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Development of Contextual Teaching and Learning (CTL) Models in Applied Physics Courses

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Abstract

Applied Physics is a basic course in engineering science. As an applied science, it is expected that it can be seen its application in learning material as skills demanded by graduates. CTL is a learning concept that help teachers connect the material they teach with real-world situations of students and encourage students to make connections between the knowledge they have and their application in their lives. The instructional development model used is the IDI (Instructional Development Institute) which consists of define, develop, and evaluate. The result of this development with a CTL-based model has syntactic of Display, Inquiry, Learning Community, and Authentic Assessment (DILA). The structure of the model in the form of a theoretical model has been validated by a hypothetical model that will be tested for its application. The syntax that exists in the DILA learning model trains students to make discoveries, cooperate and make judgments.

Keywords: *CTL; Applied Physics; DILA*

1. Introduction

The issuance of the Presidential Regulation (Perpres) of the Republic of Indonesia (RI) number 8 of 2012 and the Republic of Indonesia Minister of Education and Culture (Permendikbud) Regulation number 73 of 2013, requires Colleges, Institutes and Universities (hereinafter referred to as High Education) to redesign the curriculum simultaneously in accordance with the KKNI (Indonesian National Qualification Framework), which has been implemented no later than 2016/2017 [1].

The Study Program of Vocational Degree in Mining Engineering is one of the Study Programs under the Mining Engineering Department which was established since 2001. One of the learning achievements that must be met for Vocational Degree graduates in the scope of knowledge is: mastering general theoretical concepts of natural science, engineering principles, engineering science and engineering design needed for analysis and systems design, processes, products or components. One of special skill that must be possessed is: being able to apply mathematics, natural science, and engineering principles into technical procedures and practices to solve well-defined engineering problems in the field of specialization; and one of the general skills that Associate Degree program graduates must have according to the 2015 Permenristekdikti Appendix is "Be able to solve work problems with the nature and context in accordance with the applied field of expertise based on logical thinking, innovative, and responsible for the results independently".

Applied Physics subjects are included in the required Scientific and Skills subjects given in the second semester. The course learning outcomes (CLO) are: (1) Students can apply the concepts of Unit Systems, Vector, Mechanics (Straight Motion, Curved Motion, Circular Motion, Force, Balance, Effort, Energy, Momentum), Fluid (Statics & Dynamics), Thermophysics (Temperature & Heat, Expansion), Elasticity, Waves, and Simple Electric Circuits in the field of Mining. (2) Having a critical attitude that is contextual with the profession as an intermediate expert.

From the research, the phenomenon that occur in the learning of Applied Physics, students get unsatisfactory scores, the lecturer competencies and lecture materials are good, the teaching and learning process shows that the lecturers use less of media, and the student learning attitudes, students still lack confidence in expressing opinions, not being creative, having difficulties in practicum and not concentrating in learning and necessarily need project work that supports the learning of Applied Physics [2].

> *Physics should be given more with the help of examples from everyday life besides mathematical data and theoretical lectures,and concepts of Physics should be supported with applied activities* [3].

> On a vocational education, *vocational education needs to be taught in the context of practical problem-solving, and that high-quality vocational education almost always involves a blend of methods – something which is broadly hands-on, practical, experiential, real-world as well as and often at the same time as something which involves feedback and reflection* [4].

Thus, the development of a learning model that is in accordance with the Applied Physics Course is the development of a Contextual learning model. The essence of the CTL approach is the interrelation of courses or topic of learning with real life. To connect it can be done in various ways, besides the material learned is directly related to factual conditions, it can be dealt with by providing illustrations and examples, learning resources, media and so on, which are either directly or indirectly related or related to real life experiences [5].

