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# Impact of Learning Model Based on Cognitive Conflict toward Student's Conceptual Understanding

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**Abstract.** The problems that often occur in the learning of physics is a matter of misconception and low understanding of the concept. Misconceptions do not only happen to students, but also happen to college students and teachers. The existing learning model has not had much impact on improving conceptual understanding and remedial efforts of student misconception. This study aims to see the impact of cognitive-based learning model in improving conceptual understanding and remediating student misconceptions. The research method used is Design / Develop Research. The product developed is a cognitive conflict-based learning model along with its components. This article reports on product design results, validity tests, and practicality test. The study resulted in the design of cognitive conflict-based learning model with 4 learning syntaxes, namely (1) preconception activation, (2) presentation of cognitive conflict, (3) discovery of concepts & equations, (4) Reflection. The results of validity tests by some experts on aspects of content, didactic, appearance or language, indicate very valid criteria. Product trial results also show a very practical product to use. Based on pretest and posttest results, cognitive conflict-based learning models have a good impact on improving conceptual understanding and remediating misconceptions, especially in high-ability students.

## 1. Introduction

Problems of misconception and low understanding of concepts is a problem that many occur in the learning of physics. Various studies show that misconceptions occur on almost all physics topics. Wandersee, Mintzes, and Novak, 1994 [1] suggest that misconceptions occur in all areas of physics, as many as 700 studies of the conceptual, there are 300 examining the fields of mechanics, 159 on electricity, 70 about heat, optics, and properties material, 35 about earth and space and 10 researches on modern physics. Physical misconceptions also occur in every level of education of learners, even in teachers, such as elementary teachers [2,3] and high school teachers [4,5]. Various studies also reveal misconceptions that occur in prospective students [6-11]. Misconceptions that occur in prospective teachers, potentially spreading misconceptions to students later.

Many factors become the cause of misconception and low understanding of concept in student. Suparno [1] states that among them the cause of misconception is the learner's own factor, the educator factor, the textbook, the learning context and the teaching method by the educator. Learning



methods and models that do not involve learners in learning, such as lecture methods, tend to cause misconceptions. To address misconceptions, need interesting methods and learning strategies by associating topics with events. In addition, before starting a new topic, educators need to provide some sort of test to identify misconceptions on students. Some of the strategies that have been done to overcome misconceptions are teaching based on action research, teaching based on computer, and teaching based on real experiment video analysis [12]. Components of a fully integrated strategy or method will form a learning model. The development of learning model needs to be done to achieve the learning objectives, especially those that can overcome student misconception. This study aims to develop a cognitive conflict-based learning model and explore its impact on conceptual understanding and remediation of student misconceptions.

The learning model has five basic components [13], namely (1) syntax, is the sequence or operational steps of learning, (2) social system, describes the roles of educators and learners, hierarchical relationships and role-based rules (3) principles of reaction, is a picture of how teachers should see, treat, and respond to learners, (4) support system, ie all means, materials, tools, or learning environments that support learning, and (5) instructional & nurturant effects, is a learning outcome obtained directly based on the intended objectives and out-of-target learning outcomes. In this research, cognitive-based learning model is designed.

According to Lee, et al. (1) preliminary is done by presenting a cognitive conflict, (2) conflict is creation with the help of demonstration activities involving assimilation and accommodation process, and (3) resolution is discussion and concluding the discussion. While, Baser [2] states the implications of cognitive conflict learning are carried out as follows: (1) activation of alternative conceptions of students, (2) presentation of situations that cannot be explained by existing concepts, (3) creation of cognitive conflict with anomalous situations, (4) needs of the concep(5) students construct their own knowledge actively, (6) students interact with each other to share their ideas about the anomalous situation to find a solution, and (7) to know conception is helpful to solve the problem the same that may be faced in the future.

## 2. Methods

This type of research is Development Research or also called Design Research, is one of the research models to develop and validate the products developed to be feasible to use. Development / Design Research by Plomp [14] is: to design and develop interventions such as teaching and learning strategies, learning materials, products and systems as a solution to complex educational problems. This design / development research uses the development of the Plomp [14] model which consists of 3 stages. The first stage of preliminary research: to analyze needs and contexts, review the literature, develop a conceptual framework or theory for research. The second phase of development or prototyping phase: is an iterative design stage consisting of iterations, each becoming a micro-cycle research with formative evaluation as the most important research activity aimed at improving and refining the intervention. The third phase of the assessment phase, ie (Semi) summative evaluation to conclude whether the solution or intervention meets the specified specifications. This stage often leads to recommendations for improvement of interventions, also called summative semifinals.

