

The Development of Contextual based Direct Instruction Model for Improving Students' Mathematical Connections in *Pengantar Dasar Matematika* Course

Nurjanah

Doctoral Student of Department of Mathematics Education
Indonesia University of Education (UPI)
nurjannah@ini-itu.info

Abstract

This research was part of research and development processes with the objective to produce a learning model for improving students' mathematical connections in the *Pengantar Dasar Matematika* Course (PDM). The subjects of this research were first semester students of the Department of Mathematics Education, Nusantara Islamic University (Uninus) School of Education, in Bandung. In order to realize the objectives, the researcher employed the procedures based on Plomp (1997) which consisted of five steps as follows: 1) preliminary investigation, 2) design, 3) realization/construction, 4) test, evaluation, and revision, and 5) implementation. In the first phase, the researchers conducted an analysis on the problems. The second phase was intended to design the learning model. The third phase has resulted in the prototype 1 which was the contextual-based direct instruction model as developed previously in the second phase. The fourth phase consisted of two things as follows: validation and field implementation of the prototype 1. In the fifth phase, the model was implemented in real classroom setting. The product resulted in from this research was a contextual based direct instruction model intended for improving students' mathematical connection in PDM. The syntax of the model was the following five steps: orientation, presentation, guided practice, correction and feedback, and independent practice. The contextual approached embodied in this model was implemented through four strategies as follows: making meaningful connections, self-regulated learning, nurturing the individual, and reaching high standards. This model has been declared to be an effective, valid, and practical in nature.

Keywords: *Pengantar Dasar Matematika*, contextual based direct instruction, mathematical connections

INTRODUCTION

Background

The Introduction to Basic Mathematics course, named *Pengantar Dasar Matematika* (PDM) consists of three main topics as follows: elementary mathematical logics, introduction to set theory, and function relation. The course is provided in semester one with three credit hours. The PDM course has the objectives to provide students with necessary basic knowledge of reasoning and logics of mathematics that will be useful for further mathematics learning.

Based on the researcher experience teaching the course, PDM is not always easy to deliver by lecturer and being understood by students. According to an interview with

several students who take the course, PDM is difficult due to the following factors: high reasoning skill required to understand mathematical logics, abstract concepts underlying the development of set theory, and demand to acquire all mathematics branches. The last fact due to the facts that lecturers use examples and questions taken from other mathematics branches with the consideration that PDM (especially mathematics logics) is a tool or language of mathematics. This condition require lecturer to use a model or strategy of learning that can helps students improve their reasoning skills and at the same time understand the abstract concepts in easier ways.

In order to avoid the course of being overload, the researcher decided to use direct instruction and made many abstract concepts concrete and contextual. Meanwhile, in order to reach the objectives of improving the understanding on other mathematics branches, the researcher determined the mathematics competencies that will be developed with included mathematical connections.

Research Focus

This research was focused on combining of direct instruction and contextual teaching and learning in order to develop an alternative learning model called contextual base direct instruction.

Research Objective

The objective of this research is to produce an alternative of contextual based direct instruction model that can improve students' mathematical connection in the PDM course.

LITERATURE REVIEW

Direct Learning

Direct learning is a teacher centered model with focus on interaction between students and teachers. Direct learning model is difference to lecturing model; but the lecturing model can be implemented in direct learning model. Gersten et al (cited in Rosenshine, 2008) identified six main features of direct learning model as follows: 1) An explicit step-by-step strategy, 2) development of mastery at each step in the process, 3) teachers are given specific correction procedures to use when students make errors, 4) gradual fading of teacher direction as students move toward independent work, 5) use of adequate and systematic practice through a range of examples of the task, 6.) These are the cumulative review of newly learned concepts.

