The implementation of direct instruction assisted by incomplete handout to increase conceptual understanding

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Abstract. Facing industry 4.0 in the world of education is the responsibility of the teacher in preparing students well. One of them is to build their understanding of learning at school. Mathematics as one of the subjects that always exists in every level of education is very helpful for students in developing systematic and critical thinking, this is in accordance with the needs of students in industrial age 4.0. However, mathematics also has sufficient conditions, namely the need for an understanding of mathematical concepts. The reality found in schools in this study is the understanding of students' low concepts. Therefore, this study aims to improve the understanding of students' concepts through the application of Direct Instruction assisted by incomplete handouts in the topic of composition and inverse function. The research model used is Class Action Research according to Pelton. The research subjects were 21 students of grade XI in one of the West Jakarta High Schools. The data sources used are observation sheets and test sheets. Based on the results of the data analysis, it can be concluded that the implementation of Direct Instruction assisted by Incomplete Handouts can improve students’ conceptual understanding.

1. Introduction

When students carry out mathematics learning activities, then there are two mathematical processes in them, namely 1) horizontal mathematical processes from the real world into symbols and 2) vertical mathematical processes on the mathematical system itself [1]. According to Gaebelein, "learning mathematics is reality, patterns, and God's regularity and understand and appreciate the beauty of shapes, regularity, and the accuracy of God's World" [2]. The point is that mathematics is not just learning the abstract content but how to see and study reality or events that occur in life as a manifestation of God's work that is so beautiful and orderly in His creation. This statement is supported and added by the opinion that says, "Mathematics is also consistent because God consistently holds every part of the universe in its place [2]. Mathematics is really a testimony to God's faithfulness and power ". Humans as inventors of mathematical sciences will not be able to formulate phenomena observed in mathematical formulas such as those that exist today if, the phenomenon moves dynamically. The existence of God's support for each of His creations, including the phenomena that occur in this world, enables humans to find mathematics because humans can only count something that moves consistently. So, mathematics is one of the works of God that He has cultivated at the moment of creation and man is only the inventor of that knowledge to be used in the daily life that we know to date in the form of symbols.
In addition to learning about the origin of mathematics, it turns out there are also mathematical processes that occur when students learn mathematics such as understanding concepts, solving problems and applying mathematics. Mathematics is abstract ideas given symbols, then mathematical concepts must be understood before manipulating symbols [1]. The importance of understanding mathematics is in line with the opinion synthesized by Mulligan & Mitchelmore and Hamzah that understanding mathematical concepts is very important because it is a learning goal of mathematics that is not only memorizing but students are able to define its own [3,4].

Based on the results of observations and data collected in class XI IPS 2, it was found that students still experienced problems in expressing the concept of cartesian products, relations, and functions by definition/symbol, unable to determine the nature of functions when presented in different representations, still not able to determine the domain of a function and the existence of errors in using algebraic operations. Another proof that supports this problem is the low results of the first quiz obtained by students, namely only 1 in 21 people who can reach the standard (> 71). From the data that has been collected, the researcher concludes that the main problem experienced by students is the low ability to understand concepts.

Direct Instruction is a learning model that emphasizes skills training and mastery of student concepts. Some of the advantages of Direct Instruction include: 1) can be used to emphasize important points, 2) is the most effective way to teach concepts and skills to students with low achievement, 3) can be a way to convey a lot of information in a relatively short time [5]. Direct Instruction ensuring students learn faster and more efficiently than any other program (NIFDI) [6]. “New teachers can learn about the power of Direct Instruction, and more children experience learning and success” [7]. Direct Instruction model is a solution that is taken to overcome the understanding of concepts in the research class. A research concluded that the application of the Direct Instruction model has a positive influence on improving concept understanding [8,9]. In addition, Direct Instruction which is based on behavioristic theory also focuses on mastering concepts [10]. This is reinforced by the advantages of Direct Instruction that supports the achievement of students' conceptual understanding. The handouts used are (incomplete) in order to provide space for students to process the content provided which is then poured in the blank part of the handout. A research also concluded that in addition to students having a positive response to handouts also its use was also practical for learning mathematics [11].

Beside the model of Direct Instruction there is a media who can help the student understanding, it is Incomplete Handout. Incomplete Handout can help students learn the material which completing the exercise. “Handouts which require learners to engage with them in some way are likely to be the most effective [12]. The steps of the Direct Instruction are carried out in several phases [13,14]. This research used 5 phases which assisted by Incomplete Handouts. There are orientation phase, presentation, structured training, guided practice and independent training. Based on discussions with mentors, consider the class conditions and the advantages possessed by Direct Instruction, it was decided to implement Direct Instruction as a solution to improve students' conceptual understanding along with Incomplete Handout to minimize the weaknesses of the actions taken.