This article reports on the second stage of development or prototyping phase, which includes the prototype design process, validity test and the practical test of one to one evaluation. The process of developing / designing educational research is conducted through a systematic cycle process, from analysis, design, evaluation activities and revisions done iteratively in order to achieve the right balance between the desire and the realization achieved.

The resulting product or prototype is a cognitive-based learning model along with its components including syntactic, social systems, reaction principles, support systems and instructional impacts and counterfeit impacts contained in the model book. Model support systems in the form of Syllabus (S), Lesson Plan (LP), and Student Jobsheet (SJ) are also the products in this study. Product validity test is done to some experts on didactic, content, appearance and language aspects. Furthermore, a limited

product trial was conducted through one-to-one evaluation of 9 sample students with low, medium and high ability from 3 different universities.

### 3. Result and Discussion

#### 3.1. Prototype Design

The prototype was designed based on preliminary research results, that the students still experienced misconceptions and low-concept understanding despite having taken the basic physics course [12]. Students are still separating between understanding concepts and physics equations. The existing learning model has not fully addressed the problem of conceptual understanding, especially misconception. For that purpose, it is designed a learning model that can overcome the problem of concept comprehension and student misconception. The learning model is designed to reveal the initial knowledge of the student before the learning begins, especially identifying common misconceptions. The model also comes with presentation of phenomena or events that can generate conflict and dissatisfaction in students' thinking, especially phenomena that counter their misconceptions.

Based on various analysis in preliminary research stage, such as requirement analysis, context, student and study of various literatures then designed prototype of cognitive conflict based learning model with 4 syntax as follows: 1. preconception activation, 2. presentation of cognitive conflict, 3. Discovery concepts and equations, and 4. Reflection. The prototypes of model support systems in the form of S, LP, SJ are also designed and constructed based on the syntax of cognitive conflict-based learning model.

#### 3.2. Test the validity of Prototype

Aspects of the validity assessment of the model prototype include the suitability of learning theories that support the model and the suitability and clarity of the model components, including syntax, social systems, reaction principles, support systems, instructional and nurturant effects. Assessment also includes the language and appearance aspects of the model book (MB).

The prototypes of model support systems (S, LP, SJ) are based on the syntax of the cognitive conflict learning model. Aspects of the syllabus's validity assessment include component conformity, syntax and language compatibility. Assessment of LP validity includes both syntax and language. Aspects of the assessment of the validity of the SJ include the suitability of components as well as the compatibility of syntax, content / content, appearance and language appropriateness.

Several revisions were made to the prototype according to the expert's suggestion in the areas of language, content, didactic and appearance to obtain valid product / prototype. Among the revisions were the use of punctuation and capital letters (cover), cover and lay out (appearance), allocation of learning time of each syntax (didactic), and revision of equations and images of physical phenomena (content). The validation of 8 experts on prototype can be seen in Table 1.

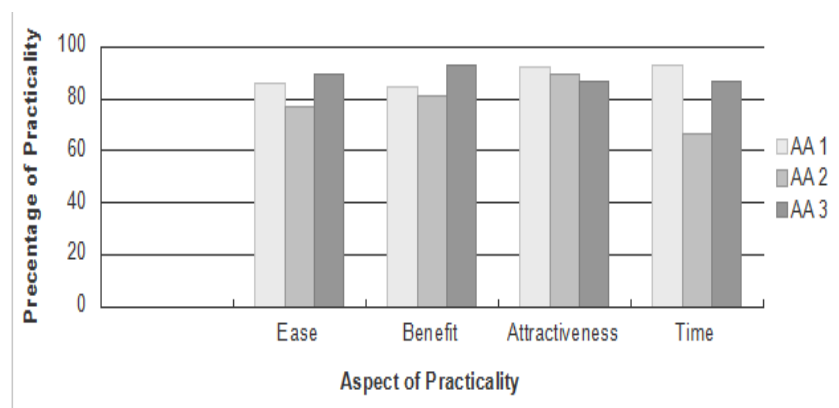
**Table 1.** Validity of prototype based on some expert review.