In general, the syntax of direct learning model consists of three main activities as follows: introduction, main presentation of the lesson, and practice. Rosneshine (as cited in Magliaro et al, 2005) elaborated that the syntax of direct learning model has six steps as follows: review, presentation, guided practice, corrections and feedback, independent practice, and weekly and monthly reviews. Meanwhile, Collins et al (2011) identified five steps in the syntax of direct learning model as follows: orientation, presentation, guided practice, correction and feedback, and independent practice.

In order to teach effectively, Rosenshine and Stevens (as cited in Rosenshine, 2008) suggested mathematics or others well-structured topics teachers to use the following patterns: 1) Begin a lesson with a short review of previous learning; 2) begin a lesson with a short statement of goals; 3) present new material in small steps, providing for student practice after each step.; 4) give clear and detailed instructions and explanations; 5) provide a high level of active practice for all students; 6) ask a large

number of questions; check for student understanding, and obtain responses from all students. 7) guide students during initial practice; 8) provide systematic feedback and corrections; 9) provide explicit instruction and practice for seatwork exercises and monitor students during seatwork.

Contextual Teaching and Learning

Contextual teaching and learning is a learning that connects actual events in real life situation experienced by students to the concept of science being discussed in classroom. A more elaborated definition of contextual learning provided by Bern and Erickson as follows: "Contextual teaching and learning is a conception of teaching and learning that helps teachers relate subject matter content to real world situations; and motivates students to make connections between knowledge and its applications to their lives as family members, citizens, and workers and engage in the hard work that learning requires." (Berns and Erickson, 2001:2).

Meanwhile, Johnson (2010) elaborated eight following strategies in contextual teaching and learning system: (1) making meaningful connections, (2) doing significant work, (3) self-regulated learning, (4) collaborating, (5) critical and creative thinking, (6) nurturing the individual (7) reaching high standards, (8) using authentic assessment.

Contextual teaching and learning has several advantages of which is as follows: Habituate students to relate between knowledge and its application to the various contexts of their lives, providing opportunities to students to develop based on their own potential, helping them to work effectively in a group, and helping the students to summarize and reflect the lesson. Meanwhile, the model has also disadvantages of which is as follows: it requires more time to implement and not all students are able to make adjustment and develop required skills using this contextual model.

Mathematical Connection

Schoenfeld (1992: 3-4) said, "The tools of mathematics are abstraction, symbolic representation, and symbolic manipulation. However, being trained in the use of these tools no more means that one thinks mathematically than knowing how to use shop tools makes one a craftsman. Learning to think mathematically means (a) developing a mathematical point of view-valuing the processes of mathematization and abstraction and having the prediction to apply them, and (b) developing competence with the tools of the trade, and using those tools in the service of the goal of understanding structure-mathematical sense-making."

According to Schoenfeld, mathematics instruction should start from simple activities that include real life context and use real materials if possible. The objectives of mathematics learning are to help students to reach abstraction skills, to manipulate symbolically, to reasoning deductively, and to apply knowledge into simple situation (simple modeling).

The bridge connecting real contexts and abstract concepts is mathematical connections that are expected to realize through contextual teaching learning (CTL). "When students connect mathematical ideas, their understanding is deeper and more lasting, and they come to view mathematics as a coherent whole. They see mathematical connections in the rich interplay among mathematical topics, in contexts that relate mathematics to other subjects, and in their own interests and experience. Through instruction that

emphasizes the interrelatedness of mathematical ideas, students learn not only mathematics but also about the utility of mathematics.”(NCTM, 2000).

Meanwhile, the indicators of *mathematical connection* used by researcher as determined by NCTM are as follows: 1) recognize and use connections among mathematical ideas; 2) understand how mathematical ideas interconnect and build on one another to produce a coherent whole; 3) recognize and apply mathematics in contexts outside of mathematics. Moreover, NCTM elaborates the indicators as follows: “Having students value mathematics because they can “see it” around them in other courses and in their everyday lives is probably one of the most valuable pieces of this standard. In addition, helping students to see the relationships between concepts within a course is also very influential for helping students to value mathematics. Making those connections between key concepts is fundamental to cognitive connections and deep learning.”