2. Methods
The method used in research was Pelton Classroom Action Research (CAR). Class action research is how teachers design a very transparent learning model that allows measuring student achievement every day without having to wait for evaluations at the end of the semester [15]. This model uses 5 stages, namely issue identification, data collection, action planning, plan activation and outcome assessment: 1) Issue identification, identification starts from the teachers which have a feeling about something to investigate. It is also done to strengthen a number of problems that have been obtained; 2) Data collection, data is an important part of action research. Collect, organize and reflect data starting from the beginning of the study and proceed through a series of processes. The data used can be derived from the results of student quizzes, homework, notes, tests, question and answer, responses of each student and the results of teacher observations while teaching; 3) Action planning, the teacher must make a plan that addresses the problems identified in the first step. When planning is done, the teacher must reflect
on the problem by tracing expert opinion; 4) Plan activation, the stage where the teacher will start his actions based on the knowledge he has from the results of data analysis, explore best practices and develop plans that are possible to meet the student needs; 5) Outcome assessment, sources of data that have been collected.

In this research used two actions to see the success of conceptual understanding of the student. The subjects of this study were 21 students in one of West Jakarta High School with 5 students male and 16 female students. The study was conducted with two times the application of action. The data sources used were observation sheets and test. The action analysis in this study will be studied qualitatively and descriptively. Students are said to be complete on each indicator of the conceptual understanding if the proportion of students' correct answers more than 65% and classical completeness more than 85% [16].

3. Result and Discussion

3.1 direct instruction with incomplete handouts

From the graph overcome below, it can be seen that most of the Direct Instruction with Incomplete Handout have been carried out optimally, from the orientation, presentation, structured exercises, guided training, and independent training.

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Success chart for the implementation of Direct Instruction assisted by Incomplete Handouts

From Figure 1, it shows that the presentation stage of both the first and second actions only reached 66.67% where one of the activities in this stage did not get a review from mentor. Even so, it does not mean that researchers do not carry out this activity. The main reason for the mentor was not to give a checklist on the review activities because according to him the review did not need to be done when starting a new sub-section, but the researchers continued to review it because it was considered to contribute to strengthening students' understanding and preparing students for the new material. In line with this, Carl reveals that a review is used to remind the students of the content that has been studied before and most importantly, a review is a stepping stone for students in the learning they will experience [17]. Therefore, in both first and second actions, review activities are still carried out by maximizing the material design containing basic content related to subsequent learning. The guidance given in each
action is semi-independent so if students do not understand how to do the problem the teacher will help provide guidance through question and answer. So far both first and second actions, students have actively participated in learning.

As explained earlier that handouts become a media which help students in the learning process that is incomplete so that students must complete and work on the questions available in it. Based on the results of the analysis of the handouts both given in the first and second actions, it can be concluded that: 1) Students have completed the handout well. This can be seen from guided training and homework that has been done by students as much as possible even though there are some questions that are not equipped; 2) Handouts encourage students to write additional information explained by the teacher during the material presented. Fill in the information in the form of short formulas and concepts.

Incomplete Handouts in this study are accompanied by student reflections that must be filled out before being collected prior to the quiz. Student reflection is used to find out student constraints and learning evaluation. Broadly speaking, the implementation of incomplete handout-based Direct Instruction in the first and second actions was good and carried out in accordance with the planning that had been done before. The disadvantages are lack of time management so that the closing stage is almost non-existent because students have moving class so that they must be excluded from the class 2 minutes when the learning is complete. Another mistake is that researchers did not confirm the success of the action to the mentor. The impact is that the review stage in the first and second actions is always not strangled, this is what researchers and mentors need to discuss in order to make thoughts in line.

3.2 Conceptual understanding

Mathematics was created to represent a small part of God Himself which was later bestowed upon humans in the form of general revelation as a source of knowing Him. "Mathematics is really a testimony to God's existence" [18]. "Mathematics is an abstract science because sometimes people find mathematical results through observation and informal reasons, they will develop symbols to represent their conclusions" [19]. "Symbols contained in mathematics contain abstract ideas so that mathematical concepts must first be understood before manipulating these symbols [1]. So, it can be concluded that learning mathematics does not just stop knowing (C1), but needs understanding (C2) for the mathematical concepts themselves. The application of conceptual understanding has potential for influencing many areas of education. The term conceptual understanding was analyzed to determine how educators can help students attain understanding in a concept [20].

Conceptual understanding is an understanding of mathematical ideas as an integrated and functional system [21]. Conceptual understanding is competence in absorbing and understanding a concept accurately. “Students taught to develop a conceptual understanding of various domains will be more proficient at problem solving, generalizing their knowledge to new situations and more likely to make connections to related information” [22]. The meaningful learning is closely related to understanding the concept [23].

There are indicators of the conceptual understanding: a) restate a concept, b) classifying objects according to certain characteristics (according to the concept), c) give examples and non-examples of concepts, d) presenting concepts in various forms of mathematical representation, e) developing necessary conditions or requirements is quite a concept, f) using, utilizing and selecting certain procedures or operations, g) apply problem solving algorithms. But this research only use several indicators, it depends on the context and the condition of the school. Three indicators were used to measure students’ conceptual understanding in this research. The indicators are (a) restate a concept, (b) presenting concepts in various forms of mathematical representation and (c) apply problem solving algorithms [24].