2. Research Methods

This research produces a product and develops a learning model, this type of research is included in the type of Research and Development, according to Sugiyono's statement [6]. The development model produced by the instructional development of IDI (Instructional Development Institute) which consists of define, develop, and evaluate. The development procedure is in accordance with the chart below:

Define: analyze the needs of the curriculum, material and needs of students

↓

Develop: determine learning goals, make prototypes of developed learning models (philosophical and theoretical foundation, syntax, support systems, media and evaluation instruments). The prototype obtained was discussed with experts (Education, Applied Physics, Vocational and stakeholders) by carrying out Forum Group Discussion.

↓

Evaluate: to look at the practicality and effectiveness of the models that have been developed by carrying out small group trials and continued with group trials besar.

Figure 1. Procedure for Developing a DILA Learning Model based on CTL

2.1 Define

At this stage a literature review is conducted related to the philosophical and psychological foundation of Physics learning, learning theory, CTL learning models,and learning in tertiary institutions. Then the needs analysis is done from both lecturers and students regarding learning of Applied Physics courses, curriculum analysis and Applied Physics material.

2.2 Develop

At this stage of the development the hypothetical model was obtained which was formulated based on the literature review and analysis of the needs of the results of the define stage. This hypothetical model was put forward in a Group Discussion (FGD) forum attended by experts on July 26, 2017. Educational Technology Specialists were represented by Prof. Dr. Z. Mawardi Effendi, M.Pd, Dr. Ridwan, M.Sc.Ed. The Learning Technology Expert was represented by Dr. Darmansyah, M.Pd. The Vocational Expert was represented by Prof. Dr. Nizwardi Jalinus, M.Ed and Dr. Azwar Inra, M.Pd. Physicists represented by Dr. Usmeldi, M.Pd and Drs. Yunasril, M.Sc. Input from users (industry) is also needed to see whether the application provided is in accordance with the industry or not. From the industry, Yelmi Arya Putra invited, ST from PT. Semen Padang. The stages of this research have reached the hypothetical model obtained from the results of the FGD with the experts. Results from the FGD: in general the development products do not yet have attractive covers and layouts.

a. Learning Development Model Design

1) The development model must be based on a philosophical foundation (especially the philosophy of vocational education), a psychological and sociological foundation.
2) The rationale for the use of the development model must also be clarified.
3) Activities in the inquiry stage are unclear.
4) The link between theory and syntax needs to be studied in more depth.
5) The structure of the model developed is adapted to the structure of the existing model.

b. Lecturer Guidance Design

1) Lecturer activities in the teaching and learning process are adjusted to the syntax of DILA.
2) Assessment assessment is one part that must be in the lecturer manual.
3) Be clear about the lecturers' activities in authentic assessment.

c. Student Guidance Design
   1) An explanation of the implementation of the development of learning models is needed to provide understanding to students.
   2) Be clear about the instructions for using the guidebook.

d. Learning Material Book Design
   1) Lay out and design are less attractive, still too general.
   2) The images and symbols used are not legible.
   3) The sample questions given are adjusted to the application of material in the mining industry and in everyday life.

e. Learning Development Model Book Design
   1) The procedure for developing learning models is not necessary in the model book.
   2) The book model is concise and clear.

f. Learning CD on Applied Physics Materials
   1) Display and background adjusted again.
   2) The text is clarified.

g. Validation Instrument
   1) There is literature used as a reference in making instrument items.
   2) Adjust instrument items with indicators and aspects to be measured.

The stages of this research have arrived at the hypothetical model obtained from the results of the FGD with experts.