Expert Validator	Areas of Expertise	Percentage value of research product Validity			
		MB	S	LP	SJ
1	Appearance	80	82	85	82
2	Content	96	96	98	97
3	Content	86	78	85	83
4	Content	99	95	98	89
5	Didactic	89	86	90	87
6	Didactic	80	87	89	84
7	Didactic	85	82	82	82
8	Langaunge	90	93	93	94
Average		88	88	90	87

The validity value of the prototype cognitive conflict-based learning model and the support systems of the models (S, LP, and SJ) ranged from 88 to 90. The value is in a very valid category [15].

### 3.3. Practicality Test Prototype

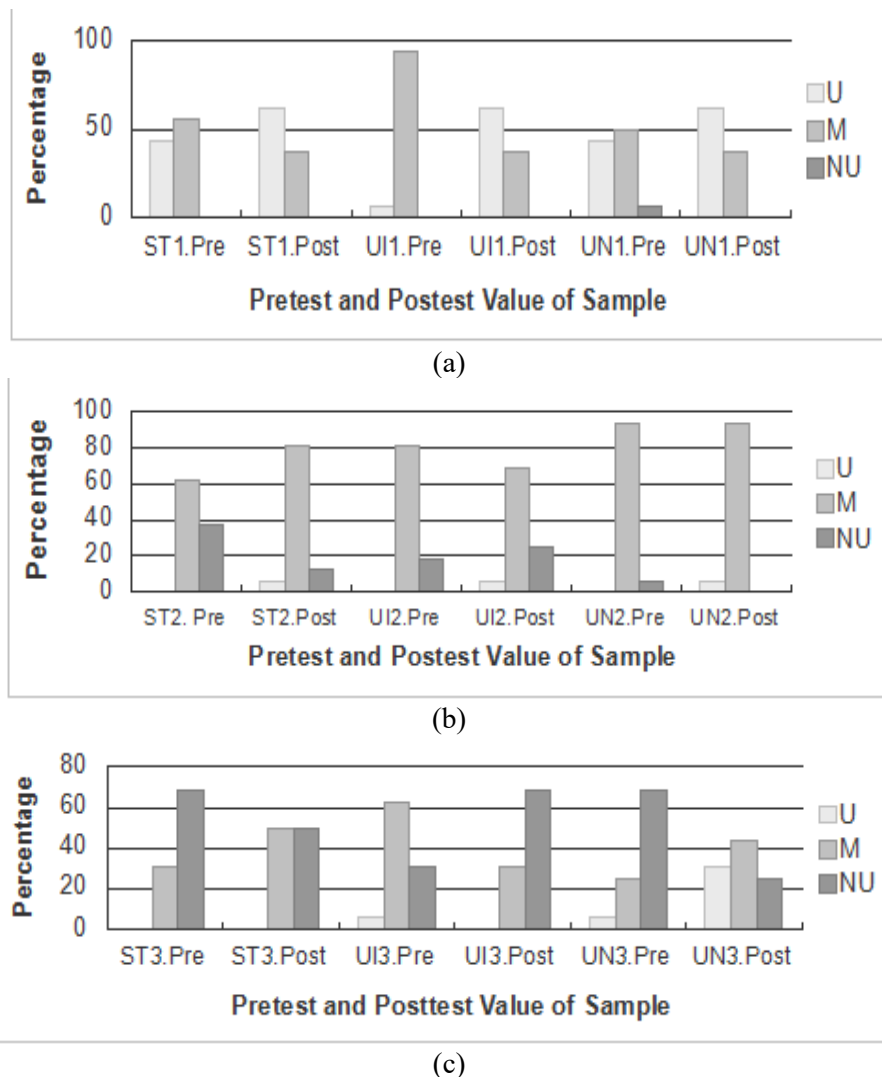
The practicality of the product / prototype JS is limited to one-to-one evaluation of 9 students, 3 students with low, medium and high ability from 3 different universities. Practicality assessment includes aspects of ease of understanding JS, benefits and appeal of JS as well as JS working time allocation. The average value of practicality is based on these four aspects by 9 student samples, ranging from 82. - 90, which is at very practical criteria. Through interviews, in general all of the samples stated that they understood JS easily in terms of language, either the workmanship or the content of JS. Based on the level of academic ability and type of college, the practicality of JS prototype can be seen in Figures 1. Figure 1. shows that sample with low-academic ability (AA3) are more comfortable with understanding SJ and feeling the benefits. However, SJ is more interesting and the time allocation of SJ work is more effectively felt by sample with high-academic ability (AA1). Students with medium ability to feel the working time of JS less effective.



