The application of multiple-choice in learning the doppler effect with PIMCA model

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Abstract. An important factor for the effectiveness of learning is an assessment factor for both the process and learning outcomes. Research has been carried out related to the use of multiple-choice assessment in the MR-SR based PIMCA (Presentation, Idea Mapping, Conceptualization, Assessment) learning model introduced and developed by Cosmas Poluakan. This study aims to determine the level of understanding of the physics concept of the Doppler effect with the PIMCA model. The research method uses concurrent mixed methods. The research stage began with a pre-test, followed by a PIMCA model treatment which was interspersed with interviews and ended with a post-test. The research was conducted at the Faculty of Mathematics and Natural Sciences, UNIMA, with 24 student teacher candidates as respondents. The research instrument used a multiple-choice model (MMC) with a written test technique. The results of data analysis obtained a pre-test score of 1.25 and a post-test score of 7.13. The results showed that using the PIMCA model using multiple-choice assessment can improve understanding of the concept of the Doppler effect physics material.

1. Introduction

The learning process greatly influences the evaluation of students, because one of the important factors for achieving educational goals is the learning process carried out, while one important factor for the effectiveness of learning is the evaluation factor both for the process and learning outcomes. The process of receiving stimuli between individuals differs according to internal and external factors [1]. In the process of learning physics, concepts and fact principles are not accepted in a procedural manner without understanding and reasoning, because physics is one of the natural sciences that is related to activities such as collecting data, measuring, calculating, analyzing, looking for relationships, connecting concepts, all of which are shown at one problem solving. Assessment is intended to collect various information about the learning process and outcomes in order to determine what needs to be done in learning. Popham defines formative assessment as a planned process in which evidence obtained from assessing student status is used by teachers to adjust ongoing learning procedures. Formative assessment provides students with specific, non-evaluative feedback in a timely manner which improves their performance [2]. There are various kinds of instruments in measuring learning outcomes, one of which is the multiple choice test. Well-designed multiple choice questions can be combined with other assessment methods to provide educational strategies as a form of enhancing the learning process and provide accurate and comprehensive evaluation of student performance [3]. In research that discusses
the form of multiple-choice questions followed by interviewing students, it can identify students' understanding of the concept of physics [4].

In Vygotsky's theory sharing and cooperation are encouraged, and the success of each individual is seen as a reflection of cultural success. For him, individual development results from his culture. Development, in Vygotsky's theory, applies primarily to mental development, such as thinking, language and reasoning processes [5]. Self-regulation refers to the level at which students are meta-cognitively active, motivated, and behave in their learning [6], which indicates a response and involvement in a process or experience, in the process of active, meta-cognitive active learner involvement. Metacognitive is the second order cognition, which is thinking about thinking, knowledge about knowledge or reflection on actions [7]. One of the main aspects of Vygotsky's theory is the idea that the potential for congenital development depends on the ZPD (Zone of Proximal Development): the level of development achieved when a child -children engage in social behavior. The full development of the ZPD depends on full social interaction. Vygotsky's insight regarding ZPD is that instruction and learning do not depend on development but instead pave the way for development to be followed. In Vygotsky's concept of ZPD, it is not only a formative assessment process that can be a part of ZPD but a teaching and learning process [8].

In learning physics, an understanding of the concept is needed, in this way it can make students better understand and arouse student learning activity, namely by using the PIMCA Model. The PIMCA learning model is a new learning model developed from MOMBI (The Model of Model-Base Instruction), MOMBI is a learning model consisting of lecturers' explanations of new concepts and skills, involving collaboration between lecturers and students individually, or in small groups focuses on achieving learning targets by providing skills training that is closely related to targets [9]. Based on the 5 steps of the MOMBI model, namely provocation, preconception, presentation, scaffolding and practice are introduced to the PIMCA Learning Model.

2. Methods
This research was conducted at the Faculty of Mathematics and Natural Sciences, Manado State University on 24 students for the 2020/2021 academic year. This research uses the PIMCA learning model introduced and was developed by Cosmas Poluakan consisting of Presentations, Idea Mapping, Conceptualization, and Assessment. The research stage began with a pre-test, followed by a PIMCA model treatment that was interspersed with interviews and ended with a post-test.