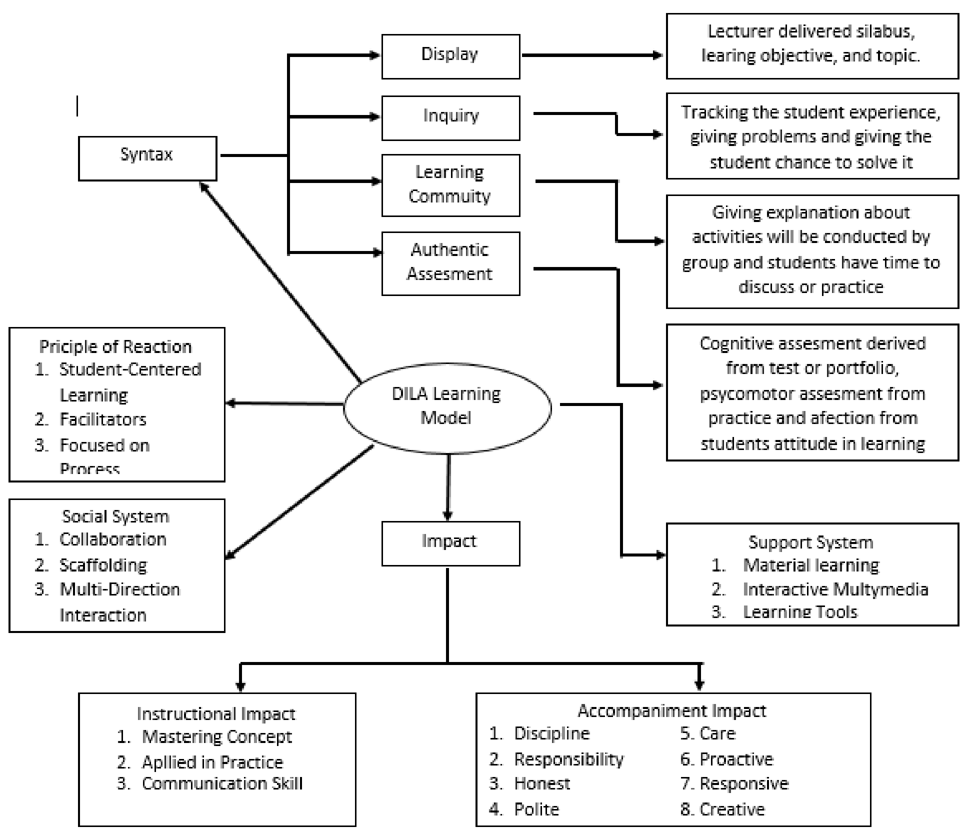

Figure 2. Prototype of CTL-based Learning Development Model

2.3 Evaluate

The results of this FGD were corrected and re-validated by the experts and tested on students in small groups (10-15) people.

3. *Research Results and Discussion*

Based on the improvements obtained from the FGD, the hypothetical design model from the development of the CTL model was developed into a structure of the final learning model. The structure of this learning model refers to Joyce and Weil 1989.