RESEARCH METHOD

In order to realize the objectives, the researcher employed the procedures based on Plomp (as cited in Rochmad, 2012) which consisted of five steps as follows: 1) preliminary investigation, 2) design, 3) realization/construction, 4) test, evaluation, and revision, and 5) implementation.

In the first phase, the researcher conducted an analysis on the problems included: identifying the position of PDM course in the curriculum of the Department of Mathematics Education and identifying students’ current condition in the course. In addition, the researcher also analyzed the materials of the course which included the following things: identifying, elaborating, and developing the concepts systematically in order to organize the learning materials. The results derived from the first phase can be used as the main consideration for conducting research and development on the second phase. The second phase was designing steps which included the following actions: designing the syntax of learning, designing the integration of direct learning and contextual approach, designing learning contexts (the role of lecturers and students’ activities in direct learning), and designing supporting system (classroom setting, learning tools, and assessment sheets, and facilities needed). The results of this phase were initial ideas and drafts.

As the continuation of the second phase, in the phase three, the researcher has successfully developed the prototype 1. It was a contextual based direct learning model consisted of components of model as elaborated in the second phase. The prototype 1 was then developed in the next phase. Meanwhile, the fourth phase was focused on two things: validation and field implementation of the prototype 1. The validation was conducted through workshop with experts, colleagues, and alumni who have taken the PDM course. After being validated, the model was then implemented in small class with limited learning topics and focus. Meanwhile, the fifth phase was real implementation step where PDM course learning was conducted using contextual based direct learning to students who take the PDM course.

Location and Subjects of the Research

The main objective of this research was to develop a valid, effective, and practical develop a contextual based learning model that will be used in PDM course in the Nusantara Islamic University. The subjects of the research were first semester students

of the Department of Mathematics Education, Nusantara Islamic University School of Education.

Instrument and Data Analysis

In order to develop a valid, effective, and practical contextual based direct learning model, the instruments employed in this research were as follows: guidelines for developing learning model design, validation forms, observation forms, and interview guidelines. The derived data were then analyzed using constant comparative analysis. This method provided opportunities to conduct analysis repeatedly according to the observed focus. In case of some parts interested to analyze, the analysis can be conducted repeatedly.

FINDINGS AND DISCUSSIONS

First Phase.

This is preliminary investigation phase where needs analysis was conducted. It included collection and analysis information, problem identification, and identification of further steps. In the first phase, the researcher conducted analysis on direct instruction and contextual approach, the position of PDM course in the curriculum, and the current condition of students who took the course. In addition, the researcher also analyzed the learning materials included identifying, elaborating, and developing systematic concepts for organizing the learning materials. The following table displays the research process in this phase.

Table 1
Preliminary investigation Phase

Analyzed Information	Problem Definition	Follow up Plan
PDM course position in the curriculum	PDM is a prerequisite course for taking the following courses: Number Theory, Calculus, Modern Algebra, Real Analysis; PDM is also prerequisite for taking teaching practice course with minimum grade C (6.0)	Commitment to reach high standard
Current condition of students who take the PDM course	First semester students are in transition phase from senior high school to university settings	Designing guided learning model with more individual learning components included
PDM materials	Logic mathematics requires higher reasoning and skillful in all mathematics branches. Set Theory provides abstracts concepts; and function-relation requires	Designing learning model that concrete the abstract concepts. Determining mathematical connections as competencies acquisition.

	ability in mathematics modeling and evidences.	
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As the result, considering those facts the researcher finally decided to develop a contextual based direct instruction model. It is an alternative of instruction model were expected can improve students' mathematical connection and also students' learning achievement in the PDM course.

Second Phase, design.

This second phase was intended to design solutions for problems identified in preliminary investigation. The process—generation of alternative (part) solutions, comparing and evaluating this alternatives, resulting in the choice of the most promising design or blue print for the solution—was displayed in the following table 2.