Look at the Table 1., it can be seen the result of the data from each indicator which gained from the teaching experience.
Table 1. Indicator I, II and III of Conceptual Understanding

| Data | Indicator 1 (Restate a concept) | Indicator 2 (Presenting Concepts in Various Forms) | Indicator 3 (Apply Problem Solving Algorithms) |
|------|---------------------------------|-------------------------------------------------|-----------------------------------------------|
|      | Learning Objectives | Total of Students | %     | Learning Objectives | Total of Students | %     | Learning Objectives | Total of Students | %     |
| Pre-Action | Students are able to explain the conditions so that a function has an inverse | 3 | 14.28 | Students are able to distinguish the nature of the function | 12 | 57.14 | Students are able to use algebraic functions | 12 | 57.14 |
| Action I | Students are able to define the function of composition and its properties | 21 | 100 | Students are able to distinguish \((fog)(x)\) and \((gof)(x)\) through arrow diagrams | 17 | 80.95 | Students are able to operate functions with rules of composition functions and their values | 13 | 61.90 |
| Action II | Students are able to explain the conditions so that a function has an inverse | 19 | 90.47 | Students are able to determine function inverses through arrow diagrams and sequential pairs | 15 | 71.42 | Students are able to determine the inverse of a function | 18 | 85.71 |

The first indicator emphasizes how students explain the concepts that have been studied both by definition and to give examples of the concepts. The short data above shows a very significant increase in both the first and second actions. The average ability to define concepts in each action is very good, namely by emphasizing the main keywords in the concept even though the language used is still very simple. The making of questions should be more careful because it is not necessarily what the makers of the questions think can be perfectly understood by students. Therefore, the question on this indicator will be corrected for further action to see whether students are truly capable of this indicator if the question level is raised. The fact that is obtained in the second action is that 19 students can fulfill indicator 1 which is able to explain the concept definition and provide an example of the concept. This is one factor why there is a decrease in action 1 to action 2 of ± 9.53% or the equivalent of 2 students. Another factor is the level of difficulty of the material. Even though, it can be concluded that students have achieved this indicator very well.

The second indicator requires students to be able to present concepts into other representations such as ordered pairs, graphs or Venn diagrams. From the data above, it can be seen that after the first act, there was a considerable increase in pre-action which passed 12 students on this indicator to 17 students. Meanwhile, in the second action, there is still an increase if viewed from the action. Even though there is a decrease from the first action to the second action but the completeness of the students can be said to be good and reach the set standard as in indicator one. The things that make students' scores less than optimal in the first action are that some students pay less attention to the request so that the answers given are not full, some students do not understand the concept of sequential pair combinations so that errors place the domain and codomain based on given definitions and errors in drawing diagrams will produce the wrong combination value. In the second act, the things that make students' grades less than optimal are lack of understanding the range of a function. Overall, the student achievement in both actions has been good, namely reaching the specified completeness standard.

The third indicator contains 3 questions so that the completeness of each student will be taken from the number of points. In the first action, most students who did not get maximum points experienced obstacles such as 1) errors in operating the exponent algebra, 2) lack of understanding the concept of substitution in composition, 3) difficulties in finding polynomial function and 4) accuracy in algorithmic analysis. In the second act, most students experienced problems in completing the root inverse. Students'
algebraic manipulation skills are still low, this is in line with the obstacles that researchers found when students worked on the handout in the second act about the root inverse problem. Previously, students had been taught how to solve root forms but perhaps because of lack of practice in the form of these questions so that these constraints exist. The meeting for the second action is only one time face-to-face so the practice time is very limited. Overall, this indicator has improved well even though the first action has not yet reached the standard however.

| Table 2. The Total Average of Conceptual Understanding |
|-----------------------------|---------------|-------------|---------------|
| Indicator | Pre-Action | Action 1 | Action 2 |
| 1 | 14,28% | 100% | 90,47% |
| 2 | 57,14% | 80,95% | 71,42% |
| 3 | 57,14% | 61,90% | 85,71% |
| Average | 42,85% | 80,96% | 82,53% |

From the data above we can find that conceptual understanding of the students during the implementation of the action is quite high. The total average got 42,85% for the identification/pre-action, 80,96% for action 1 and 82,53% for action 2. From the data that has been presented and analyzed, it appears that there is an increase in students’ understanding in each indicator both first and second actions. It means that this research is in line with the research that has been done, that Direct Instruction with workplace can improve students’ understanding. Incomplete Handouts which used for this research also can increase the student activities [25]. For example, filling out an incomplete handout while listening to the explanation from the teacher and working on the same example in the picture that has been presented in the handout. Viewed from student handouts, there are some students who write additional information emphasized by the teacher, for example writing short / alternative formulas and adding new images as a solution to the problem being worked on.

4. Conclusion

Based on the data analysis of the research conducted, it can be concluded that: 1) The implementation of Direct Instruction assisted by Incomplete Handouts can improve the conceptual understanding of students grade XI in the composition and inverse function material in one of West Jakarta High School. 2) The implementation of Direct Instruction assisted by Incomplete Handouts can improve the conceptual understanding of students through orientation, presentation, structured exercises, guided practice, and independent training.

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