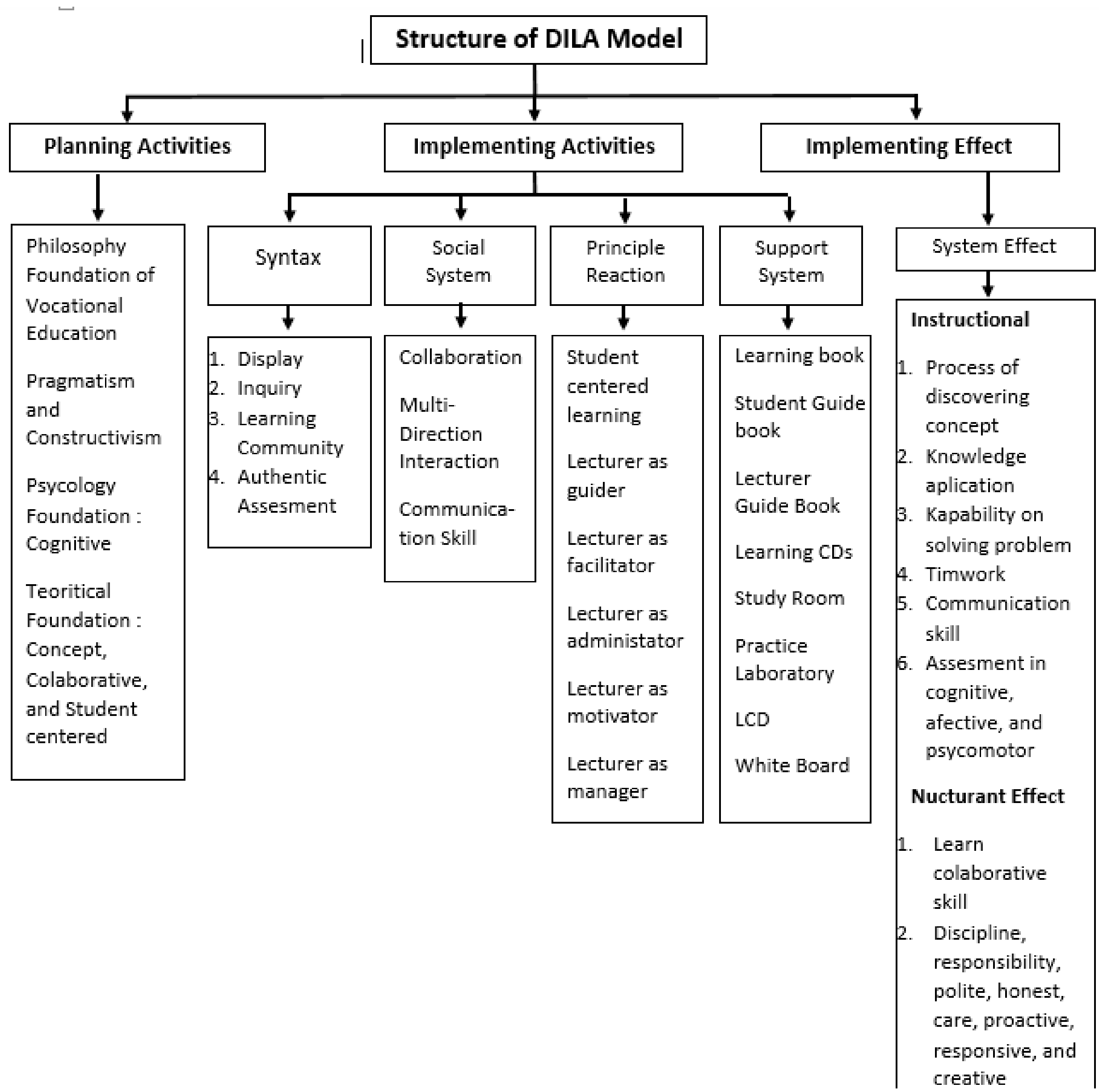

Figure 3. Hypothetical Model of the Development of CTL-based Learning Models

3.1 Philosophical Foundation

In vocational education, Miller (1994) recommend pragmatism as the most effective philosophy for education to work. Miller (1994) *advocates pragmatism as the most effective philosophy for education-for-work. He states that vocational educators have been successful in terms of practice and keeping current and relevant, by using principles of pragmatism as a frame-of-reference and basis for workplace education* [7]. He stated that vocational educators have succeeded in maintaining their practice and relevance, using the principle of pragmatism as a reference framework and basis for workplace education. Pragmatism, as defined by Miller, balances essentialism and existentialism philosophy and allows new ideas to be considered practiced (in their own philosophical framework). Pragmatism has been responsible for developing innovative programs such as technological preparation that enables vocational education to meet the needs of workplaces in the future.

The paradigm of Constructivism and Cybernetism is a philosophical foundation in the development of this DILA model. Constructivism is a fraction of cognitivism that focuses on developing the ability of students to build or construct their new knowledge through the thought process of synthesizing old and new knowledge and experiences. The leaders of this school are John Dewey, Jean Piaget, Maria Montessori, and Lev Vygotsky [8]. With the Inquiry and Learning Community syntax, it shows how the constructivism is carried out in DILA model. Inquiry makes students discover knowledge whether by conducting experiments or from guided questions by lecturers. At the Learning Community students in groups build knowledge by finding solutions to problems and planing project assignments as applications of knowledge that has been obtained.

