



Instructional Materials for Discovery Learning with Cognitive Conflict Approach to Improve Vocational Students' Achievement

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The purpose of this study is to develop an instructional materials using discovery learning with cognitive conflict approach to improve vocational students understanding of heat concept. This instructional material was developed using the Four D model, namely define, design, develop, and disseminate. Furthermore, data were obtained from the syllabus, lesson plans, students' worksheet, learning material and conceptual understanding instruments in the form of multiple-choice question with the product categories validated by three experts. Data were collected by examining the achievement of the learning implementation and questionnaire responses of teachers and students that obtained very high practicality categories. Therefore, the instructional materials developed can be stated that feasible and practical to implement with a positive impact on students' conceptual understanding.

Keywords: instructional materials, discovery learning, cognitive conflict, heat concept, learning, vocational students

INTRODUCTION

The new paradigm in learning physics requires the design of innovative instructional material. Research on the development of the innovative instructional materials is a study that enhances the quality of existing learning tools in order to positively improve vocational high school students. These students come from a variety of different junior high schools to obtain diverse initial conceptions, such as the heat theory in physics.

Based on the preliminary study conducted at one of the vocational high schools in Mataram, it was found that students are generally interested in learning physics. However, innovative instructional materials to facilitate students understanding concepts

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are yet to be produced, thereby, leading to poor outcomes as seen in the minimum completeness which are still below average. Other researchers also included that at the vocational high school level there is often a failure in maximizing the quality of graduates due to lack of motivation and enthusiasm (Yang, 2015), use of outdated learning models (Kusumaningrum et al., 2016), and inability to implement the right learning materials (Emir, 2013).

This shows that student's physics learning outcomes are related to the inability to connect the ideas obtained at the junior high school level. In addition, the utilization of poor instructional materials, are less able to facilitate students understanding especially in the field of heat material (Baser, 2006).

Various innovations can be carried out to ameliorate the inconsistencies associated with this course one of which is by developing practical instructional materials, able to support practical activities and provide a flexible platform for students to express their ideas. Research about development of instructional materials for discovery learning model with cognitive conflict approach has been much carried out by other researchers (Baser, 2006; Tompo et al., 2016). So far, only instructional materials with discovery models or with cognitive conflict approaches alone have been developed (Madu & Orji, 2015; Yuliani & Saragih, 2015). This new discovery learning model combines both techniques. However, the shortcomings of the discovery learning model can be complemented by the advantages possessed by the cognitive conflict approach which encourages students to be more active in expressing ideas while evaluating their knowledge (Madu & Orji, 2015).

According to previous research, the development of instructional materials using discovery models improves students' understanding concepts (Rahmadani et al., 2017; Yusuf & Wulan, 2016), hone skills (In'am & Hajar, 2017), and improve problem solving abilities (Fuad et al., 2017). Acquiring knowledge with discovery learning model also influences the critical thinking abilities of students. Good learning requires students to use various learning resources in order to find (discover) concepts that are in a material (Gunawan et al., 2019).

The cognitive conflict approach was also summarized effective for enhancing understanding (Baser, 2006; Basir & Karmila, 2015), and high-level abilities (Suryadi et al., 2015). Its learning tools have also stated to have good validity and practicality level (Alabi et al., 2015). In addition, it slowly addresses and equates students' concept on the subject (Bose, 2015; Huang, 2008).

The purpose of this research is to develop instructional materials for discovery model with cognitive conflict approach consisting of the syllabus, lesson plans, student worksheet, and learning material. Furthermore, the study aims at testing these instructional materials to determine the practicality of the academic process based on the teachers and students responses, in accordance with understanding heat material concept.

CONTEXT AND REVIEW OF LITERATURE

Development research is used to create better quality instructional materials using models and cognitive conflict approaches. However, the discovery model is a set of learning activities that encourages students to actively determine perception through observation. According to Shah (2004), there are several procedures that must be implemented in teaching and learning activities in order to apply this method such as stimulation, problem statement, data collection, data processing, verification, and generalization.