Table 2 Design Phase

Activities	Alternatives	Decisions
Designing learning syntax	Engelmann's Direct Instruction model, or Collinns five phases Direct Instruction	Five phases Direct Instruction: Orientation, Presentation, Guided practice, Corrections and feedback, Independent practice.
Integrating CTL and direct instruction	As syntax or strategy of learning	Integrating CTL as strategy of direct instruction
CTL strategy	Implementing the eight strategy of CTL or choose several strategies needed	Four components of CTL (making meaningful connections, self-regulated learning, nurturing the individual, reaching high standards) were chosen as contextual based direct instruction strategy
Designing learning context/setting	During the learning and teaching process; the lecturers: prepared students to learn, provided information steps by steps, planned and provided teaching, provided feedback, gave special attention to the implementation of the model by including more complex and real-life situation. Students activities were as follows: active participation in all learning activities, conducts practices, and provides feedbacks.	Students need guidance, but self-regulated learning were started to be given.

<p>Designing supporting system</p>	<p>Classroom setting: real-life situation or designed in order to provide additional supporting facilities</p> <p>Learning tools: already available module and practice guideline.</p> <p>Instruments: Guidelines for learning material development, validation form, mathematical connection form, student questionnaire responses, and interview guidelines.</p>	<p>No design for classroom</p> <p>Using already available module and practice guideline.</p> <p>Guidelines for learning material development, validation form, mathematical connection form, student questionnaire responses, and interview guidelines.</p>
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It should be explained in more detail hereinafter about the implementation of our strategies of CTL. Doing a meaningful connection, through learning material connection with situational context of daily life of the students, held on the phase of orientation and presentation. Self-regulated learning was implemented in the following steps: structured trainings, guided training, and independent training. Nurturing the individual was conducted by lecturers with considering and focusing on every steps and the students in every skill level. Reaching high standards was implemented early in the beginning of the learning in which students and lecturers agreed to the standards. Meanwhile, we decided to use classroom with white board and LCD Projector in addition to the learning facility.

Third Phase, realization/construction.

The results of second phase were ideas and initial drafts. As the continuation of the second phase, the third phase has resulted in prototype 1. This was a contextual based direct instruction model consisted of components of model that has been elaborated in previous phase. This prototype will be developed in the next phase.

Fourth Phase; test, evaluation and revision.

The fourth phase was focused on two things: validation and field implementation of the prototype 1. These activities were intended to find out the validity, effectiveness, and practicality of the model and learning tools that were being developed. The validation was conducted through workshop with experts, colleagues, and alumni who have taken the PDM course. After being validated, the model was then implemented in small class with limited learning topics and focus. The result found that the model and the instruments were effective, valid, and reliable to use in PDM course learning.

Fifth Phase, Implementation.

After being declared to be valid, effective, and practical, the model was then implemented in real classroom activities. They were first semester students of the Dept. of Mathematics Education, Nusantara Islamic University School of Education of the Academic Year 2013-2014.

During the learning process, all activities were documented and observed by observers. The learning was organized into an action research setting that include six cycles in which each cycle ended with formative test. In addition, students were also asked to fill in a questionnaire in order to elicit their views about the use of contextual based direct instruction in PDM course. The questionnaire was given in the last third meeting. The results derived from the fifth phase were studied by a researcher team and partners in order to improve the quality of the model and instrument of assessment.

CONCLUSION

1. The learning model resulted from this research was contextual based direct instruction model with five syntaxes and use four contextual strategies. The syntaxes are as follows: orientation, presentation, guided practice, correlation and feedback, and independent practice. The four strategies are as follows: Making meaningful connections, self-regulated learning, nurturing the individual, and reaching standards.
2. The learning model resulted in this research has gone through a test in order to determine its validation, effectiveness, and practicality.

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