Algorithmic Thinking	a. The lecturer invites students to attempt to solve these problems by considering automating solutions through algorithmic thinking (a series of sequential steps). b. Students work together to solve these problems by considering automating solutions through algorithmic thinking (a series of sequential steps).
Creating a Project Schedule	a. The lecturer instructs the students to create a timetable for completing the project. b. Students plan activity schedules for project completion. At this stage, activities include: (1) creating a timeline for completing the project, (2) setting project completion deadlines, (3) bringing students to plan new ways, (4) guiding students when they make ways that are not related to the project, and (5) asking students to explain (reason) why they chose a method.
Track and evaluate project progress.	a. Based on guidelines and learning methods, the lecturer analyzes the Project Pre-test data and provides assessment results for the suitability of the Project design with the rules for using software. b. Students create a creative way of thinking about the problems

	of an Information System-based software by formulating the results of the Project Pre-test analysis. c. Lecturers conduct simulations to identify and prove the level of success of the project design based on the results of data processing that has been formulated and obtain verification results from the learning objectives and activities carried out by students in accordance with the project. d. Students explore Project activities from the identification results by creating an Intelligent System based on the concepts that have been set at the beginning.
Evaluation	a. The lecturer inquires about the student's final project outcome. Students submit project results to lecturers b. Students provide the results of the completed Design Project to the lecturer. c. The lecturer tests the Project Design as the final result and provides an assessment of the learning evaluation results d. The lecturer assesses skills. e. The lecturer assesses soft skills/affective skills. f. Cognitive assessments are carried out by lecturers.

b. Social System

In this learning model, lecturers and students share a proportional share, with students expected to be active and creative in their use of learning applications. Lecturers, on the other hand, must be active in exploring, guiding, and providing direction and arguments in response to student questions and statements. In this learning, the full duplex communication model or multi-way communication model is used, and this learning communication model is not limited by time or space, because learning with this learning application can be done at any time and from any location. This study maintains communication principles such as honesty, politeness, mutual respect, respecting the opinions of others, not forcing opinions, and being democratic. As a result, these characteristics will develop in students. Because there is a project that must be completed, students must be creative in channeling their ideas in order to complete assignments/projects properly and on time.

c. Reaction Principle

The principle of the reaction that occurs in the implementation of the PjBL-CT learning model is how the lecturer creates a conducive environment such as smooth communication without being hampered by time and place. Then, through social interaction, lecturers and students learned about each other's roles and responsibilities in this learning model. Furthermore, there is a reaction principle between students and the company regarding how students respond to requests and problems raised by the company regarding mobile programming problems (project assignments).

d. Support System

The support system describes the situations and conditions required to support the implementation of the PjBL-CT learning model, including facilities and infrastructure such as tools and materials, room atmosphere, learning equipment, lecturers' and students' readiness, and willing companies to collaborate. Several support systems are required in this model, including Internet and bandwidth, manuals, learning tools, educators, and learner readiness.

e. Instructional Impact and Accompaniment

Students gain knowledge and knowledge about the material in accordance with the learning objectives, which has a direct impact. Furthermore, students gain knowledge of the problems that may exist in a developed application or tool. While the PjBL-CT learning model has an indirect impact on instilling and cultivating noble values such as honesty, mutual respect, listening ability, politeness, and can increase motivation, creativity, and discipline.

3.4 Research Product Design

Model books, teaching modules, lecturer guides, student guides, and learning tools are examples of supporting products.

a. PjBL-CT Model Book

The model book is based on theories concerning the development of learning models, systems development models, information system concepts, and several supporting theories such as models that are used as references in model development. The display of the model book is shown in the figure below:

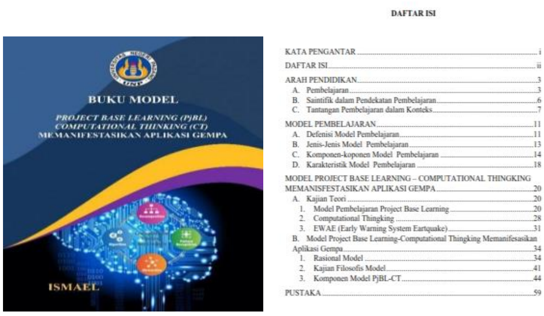

Figure 7. Book Cover and Table of Contents Model Book

b. Lecturer and student guide

This user guide was created to assist lecturers and students in using the developed model, as well as the activities and learning steps. The guide is divided into two sections: general system design and detailed system design. The following figure depicts the results of the design and draft guidelines:

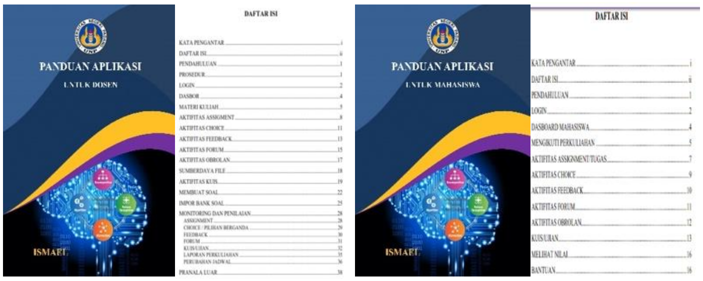

Figure 8. Cover and Table of Contents for Lecturer and Student Guide

c. Teaching Module

The modules are based on material sessions that have been tailored to the syllabus and semester learning plans (RPS) that have been agreed upon by a consortium of course lecturers. The following figure depicts the results of the developed module's design:

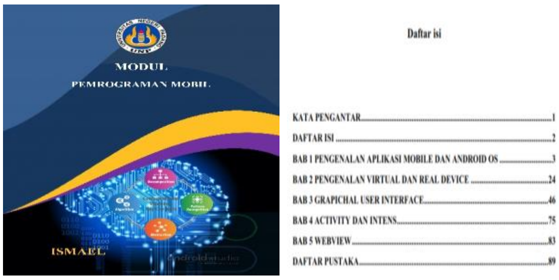

Figure 9. Learning Module Design

3.5 Validation and Trial Phase

a. Product Validation and Revision

1) Research Instrument Validity

Aiken's average value ranges from 0.82 to 0.86 in the validation results. According to Azwar (2004), Aiken's average value is considered valid if it has a value of 0.667, which means that all of the instrument quality validation results are considered valid. The validation instrument and the validation calculations are shown in the appendix.

2) Model Validation

a) Validation of PjBL-CT Model

• Model Syntax

Figure 9 depicts the results of the data analysis for the syntax construct validation of the PjBL-CT learning model.

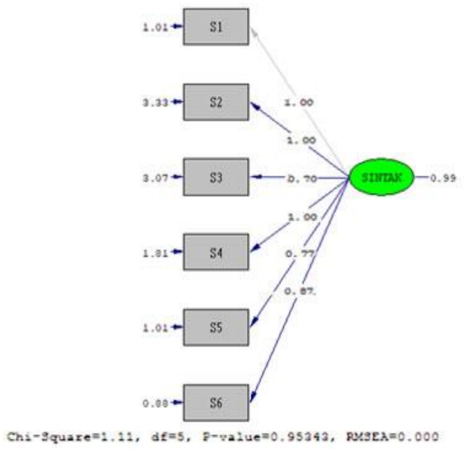

Figure 9. Syntax Analysis Results

- Social System

Figure 10 depicts the results of the data analysis for the social system construct validation of the PjBL-CT model.

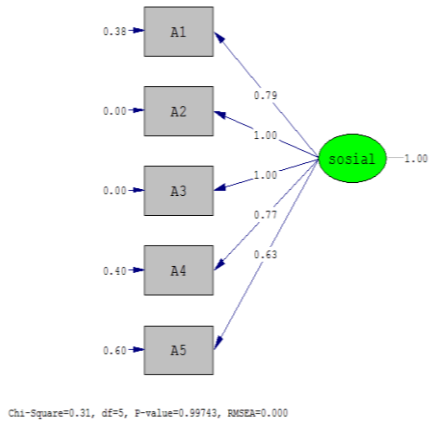

Figure 10. Results of Social System Analysis

- Reaction Principle

Figure 11 depicts the results of the data analysis for the reaction principle construct validation of the PjBL-CT learning model.