This cybernetism assume that the human brain as actively processing information as well as information technology or computers, but humans actively seek not only passively accept. Students capture stimuli from their five senses, both in the form of objects, data, and events, then pay attention to or ignore, choose partially or accept it entirely, and make reactions by making responses. The leaders of this school are Hilda Taba and David Ausebel.

In the learning process, the teacher drawe attention of the students in order to make their mind, physical, and attitude are focused on the learning material that will be discussed. The readiness of students to learn is built as early as possible by linking the material to be discussed with the material that has been mastered by students and more focused on understanding rather than memorization.

3.2 Theoretical Basis

3.2.1Contextual

Contextuals have the meaning of "relating to context". Contextual teaching and learning are a learning concept that can help teachers associate the material they teach with real-world situations of students and encourage students to make connections between their knowledge and their application in their lives as family members and society [5].

The philosophy of contextual learning is derived in progressivism of John Dewey [5]. Progressivism combines theory with practice. The point is students will learn well if what they learn relates to what they know, and the learning process will be productive if students are actively involved in the learning process in school. Learning using a contextual approach will make it more meaningful for students.

Ausebel [9] states: Meaningful learning is a process of relating new information to relevant concepts contained in the cognitive structure of students. The learning process is not just memorizing concepts but also activities that connect concepts learned with learning experiences that have been obtained by students.

The standard of learning process according to Permenristekdikti No. 44 of 2015 article 11 states that the characteristics of the learning process are interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and student-centered. The contextual means that the learning outcomes of graduates are achieved through a learning process that is adjusted to the demands of the ability to solve problems in their expertise.

3.2.2Student Centered Learning

Harden and Crosby [10]: *Student–centred learning as focusing on the students' learning and 'what students do to achieve this, rather than what the teacher does. This definition emphasises the concept of the student 'doing'*. SCL focuses on student learning and what students do to get it compared to what the teacher does. This definition defines the concept of students doing something.

Student-centered states that the learning outcomes of graduates are achieved through a learning process that prioritizes creativity, capacity, personality, and student needs, and develops independence in seeking and finding knowledge (Permenristekdikti No. 44 of 2015 article 11).

3.2.3Collaborative

John Myers points out that the dictionary definitions of "collaboration", derived from its Latin root, focus on the process of working together. Collaborative learning advocates distrust structure and allow students more say if forming friendship and interest groups. Student talk is stressed as a means for working things out. Discovery and contextual approaches are used to teach interpersonal skills [11]. "Collaborative learning" is a general term for a variety of educational approaches that involve joint learning by students, or students and teachers. Usually, students work in two or more groups, seek mutual understanding, solutions, or meanings, or create a product so the key to collaboration is positive dependence, interaction, individual accountability and social skills. [12] [13] [14] Collaborative states that the achievement of graduates is achieved through a joint learning process that involves interaction between individual learners to produce a capitalization of attitudes, knowledge, and skills (Permenristekdikti No. 44 of 2015 article 11).

> Collaborative learning is in accordance with the zone of proximal development (ZPD) stated by Vygotsky: *"the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers"* [15].

Vygotsky describes the actual level of learning development of students and the next level that can be achieved through problem solving facilitated by adults or competent colleagues. The goals is that individuals learn their best when working with others, and through such collaborative efforts with people who are more skilled, so that the students learn and internalize new concepts, tools, and skills.

3.3 The Stucture of Learning Model

Based on rational and theoretical foundations that support the model, the DILA model was developed which was visualized through Figure 2 where the structure of this model refers to Joyce and Weil 1989.

3.3.1 Syntax

The CTL-based DILA model has a syntax with the following steps, namely; (1) Display, (2), Inquiry, (3), Learning Community, and (4), Authentic Assessment.

a. Display

Displaying here has the meaning of giving an overview of the material to be studied largely. At this stage lecturer present video about the application of materials related to the mining industry. Students observe the video and associate it with the material to be learned.

