Application of Test Instrument Designs for Momentum and Impuls In Achieving The Conceptual and Procedural Knowledge of High School Students

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ABSTRACT

This study aims to develop momentum and impulse material test instruments on the achievement of high school students' conceptual and procedural knowledge learning outcomes. The research method used in the design of test instruments is to determine the purpose of the test, compile the grid, choose the form of the test instrument, determine the length of the test instrument, validate the test and test the test to find out the test results. The test instrument was used to assess students' conceptual and procedural knowledge abilities on the material of momentum and impulses. The subject of the study was the test instrument. This research successfully developed a test instrument for momentum and impulse material on the achievement of learning outcomes of high school students' conceptual and procedural knowledge.

Keywords: instrument, test, conceptual, procedural

INTRODUCTION

Educational assessment standards state that the principles underlying the assessment of learning outcomes are valid, objective, fair, integrated, open, comprehensive and continuous, systematic, criteria-oriented, economic, accountable, and educative. These principles require questions included in a standardized test. (Minister of National Education, 2007; Minister of Education and Culture, 2013). Standard tests are tests where the questions have undergone a process of analysis both qualitatively and quantitatively (Puspendik Balitbang Depdiknas, 2007).

The assessment was carried out thoroughly covering cognitive, affective, and psychomotor aspects for each level of education. Thinking skills and cognitive learning outcomes are important for students in learning various subjects, including natural science (IPA) (Mahaputri, 2013; Sudijono, 2015). The dimension of one's knowledge is not only reflected in the results but also in the process that is carried out. This is in line with the demands of learning in the 2013 curriculum which is the current reference that not only prioritizes results but also looks at the thought processes put forward by students. However, each individual has the ability to receive, process and interpret different information according to their respective characteristics. This needs to be taken into consideration in learning activities (Amin, 2018; Lusiana, 2017; Adibah, 2015).

Learning concepts that are developing lately focus on active, cognitive, and constructive processes in meaningful learning. Learning (learner) is assumed to be

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an active actor in learning activities (Peter, 2015). Developing learning concepts are focused on active, cognitive, and constructive processes in meaningful learning. Learners are assumed to be active actors in learning activities; they choose information they will know when active in learning. The cognitive process dimension contains six categories, namely: remembering, understanding / undestanding, applying, analyzing, evaluating, and creating. Remembering is an attempt to retrieve knowledge from memory or memories that have been in the past, both those that have just been acquired and those that have long been obtained. Understanding is building an understanding from various sources such as messages, readings, and communication. Applying refers to the cognitive process of utilizing or using a procedure to carry out an experiment or solve a problem. Analyzing is solving a problem and looking for the relationship of each part. Evaluating with regard to cognitive processes provides assessments based on existing criteria and standards. Creating leads to the cognitive process of putting elements together to form a unity and directing students to produce a new product by organizing several elements into different forms or patterns from before, applying, analyzing, evaluating, and creating. The knowledge dimension contains four categories, namely factual, procedural, and metacognitive (Anderson, 2001).

Conceptual knowledge deals with classification, categories, principles, generalizations, theories, models and structures. Mastery of factual knowledge is characterized by the ability to classify data, group data based on similarities, or based on differences, show the strengths or weaknesses of a statement, recognize principles, infer, master theories, show examples, and recognize structures. Conceptual knowledge includes ideas (ideas) in a discipline that allows people to classify objects as examples or not examples, also classifies (categorizes) various objects. Conceptual knowledge includes principles (rules), laws, theorems or formulas that are interrelated and well-structured. Whereas procedural knowledge is knowledge about how to sequence steps in doing something. Procedural knowledge includes knowledge from general to specific and knowledge of specific methods and techniques and knowledge of criteria to determine the use of appropriate procedures (Anderson & Krathwohl, 2001). Procedural knowledge is not only seen from the skills and abilities of students in writing steps or sequences in solving problems, but they must also understand that the next completion step is the result of the previous stage. Students demonstrate procedural knowledge when they choose and implement procedures that are appropriate (Rafiq, 2018; Asmida, 2016; Rittle, 2015).

Until now many learning outcomes instruments have not met the requirements for a good test. One thing that might be the cause is the ability of teachers to make tests that are still low so that measurements become inaccurate. (Mardapi, 2011; Suwarto, 2009). The analysis of these items shows that the test instruments that have been used so far have not been standardized. The analysis conducted by the teacher still does not show independence and non-bias from the questions that have been tested. Therefore, we need a standard cognitive test instrument that can be generated through the stages of test development.

Based on the previous description, the purpose of this study is to develop a test instrument for one of the materials available in physics that is momentum and

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impulses on the achievement of students' conceptual and procedural learning outcomes according to Bloom's revised cognitive level. The results of this study are obtained test instruments for the material momentum and impulses on the achievement of conceptual and procedural learning outcomes of high school students who are good.