Cognitive conflict is a set of learning activities that aim to turn students' misconceptions into scientific conceptions (Madu & Orji, 2015; Yuruk & Eroglu, 2016). According to Suparno (2005), these steps include: expressing students' initial notion explicitly, discussing and evaluate initial concepts, creating conceptual conflict against the original idea, and encouraging and directing students to restructure their theory. The learning steps obtained as a result of combining the model discovery and cognitive approaches are shown in Table 1 below.

Table 1
Steps of Discovery Learning Model with the Cognitive Conflict Approach

No.	Steps of the Discovery Learning Model	Steps of the Cognitive Conflict Approach
1	Stimulation	Reveal the initial concepts of students Discussing and evaluating the initial concepts
2	Problem Statement	Creating conceptual conflicts against the initial concept
3	Data Collection	
4	Data Processing	Energizing and directing students to restructure their concepts
5	Verification	
6	Generalization	

The application of an appropriate learning model must also be accompanied by a good understanding of students' conceptual understanding. Understanding the the concept is an understanding of abstraction or description of ideas that represent several objects, events, activities, or relationships with the same characteristics (Bilgin, et al., 2017). In Bloom's cognitive domain taxonomy in Prasetyarini (2013), conceptual understanding is divided into three aspects, namely translation (translating ability), in the form of the ability to change certain symbols without changing meanings, interpretation (ability to interpret), in the form of the ability to explain the meaning contained in a symbol (verbal and nonverbal), and extrapolation (ability to predict).

On the hot concept, there are still many difficulties found in achieving good students' understanding. In Alwan's (2011) it was found that many students had diverse notion of the heat material with difficulties in making connections between knowledge and everyday experience (Gonen et al., 2010), as well as between current learning and those previously gained (Daud et al., 2015), for proper interpretation and understanding. Thus learning capable of reducing the gap that occurs in students especially in heat material is required. Learning that requires students to actively find and build their own knowledge,

has been proven to increase student learning achievement (Wahyuni et al., 2019). Therefore, discovery-based learning that is supported by an appropriate approach and good instructional materials will greatly help students improve their learning achievement.

The description that the author has provided gives an insight into the importance of good instructional material. Based on this, we have provided a good solution to the problem of lack of student achievement. The solution is to develop instructional material for discovery learning with cognitive conflict approach. Its development requires a long process and provides good data to provide a more detailed understanding of student learning achievement.

METHOD

This research is a study that develops instructional materials using a discovery model with cognitive conflict approach on heat material. The products developed in this study consisted of the syllabus, lesson plans, students' worksheet, learning materials, and conceptual understanding instruments in the form of multiple choice questions. It adopted the instructional materials consisting by Four D Model (Thiagarajan et al., 1974) which comprises of define, design, develop, and disseminate stages.

Define

At this stage, a preliminary analysis consisting of literature and field studies was conducted by collecting various references to obtain information related to the instructional materials and its application.

Design

At this stage, answers are provided in line to the needs of the school in accordance to the learning tool and its application by selecting the instructional materials format to be developed and test standard to be utilized. The design made by researchers was of instructional materials by discovery model combined with cognitive conflict approaches.

Develop

At this stage, instructional materials were developed by discovery model with cognitive conflict approaches in order to enhance students' understanding of physics concept. It was also carry out to measure and analyze the level of achievement of learning implementation, teacher and student response, and learners understanding.

Disseminate

After implementing define, design, and develop stages, the disseminate phase was then carried out to publicize the results.

Instructional materials were applied in one of the Vocational Schools in Mataram. The application of this learning was practically carried out by a model teacher for three meetings in a class containing a total of 25 students. Data were collected through observation and teacher/student response to questionnaires. The results in the

observation and questionnaire sheets were then analyzed in percentage using the following formula.

$$\text{Practical Percentage} = \frac{\text{Total Score}}{\text{Max Score}} \times 100\%$$

Based on the percentage of practicality level obtained, the practicality criterion of the learning process is determined according to Table 2 below.