**Figure 1.** Practicality of SJ based on Sample Academic Ability Level

### 3.4. Pretest and Posttest Results

The impact of the implementation of cognitive-based learning model on student concept understanding is seen from the comparison of pretest (Pre) and posttest (Post) results given to 9 sample students. There are three categories of level of understanding of concept that is understood concept (U), misconception (M) and not understand concept (NU). In Figure 2. (a) it can be seen that the three samples with high ability have increased concept comprehension and decreased the number of misconceptions after using JS. Some concepts are not understood (UN) students on pretest, become understand (U) on posttest. Most moderately moderate samples (Fig. 2.b) also experienced increased conceptual understanding and reduced misconceptions after using JS-based cognitive conflicts. Meanwhile, low-capacity samples (Fig. 2.c) have not partially shown a good impact on increasing conceptual understanding and reduced misconceptions. In general, from 9 samples of one-to-one evaluation, it was found that the application of cognitive conflict-based learning model through the use of JS had a positive impact on increasing conceptual understanding and decreasing misconception. This is because the cognitive conflict-based learning model has a syntax that has the potential to improve conceptual understanding and remediate student misconceptions.



**Figure 2.** Level of Understanding Concept of Students based on academic ability level: (a) high, (b) medium and (c) low.

The first syntax of 'preconception activation' functions for learners to understand their misconceptions and educators can identify difficult concepts and concepts that become misconceptions. In accordance with Ormrod's [16] opinion, among the general strategies that have been shown to have an impact in overcoming misconceptions, namely: identifying existing misconceptions before learning begins and convincing learners that their beliefs need to be revised. The second syntax of 'presentation of cognitive conflict' will lead to conflict and discontent in the minds of learners and they will be motivated to find the correct concept. Trumper, 1997 (in [17]); also stated that the first step required for conceptual change is to allow learners to recognize the need to change the initial concept and to feel dissatisfaction with an explanation based on prior knowledge. The third syntax of 'discovery of concepts and equations' provides an opportunity for learners to actively engage in experiments and discussions to discover concepts and equations that support the concept. As Carin [18] points out, some strategies in guiding learners to revise their misconceptions are: helping learners learn the right information to a meaningful level rather than just rote. In addition, focusing on a deep understanding of ideas is more important than teaching all topics but superficially. The fourth syntax of 'reflection' also plays an important role in conceptual change. Carin [18] also states that providing corrective feedback to learners about responses that reflect their misconceptions

including a strategy for revising misconceptions.

In addition, cognitive conflict or conceptual conflict strategies are consistent with the philosophy of constructivism theory, which allows learners to construct new concepts or knowledge. Educators do not monopolize learning by rushing to teach the content without paying attention to learners about their initial knowledge. Learners are given the opportunity to realize conceptual mistakes (misconceptions) that may occur in constructing new concepts, and presents cognitive conflicts for learners in getting a new concept right. Cognitive conflict strategies train learners to think deeply, discover and realize mistakes, discover and test ideas, and construct new concepts or knowledge.

#### 4. Conclusion

Cognitive conflict-based learning models have been designed and produced four syntaxes: (1) preconception activation, (2) presentation of cognitive conflict, (3) discovery of concepts and equations, (4) reflection; as an attempt to overcome the concept problem, especially the problem of misconception. The prototype of cognitive conflict-based learning model resides in very valid criteria through expert review process and very practical criteria through one-to-one evaluation limited test. In general, cognitive-based learning models have a good impact on improving conceptual understanding and remediating misconceptions, especially in students with high academic ability.

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