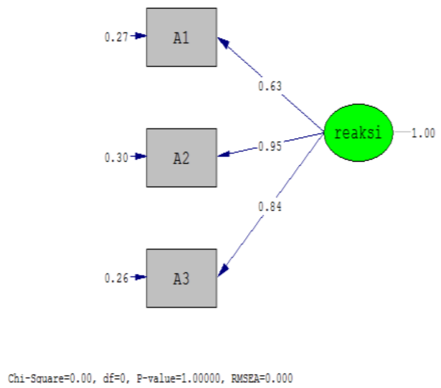

Figure 11. Result of Reaction Principle Analysis

- Support System

Figure 12 depicts the results of the data analysis for the construct validation of the PjBL-CT model support system.

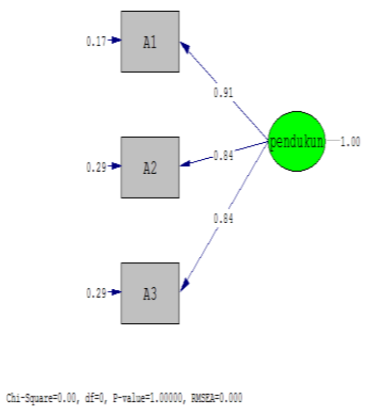

Figure 12. Results of Support System Analysis

- Instructional/accompaniment impact

Figure 13 depicts the findings of the instructional/accompaniment impact construct validation data analysis.

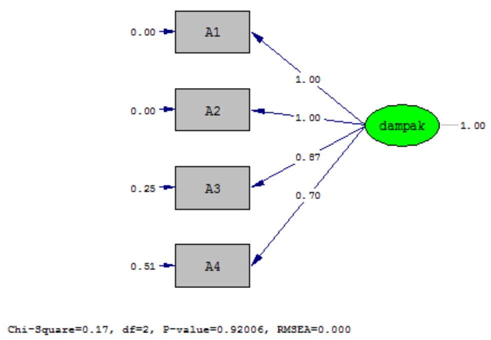

Figure 13. Instructional Impact Analysis Results

Based on the results of the above test, it is clear that all items in each indicator satisfy the goodness of fit models. As a result, the construct validity is classified as either fit or valid. The following figure depicts the magnitude of the influence of each indicator of the PjBL-CT model:

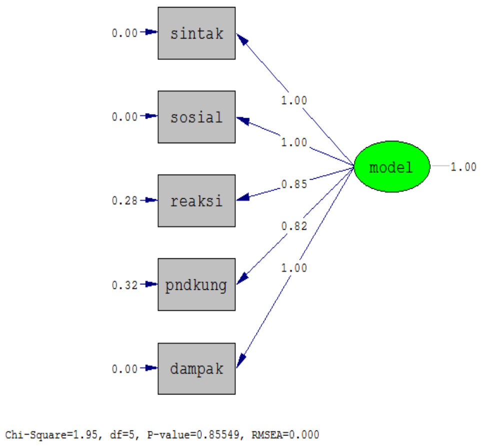

Figure 14. Results of Indicator Analysis on the PjBL-CT Model

3) Validation of Project Based Learning Model Books

Validation of the PjBL-CT model book was performed by 5 (five) validators/experts, including IT experts, vocational experts, language experts, material experts, and learning model experts. The validation of the model book results in aspects of the model book being obtained. 1). Rational Model has a score of 0.90 on average. The average score for Supporting Theory is 0.91. 3). The model syntax has a score of 0.88 on average. The average score for Social System is 0.89. 5). The Reaction Principle received a mean score of 0.85. The average score for Support System is 0.9. 7). The mean score for instructional impact and accompaniment was 0.89. The model book validation results have an overall average value of 0.89. The result 0.667 can be interpreted as a relatively high coefficient, indicating that the validity category is "valid" (Azwar, 2014:113).

4) Validation of Lecturer Guide

The outcomes of the lecturer's guide validation with aspects 1). The average score for Writing Format is 0.85. The average score for language use is 0.87. 3). The introduction received a mean score of 0.86. The average score for Content Aspect is 0.87. 5). The average score for the Evaluation System is 0.89. The manual validation results have an overall average value of 0.87. The result 0.667 can be interpreted as a relatively high coefficient, indicating that the validity category is "valid" (Azwar, 2014:113). The appendix contains detailed results of processing the validation data for the lecturer's guide.