Table 2
Categories for Practicality

Practicality Range (%)	Practicality Level
0 – 20	Very low
21 – 40	Low
41 – 60	Sufficient
61 – 80	Height
81 – 100	Very High

(Source: Arikunto, 2013)

FINDINGS

Development of instructional materials using discovery model and cognitive conflict approaches have been validated by three expert lecturers. The researcher has also revised the product developed in accordance with the advice given by the expatriates. After revising the product, a test of the question instrument is carried out to obtain data on the level of validity, reliability, power difference, and difficulty of each item. Furthermore, a test was conducted to validate the obtained data using product moment correlation formula, Sperman Brown formula, different power test, and difficulty level use different power formula and discrimination index.

This study applies discovery model learning tools with conflict approaches that have been revised to obtain data on the practicality level of the learning process. Data was obtained from learning performance achievement by observers, teacher and learners responses to educational process, and student final grade data related to the level of understanding of their concepts. The results of the analysis of the achievement can be shown in Figure 1 below.

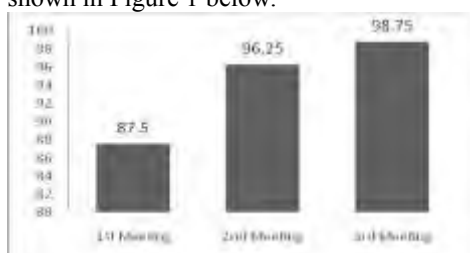


Figure 1
Percentage of Achievement of Learning Implementation

Based on the learning feasibility percentage in Figure 1, it can be seen that the first to

the third meeting was implemented in the range of 81% -100% which is in the very high categories.

The researcher also analyzed the data based on the results of the teacher's response and students' responses to the application of the developed tools. The result of the analysis is shown in Table 3 below.

Table 3
Percentage of Teacher Response and Students' Response

	Learning Process (%)	Learning Materials (%)	Students Worksheet (%)	Understanding the Concept Instrument (%)
Teacher Response	91.67	100.00	93.33	90.00
Students' Response	79.04	77.28	79.47	75.04
Average	85.36	88.64	86.40	82.52

Table 3 shows that the average teacher and student responses in all aspects are in the range between 81%-100%, and if based on Table 2, it is included in the very high practicality categories.

After the learning process was complete, the researcher also measures the level of understanding of students' concepts by giving them the opportunity to answer twenty-five multiple choice questions. Their final scores can be shown in Table 4 below.

Table 4
Students' Achievement

No.	Class	Number of Students	Average	Standard Deviation
1	X Bs2	25	89.44	9.37

Based on Table 4, it appears that the average value of class X Bs2 students is 89.44 with a standard deviation of 9.37. This shows that the learning tools applied have a positive impact on the level of understanding of students' ideas.

Table 5
Students' Achievement Based on Sub Material

	Students Achievement				
	Sub Materials I	Sub Materials II	Sub Materials III	Sub Materials IV	Sub Materials V
Total Score of Students'	113	111	112	108	115
Max Score	125	125	125	125	125
The Percentage (%)	90.40	88.80	89.60	86.40	92.00

Table 5, classifies student grades based on each heat sub material temperature, expansion, heat, Black principle, and heat transfer with its percentage range between 81%-100%. The value of students' conceptual comprehension based on Table 2, is classified as very high categories.

In addition to classifying the final grades of students based on sub-material, researchers also classify students' final grades in accordance with the cognitive levels shown in

Table 6 below.

Table 6
Students' Achievement Based on Cognitive Level

	Students' Achievement					
	C1	C2	C3	C4	C5	C6
	(4,11, 16)	(15,22, 23,25)	(1,2,6,12,13, 17,19,21)	(3,5,8,18 ,20)	(7,10, 14)	(9, 24)
Total Score of Students'	66	91	179	112	65	46
Max Score	75	100	200	125	75	50
The Percentage (%)	88,00	91.00	89.60	89.60	86.67	92.00

Table 6 shows the students' achievement of conceptual understanding classified per cognitive level consisting of C1, C2, C3, C4, C5, and C6. All gains range between 81%-100% with very high categories when based on Table 2.