METHODS
Test Instrument Development Process

This product design is related to the new test instrument. This stage is carried out in accordance with the stages of test development. The initial step in developing tests is the preparation of test instrument specifications and question assembly. The preparation of the test instrument specifications consists of: Determine Test Objectives, The purpose of the test developed was to measure students' cognitive abilities at the cognitive level on the material momentum and impulses by analyzing KI and KD and SKL on the 2013 curriculum syllabus for momentum and impulse material. This is carried out to determine the competency requirements of the knowledge competency to be measured, namely conceptual and procedural knowledge. The basic competencies achieved in the material of momentum and impulse are applying the concepts of momentum and impulse, as well as the law of conservation of momentum in everyday life and presenting the results of testing the application of the law of conservation of momentum, for example a free falling ball to the floor and a simple rocket; Arranging the grid, the results of this analysis of KI and KD and SKL on the 2013 curriculum syllabus for momentum and impulse material are then used as the basis in determining indicators and instrument lines. Arranging the grid is done by filling in the specified grid components and inserting them into a grid format in the form of a matrix. Each graduate competency standard is developed into a question consisting of conceptual and procedural dimensions; Choosing the Form of Test Instrument, The form of standard cognitive test instrument developed is an objective test in the form of multiple choice (multiple choice) with five answer choices; and Determine the Length of the Test Instrument, the allocation of time is determined according to the need to achieve basic competencies and learning burdens. 1) Time available and 2) The nature of the material being tested is something that must be considered in determining the form of the test. The time used for completing multiple choice objective questions is 2 minutes for each test item. (Arikunto, 2017). The length of the developed test instrument was 20 items with an allocation of 40 minutes. After compiling the specifications of the test instrument proceed with the assembly of questions. Each item is written based on the formulation of indicators that have been compiled in the grid by paying attention to the rules of writing good multiple-choice questions in the form of question cards. The development of cognitive test instruments at this stage is called the initial product (Prototype 1).

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Table 1. Test Instrument Grid for Momentum and Impulse

No	Indicator	Category / Problem No.			
	Dimensions of Cognitive Process	*Understanding*	*Apply*	*Analysis*	*Evaluate*
	Dimension of Knowledge	Conceptual		Procedural	
1	Calculate the relationship of impulse and change in momentum given by the hitter with a certain mass and speed.	1			
2	Linking free-fall motion with impulses acting on an object to solve problems presented in the form of stories.	2			
3	Discover the application of the types of collisions in everyday life, find the types of collisions that occur in the event of the fall of objects to the surface of clay in everyday life.	3 4			
4	Determine the amount of impulse correctly		5		
5	Give examples of the application of the concept of the law of conservation of momentum in everyday life.		6		
6	Classify the value of the restitution coefficient according to the types of collisions.		7		
7	Analyzing the perfectly resilient collision to complete the ball's speed just after the collision.		8		
8	Identify the types of collisions that occur on objects presented in the form of images.			9	
9	Summing up the concept of impulse			10	
10	Summing up the concept of momentum			11	

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No	Indicator	Category / Problem No.			
	Dimensions of Cognitive Process	*Understanding*	*Apply*	*Analysis*	*Evaluate*
	Dimension of Knowledge	Conceptual		Procedural	
11	Infer the relationship of impulse and momentum			12	
12	Interpret the application of impulse and momentum theorems			13	
13	Determine the amount of impulse-momentum in the graph			14	
14	Determine the application of Newton's second law relationship with momentum in everyday life				15
15	Conclude the law of conservation of momentum				16
16	Interpret the concept of perfectly resilient collisions				17
17	Interpret the concept of partially resilient collisions				18
18	Interpreting the concept of collision is not resilient at all				19
19	Determine the relationship between the coefficient of restitution and one-dimensional collisions				20
	Number of Questions	**4**	**4**	**6**	**6**
	Total Questions	**20**			

Design Validation

Reviewing the items, At this stage, the items that have been made are examined in terms of the rules of writing multiple choice questions. The items that have been reviewed and are not in accordance with the rules, it is necessary to revise the items. This is done in order to produce good items before being tested. The study refers to 16 rules for writing questions developed by the Ministry of National Education (2008), which consist of material, construction, and language. 3 (three) validator has been examined by the items. The sheets of the rules for writing multiple choice form questions and test kits are given to the validator to assess the suitability of the items tested based on the rules for writing multiple choice form questions.