If we look at the theory of cognitive information processing [16], the memory consists of three parts: sensory buffer, working memory, and long-term memory. According to Mohammad Surya [17] the initial stages in this process are perceptions that make us detect perceptual stimuli by paying attention to them. A number of stimuli in the environment are obtained through hearing, vision or other sensing. This stimulus is then transferred in a process called storage. Then proceed with the pattern recognition process. The next step is the process of assignment of meaning, which is making decisions about giving meaning to stimuli by combining a number of existing knowledges.

This display is in line with the psychology flow of cybernetism. This flow views the human brain as actively processing information as well as information technology or computers, but humans actively seek not only passively accept. Students capture stimuli from their five senses, both in the form of objects, data, and events, then pay attention to or ignore, choose partially or accept it entirely, and make reactions by making responses.

The different communication media (videos, photos, texts, animations and tests feedback) help the construction and transformation of conceptual representations that are necessary in the Physics teaching-learning process [18]. *Most of the methods developed use computer technology and multimedia to give interactivity and visualization. The methods do improved students' performance and developed skill among students* [19]. From some research results, it shows that the presence of visual media, for example video can help students in constructing knowledge, representing concepts and improving skills.

b. Inquiry

Inquiry which means participating, or being involved, in asking questions, seeking information, and conducting investigations [20]. At this stage students discover the concept by conducting experiments or by answering questions from lecturers. The lecturer is the facilitator.

One of the five principles of improving the quality of learning by Merrill [21], namely the Integration Principle where learning must make students create, discover, or explore to use their new knowledge or skills. Schwab, 1965 in Joyce et.al [22] explains: invitations to inquiry: involve students in activities that allow them to follow and participate in logic/reasoning related to object research or methodological problems. Today's knowledge is science based on well-tested facts and concepts that we have today. Each lesson describes certain disciplinary concepts and methods. Providing examples of the process itself and involving student participation in the process will increase student understanding.

Inquiry as did Prophet Ibrahim AS in searching for his God (QS. Al An'am. 76-80) observed the existing phenomena and concluded. Inquiry is recommended in science learning by using examples of application in everyday life and exploring the phenomena freely so students will see the relevance of the material to the existing context [4] [15] [23].

c. Learning Community

Leo Smenovich Vygotsky, a Russian psychologist states that children's knowledge and understanding is sustained by the amount of communication with others [24]. At this stage, they seek application in a group according to activities in the mining industry. They can just do lab work or carry out project work to apply the lecture material that has been obtained. So that carrying out authentic tasks is one of constructivism approaches where students are active in carrying out tasks because learning is centered on itself and he himself also directs it [20] [18] [25].

d. Authentic Assessment

Assessment is the process of collecting various data and information that can provide an overview or guidance on student learning experiences. Authentic assessment is defined as a form of assessment that requires students to carry out real tasks that show meaningful application of an essential knowledge or skill [26]. At this stage lecturers assess students both cognitively through tests and assess psychomotor and affective through the rubric.

The DILA model is student centered learning so the assessment model that is considered appropriate for assessing the learning process is Authentic Assessment. Authentic Assessment consists of three basic activities, namely (1) the lecturer gives the assignment, (2) the student shows his performance, and (3) the lecturer with the student evaluates the performance based on certain indicators with an instrument called the rubric [1].

3.3.2 Principle of Reaction

This DILA model developed requires learning to be student-centered. Lecturers act as facilitators, motivators, administrators, managers, and conceptors.

3.3.3 Social System

The social system in this DILA Model is cooperation, multi-direction interaction, and communication skills.

3.3.4 Support System

The support system in this DILA model is the presence of learning materials for lecturers and students, guidebooks for lecturers, guidebooks for students, DILA model books and learning media in the form of CDs and practicum facilities available at the FT UNP Physics laboratory.