DISCUSSION

Instructional materials using discovery model with cognitive conflict approach developed by the researcher had been validated. The results show a very high efficacy level of all components because each component developed was between 81%-100%. These results are reinforced by the statement of previous researchers that the validity level of instructional materials developed by discovery models is high (Rambe et al., 2018; Yuliani & Saragih, 2015) and good validity levels (Tompo et al., 2017).

During the validation process, there were suggestions given by improve the product being developed using the learning activities presented in the syllabus table. Based on the suggestions, the researcher revised by clarifying the steps involved in the syllabus according to the syntax of discovery using cognitive conflict approaches.

The next resolution is to enhance the developed lesson plan used in allocating time which was previously grouped based on preliminary, core and closing activities with revisions made based on each syntax. In addition, suggestions were made for operationalizing the learning steps to be more specific at the first, second, and third meeting which the researcher redesigned to be more operational and in accordance with the scenario or concrete steps taken during the learning process.

Suggestions for students' worksheet had been developed by researchers to improve the layout and systematic writing editor. Therefore, it was more operational and easier to understand. Learning material developed by researchers also received suggestions for improvement from expert validators revisions are made by completing each picture by including a reference to its sources.

The revision was also carried out on test instruments for understanding concepts developed by researchers. Suggestions from the validator were to simplify a few sentences on the same meaningful questions. In addition, a re-adjustment of the cognitive categories was also carried out on each question starting from C1 to C6 with the original answer choices (a, b, c, d, e) changed to those of the validator (A, B, C, D, E). In addition, the answer which was initially written vertically became horizontal and

quite short.

After the product has been revised, the test instruments are conducted so that the learning tools applied to one of the Vocational Schools in Mataram are in line with the syllabus of the meeting.

The implementation of learning in the first meeting was 87.50% which was lower than the second and third meeting which were 96.25% and 98.75% respectively. This is because the teachers of the model are increasingly accustomed to applying learning tools developed by researchers, thereby minimizing the various shortfalls inherent the system. The results obtained are in line with research from Prasetyana et al. (2015) who found that implementing a discovery model device was in the high category. Besides that Hartini et al. (2018) also found its model to be 89% practical. Similarly, Indiastuti (2016), study namely showed the instructional materials utilized to be practical.

In addition to analyzing the level of achievement in accordance with learning, the teachers and students responses to questionnaires related to product development applied in the classroom were examined. The results of student responses to the learning process, material, worksheet, and conceptual understanding instruments were between 75% -80%, which is quite good although not as high as the teacher's response percentage of above 90%. This was obtained because some learners were still relatively new to the model.

Based on the results analysis of the teacher and student responses to the learning process, the average percentage is between 81%-100% which is classified very high. The results obtained are in line with those obtained Allo et al. (2015) who argued that physics instructional materials had met the practical categories, thereby making it suitable for use in the classroom. Other researchers also stated that students gave a positive response to the knowledge acquisition techniques (Leung et al., 2018), with the response of teachers and students to the products in the very feasible a practical category (Wulandari et al., 2018). This makes learning more practical when applying the discovery models (Alabi et al., 2015).

When measuring the concept's level of understanding using 25 multiple choice questions, students also obtained a high final score from each sub-material and cognitive level. The highest heat transfer was 92.00%, while the lowest amounted to 86.40%. However, the difference in acquisition is included in the high categories because it is between 81%-100%.

The results of this study are reinforced by Dedonno (2016); Kunsting et al. (2013); and Kistner et al. (2016) which stated that the application of learning dominated by the discovery process would further enhance students' understanding of concepts. Other researchers also stated that instructional materials affect increasing significant understanding concept (Gunawan et al., 2018). Another study found that the implementation of cognitive conflict approaches in effective knowledge acquisition aids to enhance understanding of ideas (Baser, 2006; Basir & Karmila, 2015), and places students in high categories (Suryadi et al., 2015).

CONCLUSION

Based on the results and analysis conducted, it was found that the instructional materials using a discovery model with cognitive conflict approach developed a very high level of validity and practicality. In addition, it also has a positive impact on students' conceptual understanding, especially in heat material. Therefore, it can be concluded that this model is very feasible and practical to be applied in the classroom.

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