5) Student Guide Validation

Student guide validation results with aspects 1). The average score for Writing Format is 0.87. The average score for language use is 0.87. 3). The introduction received an average score of 0.88. The average score for Content Aspect is 0.91. 5). The average score for the Evaluation System is 0.88. The manual validation results have an overall average value of 0.88. The result 0.667 can be interpreted as a relatively high coefficient, indicating that the validity category is "valid" (Azwar, 2014:113). The appendix contains detailed results of the student guide validation data processing.

6) Module Validation

The findings of the teaching module validation assessment in terms of 1). The average score for Self Instruction is 0.97. The average score for Self Contained is 0.80. 3). Stand Alone has an average rating of 0.80. The average score for adaptive is 0.85. The average score for User Friendly is 0.78.6. Graphics Aspect has an average score of 0.81. 7). The average score for the Language Aspect is 0.80. The average score for the Evaluation System is 0.80. In the teaching module, the validation results have an overall average score of 0.83. The result 0.667 can be interpreted as a relatively high coefficient, indicating that the validity category is "valid" (Azwar, 2014:113).

b. Product Revision

1) Model Book

The revised model book produced the following results:

Table 2: Product Suggestions and Changes Model portfolios

No	Source person	Initial Product Input	Repair
1	Exspert1	Include relevant research that supports the model.	Relevant research has been added
		Make a model conceptual framework.	The model's conceptual framework has been updated.
2	Exspert2	Make use of proper Indonesian.	Language has been fixed
3	Exspert3	Clarify the developed model's concept.	The developed model has been clarified
4	Exspert4	Make a case for model development based on previous research.	Model development argument has been made
5	Exspert5	No Novelty models yet	Novelty model has been added

2) Teaching Module

The following are the outcomes of the revision of the teaching module:

Table 3: Product Suggestions and Revisions for Teaching Modules

No	Source person	Initial Product Input	Repair
1	Exspert1	Create teaching modules in accordance with the format.	The format was followed when creating the teaching module.
2	Exspert2	The teaching module is tailored to the lesson plans and curriculum.	The teaching module has been adapted to the hospital and syllabus
3	Exspert3	A learning evaluation is performed in the module.	An evaluation question has been added
4	Exspert4	In teaching modules, use EBI-compliant language.	Fixed language in module
5	Exspert5	Creating module learning objectives	Learning objectives have been added to the module

3) Panduan dosen

Untuk hasil revisi panduan dosen sebagai berikut:

Table 4. Saran dan Revisi Produk Panduan dosen

No	Source person	Initial Product Input	Repair
1	Exspert1	An explanation of the used model has been added to the guide.	Model explanation has been added
2	Exspert2	The steps are clearly laid out in the lecturer's guide.	The lecturer's steps in learning have been clarified
3	Exspert3	Writing correctly according to Indonesian spelling (EBI).	Writing has been corrected according to EBI
4	Exspert4	16 meetings were scheduled in the lecturer's guide.	A total of 16 meetings have been held
5	Exspert5	Letters clarify the cover design of the lecturer's guide.	The lecturer's guide voucher has been fixed

4) Student guide

The revised student guide produced the following results:

Table 5: Product Suggestions and Changes Student Handbook

No	Source person	Initial Product Input	Repair
1	Exspert1	Writing correctly according to Indonesian spelling (EBI).	Writing has been corrected according to EBI
2	Exspert2	The student guide includes clear steps that are simple to follow.	It has been clarified what steps and activities students take.
3	Exspert3	In the student guide made practical	Student guide that is practically packaged
4	Exspert4	The student guide includes an evaluation question.	The student guide now includes an evaluation question.
5	Exspert5	The lettering on the student guide cover design has been improved.	Student guide voucher has been fixed

4. CONCLUSION

This research model's concept is to create earthquake applications in order to develop a PJBL learning model that combines the concept of Computational Thinking in mobile programming courses. There are project elements and computational thinking as learning concepts, as well as 4C elements, learning to improve student competence in mobile programming courses. Model books, teaching modules, lecturer guides, and student guides are among the products created. This model generates six (syntax) syntax: 1) Formulate the problem's focus, 2) Arrange and analyze the data logically. 3. Algorithmic

Thinking 4).Make a project schedule. 5).Project monitoring and evaluation. 6) The validity of the PjBL-CT learning model was demonstrated. Students' competence and 4C in vocational education can be improved.

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