PIMCA (Presentation, Idea Mapping, Conceptualization and Assessment) learning model based on MR-SR. Multi Representative is a form of representation that combines text, real pictures, or graphics [10]. A problem that is considered to be complex and complex, can be simplified by using representations. Semiotic Resources is a cultural tool created by humans to represent and communicate meaning, or it can be said as the study of the study of signs. The PIMCA model consists of four stages starting with (1) presentation in the form of initial information through the presentation of various forms of representation, this stage is a combination of provocation steps and preconception of the MOMBI model; (2) Idea Mapping learners construct concepts and build conceptual relationships based on the information received from various forms of representation; (3) Conceptualization is the stage where learners receive information and are accompanied by instructions from the teacher or lecturer who functions as a resource or facilitator or tutor, so that the scaffolding function can take place. At this stage, the immature idea mapping is corrected and constructed into the correct concept so that no wrong concept is built; (3) The formative assessment at this stage ensures that the concept of knowledge constructed by the learners is correct [11].

3. Results and discussion
Analysis of the research data shows that there are several differences in student learning outcomes based on the use of the PIMCA Model in the learning process, which is differentiated by using the Pre-test and post-test in the form of Multiple-Choice. Where the pre-test average is 1.25 before the learning process
using the PIMCA Model is carried out while the average Post-Test is 7.13 after students get treatment using the PIMCA model in the learning process.

![Histogram](image1.png)

**Figure 1.** (a) Pre-test result histogram data, (b) Post-test result histogram data.

| Pair   | Mean | N  | Std. Deviation | Std. Error Mean |
|--------|------|----|----------------|-----------------|
| Pre-test | 1.25 | 24 | 3.068          | .626            |
| Post-test | 7.13 | 24 | 2.213          | .452            |

In the post-test, there is higher data than the pre-test so that the results of both experience significant changes and these results illustrate that using the PIMCA Model in the learning process can improve student understanding.

Based on the analysis of research data on prospective teacher students from the Department of Physics, State University of Manado for the 2020/2021 academic year, it shows that there are differences in student learning outcomes after using the PIMCA Model in the Learning Model, accompanied by direct interviews so that the conceptualization contained in the PIMCA model during the learning process is conveyed and well received by students so that the teacher or lecturer can conclude the understanding received by students, this shows the level of understanding of the concept in the Doppler effect physics material. With the pre-test and post-test, it can be seen the difference before and after the PIMCA model treatment is carried out on students, the increase in student learning outcomes can be seen in the average pretest 1.25 <Posttest 7.13 because of the difference in the average learning outcomes at the pretest and posttest. meaning that there is an effect of using the PIMCA learning model in increasing learning outcomes. In several studies related to improving learning outcomes and understanding the concept of physics of the Doppler effect material [12], the use of learning models other than the PIMCA model which uses multiple-choice assessment can also improve learning outcomes but it cannot be known about students' understanding of concepts.

**4. Conclusion**

The PIMCA learning model developed from MOMBI can improve learning outcomes and know the understanding of concepts from learners, especially in the PIMCA Model which uses formative assessment in the form of multiple choice questions.
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References
[1] Vygotsky L S 1980 Mind in society: The development of higher psychological processes (Harvard university press)
[2] Rosengrant D, Etkina E and Van Heuvelen A 2007 An overview of recent research on multiple representations AIP Conference Proceedings vol 883 (American Institute of Physics) pp 149–52
[3] Tololiu C, Poluakan C and Mongan S W 2019 Use of representation of unit vector semiotics through Cartesian coordinate
[4] Mondolang A H, Poluakan C and Mongan S W 2020 The use of teaching semiotic vectors in the introduction to physics Journal of Physics: Conference Series vol 1572 (IOP Publishing) p 12086
[5] Maba W 2017 Teacher’s Perception on the Implementation of the Assessment Process in 2013 Curriculum Int. J. Soc. Sci. Humanit. 1 1–9
[6] Popham W J 2011 What teachers need to know
[7] Brady A-M 2005 Assessment of learning with multiple-choice questions Nurse Educ. Pract. 5 238–42
[8] Schunk D H and Ertmer P A 2000 Self-regulation and academic learning: Self-efficacy enhancing interventions Handbook of self-regulation (Elsevier) pp 631–49
[9] Weinert F E and Kluwe R H 1987 Metacognition, motivation, and understanding
[10] Poluakan C 2019 Moldel Asement Formatif Kelas Berbasis Semiotic Resources dalam pembelajaran Fisika (Proposal Penelitian DPRM Kemenristrkdikti)
[11] Shabani K, Khatib M and Ebadi S 2010 Vygotsky’s zone of proximal development: Instructional implications and teachers’ professional development. English Lang. Teach. 3 237–48
[12] Susilawati G M Pengembangan Modul Praktikum Pembelajaran Abad ke-21 dengan Menggunakan Metode Project Based Learning Berbantuan Software Audacity untuk Meningkatkan Penguasaan Konsep Efek Doppler