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Table 2. Assessment Characteristics

Assessment criteria	
Theory	Questions according to indicators
	The material in question is in accordance with the competency
	Homogeneous and logical answer choices
	There is only one answer key
Construction	The subject matter is formulated briefly, clearly, and firmly
	The formulation of the subject matter and choice of answers is a statement that is needed only
	The subject matter does not give clues to the answer key
	The subject of free questions and statements is double negative
	The choice of homogeneous and logical answers in terms of material
	Figures, graphs, tables, diagrams, or the like are clear and functional
	The length of the answer choices is relatively the same
	Answer choices do not use the statement "all of the answers above are true / correct" and the like
	Answer choices in the form of numbers / time are arranged in the order of the size of the numbers or chronology
	Item items do not depend on the answer to the previous question
Language	Use language that is in accordance with Indonesian language rules
	Use communicative language
	Do not use local / taboo language
	The answer choices do not repeat the same word / group of words, unless it is a unity of understanding

Analyzing the items, the trial results are then analyzed to find out the validity, reliability, level of difficulty, different power, and the effectiveness of the deception of each item made. At this stage, items will be determined which are worthy of acceptance, not worthy of acceptance, or must be corrected. The resulting question product is intended for the purpose of testing locally in class in the form of practice questions, daily tests, midterm tests, and end of semester tests. Therefore, the analysis of the data used refers to the quantitative analysis of reference norms (Kusaeri; Suprananto 2012).

RESULT & DISCUSSION

The reliability test results reached 0.763, which means the tests used already have a good rebility (Kara, 2015; Singh, 2016). At the level of difficulty, 8 items (40%) were obtained in the easy category, and 12 items (60%) were in the medium category. Thus the level of difficulty of cognitive learning achievement tests on the material momentum and impulses describe the level of difficulty of a range that is high, medium, and low (Lichtenberger, et al 2017). From the power of different problems obtained 9 items (45%) have excellent distinguishing power, .8 items (40%) have good differentiation, 1 item (5%) has poor distinguishing power, and 2 items (10%)) has a very poor distinguishing power. Thus, for tests of cognitive learning outcomes in the material momentum and impulses describe a good differentiating power if it has a point-biserial correlation coefficient ≥ 0.20 (Li &

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Singh, 2016). Based on the effectiveness of fraud, if calculated 5% of the 66 students is 3.3 which means that in this test a cheater is said to be effective if at least 3 students are chosen. The results of the recapitulation analysis of the deception effectiveness showed that 3 (15%) of the questions were not yet effective and 17 (85%) of the questions were effective.

Based on the data above, it is known that 17 items were accepted and 3 questions were rejected because they could not be used because they did not meet the validity criteria, the level of difficulty, distinguishing power, and good deception effectiveness.

Analysis of Students' Capability on Each Item of the Problem

The test that is tested on students aims to determine the ability of conceptual and procedural knowledge achieved by students. Questions that contain material on momentum and impulses consist of 20 questions. Each question consists of the ability to understand, apply, analyze and evaluate.

The research data shows that 50 out of 66 students answered the ability to understand correctly and 40 of 66 students answered the ability to apply correctly. That means students can do conceptual knowledge tests on the test well. While on procedural knowledge, 38 out of 66 students answered questions about ability to Analyze correctly and 41 of 66 students answered questions about ability to Evaluate correctly. That means, students can do procedural knowledge tests on tests well. Based on the description that has been described it can be concluded that conceptual knowledge is a comprehensive understanding of the concepts of momentum and impulse. The indicators of conceptual knowledge include: students can understand the concepts of momentum and impulses, students can mention the nature of the principle and the relationship between momentum and impulses, students can know examples of concepts, and students can express concepts using shapes and graphs. Whereas on procedural knowledge students can determine the steps needed to solve a problem, students can sort an action in solving a problem, students can use symbols and justify one way of solving a given problem (Star, 2012; Solso, 2008).

In solving problems (problems) conceptual and procedural knowledge is needed. Conceptual knowledge that is not supported by procedural knowledge will result in students having good intuition about a concept but students will not be able to solve a problem. On the other hand, procedural knowledge that is not supported by conceptual knowledge will result in students being able to manipulate symbols but not understand and know the meaning of these symbols. This shows students can give answers to an issue (problem) without understanding what they are doing. It is clear that conceptual understanding is needed in solving problems as well as the procedural understanding must be met in solving problems (Fiantika, 2017; Johson, 2012).

CONCLUSION

The product produced is a test instrument for momentum and impulse material on the achievement of high school students' conceptual and procedural learning outcomes. Products in the form of multiple choice objective tests with the level of

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distribution of questions starting at the level of ability to understand (C2), apply (C3), analyze (C4), and evaluate (C5). Based on the process of developing and analyzing test results data that have been done by the developer, the validation results can be concluded that the instrument has been valid and meets the criteria as a test instrument. From the test results of the test instruments for the material momentum and impulses on the achievement of conceptual and procedural learning outcomes of high school students who meet the instrument criteria that is feasible, in terms of qualitative analysis, the quality of the test questions is good with an average value of the general assessment by the validity test expert is 74.4 means that the test is valid with minor revisions. And in terms of quantitative analysis, the test instrument for the material momentum and impulses on the achievement of conceptual and procedural learning outcomes of high school students who meet the criteria of an appropriate instrument namely validity, reliability, level of difficulty, distinguishing power and effectiveness of deceivers. So it can be concluded / said that the test instrument is well used to find out the learning outcomes of students' conceptual and procedural knowledge.

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