3.3.5 Implementation Impact

The DILA model is designed to train students to make discoveries based on observations and experiments as well as their application in accordance with their expertise. Creating teamwork to solve problems and obtain better results and sharpen communication skills both orally and in writing. Learning outcomes can be measured both cognitive and psychomotor so that students' abilities will be seen as a whole.

Nucturant effect seen from this model is the mastery of collaborative skills, whether in respecting people's opinions, issuing opinions so that attitudes will arise affective including discipline, responsibility, courtesy, honesty, caring, proactive, responsive and creative.

3.4 Product Validity

Development products are: DILA Learning Models, DILA Learning Model Books, Lecturer Guidebooks, Student Guidebooks, Learning Material Books and Applied Physics Learning CDs. All of these products have been tested for validity by several experts. There are 2 experts in Physics and 1 expert in vocational education and 1 expert in Learning Technology and 1 person in industry.

Table 1. Product Development Validation Results

No.	Instrument	Validation results (V)	Information
1.	Validation of the DILA Learning Model	0,81	Valid
2.	Validation of DILA Learning Model Book	0,875	Valid
3.	Lecturer Manual Validation	0,89	Valid
4.	Student Guide Validation	0,89	Valid
5.	Book Validation of Learning Materials	0,86	Valid
6.	Learning CD Validation	0,89	Valid

Several improvements were made to the product again in accordance with the validator's advice, such as: (1) giving an explanation of the syntax of DILA in the Lecturer and Student Guidebook, (2) improving the writing and layout of books, (3) presenting the material in accordance with the syntax of DILA, (4) revision of LKPD to XI, and (5) improvement of book covers.

Products developed in general have obtained a validity price of around 0.875, so that this product can be used in learning Applied Physics.

3.5 Limited Trial

The limited trial class consists of 7 D3 students from the 2017 class taking the Applied Physics course. Limited trials were conducted for 4 (four) meetings which took place from September 5-18, 2017. Each student was given a Student Handbook and a Learning CD. Supporting lecturers participated in following the implementation of this learning model trial. The results of product practicality in limited trials can be seen in table 1.

Table 2. Practicality Results of Limited Trial Classes

No.	Instrument	TCR results	Description
1.	Practicality of Learning Material Books	0,9	Very practical
2.	Practicality of Learning CD	0,89	Very practical
3.	The Usability of Student Guidebooks	0,87	Very practical
4.	Practicality of DILA Learning Model	0,89	Very practical

The practicality of the product is 0.887, so this product development is very practical to use. From the results of the product validity and practicality of the DILA model, the results of this study can already be tested on a broader scale, of course this requires further research.

The DILA learning model has a simple syntax and can produce meaningful learning because it is based on CTL. CTL motivates students to make relationships that express meaning. Alfred North Whitehead states "The child must make it (the ideas) their own and must understand its application in their real life situations at the same time" [5]. The idea of practice-based and professional education (P & PBE) is becoming a hot topic in higher education. Professional and practice-based education (P & PBE) prepares students for professional-oriented practices. It is always very challenging to introduce the P & PBE component in the teaching subjects of services in any academic field. In scientific subjects the P &

PBE component can be introduced as a practical class that fosters professionally oriented practice based on students' problem solving skills through an effective and collaborative learning environment [27].

Conclusion

The DILA learning model (Display Inquiry Learning Community and Authentic Assessment) to solve the problems regarding the learning of supporting subjects for special engineering students. Like learning Applied Physics, Applied Chemistry, and Applied Mathematics. Physics, chemistry and mathematics are the basic subjects for engineering science. Students have learning outcomes that are not satisfactory in this course because they do not see how it applies in their work.

The syntax contained in the DILA Model will guide learning to be student-centered and the overall assessment, not only in terms of cognitive, psychomotor and affective is also considered.

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