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The Development of Student-cantered Learning Model Textbook to Teach Mathematics: A Preliminary Research

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ABSTRACT
This research is exploring the need of development of student-cantered learning model textbook to teach mathematics through Innovative Learning II course. This course is compulsory course for students of mathematics education study program. The paper focuses on the preliminary research of the three main phases in design research by Plomp that consists of needs and context analysis, review of literature, and development of a conceptual or theorical framework for the study. Referring to the curriculum of the mathematics education study program, Innovative Learning II course has been going on for several years, but the learning resources used by students from several separated sources and have not adapted to the latest yet. Also from questionnaire, about half of the students don't have textbook to assist their learning. The other half who had already have, felt that they need more features to assist their learning such as more explanation about discovery learning and inquiry, and printed textbook in Bahasa Indonesia. The development is one of step to facilitate students, so that the goal of constructing a pedagogical scientific foundation on student-centered learning models can be achieved since the availability of complete textbooks will make it easier for students to study these subjects. This textbook is expected can give clear explanation about models using student-centered approach by serving complete materials (from characteristics, the objectives, theorical underpinning, and assessment), also accompanied by sample of its application with valid, practical, and efficient criteria.

Keywords: *Development of textbook, Student-centered learning, Mathematics.*

1. INTRODUCTION

Rogers defined student-cantered learning (SCL) as an approach to learning, in which students have option, not only what to study but also how and why that topic might be of interest [1]. SCL is based on constructivism, which is built on the idea that students must construct and reconstruct knowledge to learn effectively, with learning being most effective when the students have experiences in constructing a meaningful product [2]. This approach is different from teacher-cantered learning (TCL) which is common widely applied in school, where teacher acts as a cesnter of learning and transfer knowledge to students. In SCL, teacher acts as facilitator and motivator rather than the only one learning sources [3].

In applying SCL, students need individualization, interaction, and integration [1]. Individualization is needed to ensure that students are encouraged to create their own activities and select their own authentic materials, then students interact through team learning and by teaching each other. Moffet & Wagner said that students integrate what they have learned with prior learning and construct new meaning in the learning process [1]. There are ten overlapping elements in SCL, i.e., students and teacher as co-learners, student-student interaction, learner autonomy, focus on meaning, curricular integration, diversity, thinking skills, alternative assessment, learning climate, and motivation [4].

SCL in classroom gives positive impacts, not only in learning achievement but also social skills, speaking, listening, logic and solving problems with experiential interaction [5]. SCL is similar to transformative learning that contemplates a qualitative change process in students as continuing transformation that focuses on students' enhancement and empowerment, develops their critical ability [2].

SCL can encourage deeper learning, so that increase students' motivation to learn, and since in SCL students must engage with the course material and are in control of their learning, it creates independence and responsibility in their own learning [2]. SCL reflects the reality of how students learn regardless of how teacher teach, also SCL focuses on lifelong learning, for instance on thinking skills, on diversity, and on student–student interaction, potentially empower students to shape better future [4]. Students who were taught with SCL approach agreed that the group work gave them motivation to learn mathematics and built their confidence in doing mathematics [6]. SCL in mathematics also exposes students to the application of concepts in and out of classroom, gives students freedom to ask or get answer from other members, lets students talk how to solve problems with others, and gives higher confidence to learn following lessons [7]. Therefore, SCL is suitable when applied in mathematics classroom.

Some learning models that are compatible with SCL in mathematics classroom are cooperative learning, problem-based learning, discovery learning, and project-based learning.

1.1. Cooperative Learning

Cooperative learning is a set of instructional strategies in which students work in mixed-ability groups to reach specific cognitive and social development objectives [8]. In addition to diversity of abilities, group arrangement, if possible, also varies in ethnicity, gender, background, and culture. This is because cooperative learning is designed and implemented with the aim of developing social strategies and social attitudes in students, as well as improving social relationships within and between groups [9] and developing mutual respect among students [10]. There are five main elements of cooperative learning: positive interdependence, face-to-face, individual accountability, social skills, and group processing [11]. Mathematics education offers specific opportunities for cooperative learning that makes cooperative learning in mathematics different from other domains, such as languages and world orientation, which the content of mathematics allows for specific models of cooperative learning in order to accommodate individual differences between students and mathematical problems can be situated in real-life contexts and designed in such a way that solutions can be reached along different routes and at different levels [9]. Other than the characteristics above, cooperative learning needs students to construct their knowledge by themselves [10]. This characteristic is suitable for mathematics learning to become meaningful for students, for example cooperative learning can be applied to teach triangle, quadrilateral, natural numbers, whole numbers concepts etc.

1.2. Problem-based Learning (PBL)

PBL is a learning approach that challenges students to learn through problem solving in which done by cooperatively in small groups [12]. Rather than looking for one single right answer, students interpret problem, collect needed information, identify possible solution, evaluate alternatives, and present conclusion as of PBL focuses on learning experiences through investigation and problem-solving [13]. Therefore, when PBL is applied in mathematics classroom, it enhances students' mathematical critical thinking ability [12] since PBL serves problems to be solved by students that activate students' thinking. Thus, PBL is compatible for learning that has objective is applying mathematics concepts for problem-solving [10].

1.3. Discovery Learning (DL)

DL organizes learning in such a way that students acquire new knowledge without direct teaching, with some or all of it discovered by the students themselves [14]. This model emphasizes the importance of helping students understand the structure or key ideas of a discipline, the need for active student involvement in the learning process, and a belief that true learning comes through personal discovery [10]. DL evokes students' curiosity, motivates them to work until they find answer, and since they must analyse and manipulate information, students also learn independent problem-solving and critical-thinking skills [15]. DL also serves learning process that gives an emphasis on the students optimally so that the objective in mathematics education can be achieved, for example in learning geometry [16].

1.4. Project-based Learning (PjBL)

PjBL is typically considered an approach to teaching in which students respond to real-world questions or challenges through an extended inquiry process [17]. The characteristics of PjBL are developing students' thinking skill, enabling creativity, encouraging student to collaborate, and directing students to access information by themselves and to demonstrate the information [18]. Furthermore, Park explained the characteristics of PjBL [13] are (1) using real world problem, (2) problem is used to directing learning; not for assessing skill, (3) using ill-structured problem, (4) students are given responsibility progressively, so that their independence increase, and (5) resulting independent students, life-long learners. The example of PjBL in mathematics classroom is shown in statistics, especially central tendency [19].

From the description above, it is clear that SCL is beneficial for students. But SCL not only give benefits to

students, but also teacher in connection to pre-service students. Attard, Iorio, Geven & Santa proposed that SCL gives a more interesting role for teacher, provides solutions to tackling massification and diversity, gives positive impact on working conditions, allows continuous self-improvements, increases learner motivation and engagement, and offers professional development for academia [2]. Willower, Eidell & Hoy in [20] said that the transition from TCL to SCL classroom management also gives transition in teacher's belief, from likely to be highly controlling, employing punitive sanctions, moralistic perceptions, highly impersonal relationships with students, attitude of general mistrust and a major focus on the maintenance of order to be more humanistic, likely to maintain a classroom climate that allows active interaction and communication, mutual respect, positive attitudes, and flexibility of rules, as well as student self-discipline, self-determination and independence are fostered.

Learning models using student-centered approach are studied in Innovative Learning II. This course is a continuation of the Innovative Learning I course which studies TCL models. The course is compulsory for all students of mathematics education study program. Referring to the curriculum of the mathematics education study program, Innovative Learning course has been going on for several years, but the learning resources used by students from several separated sources and have not adapted to the latest yet. Thus, it is necessary to develop Innovative Learning II textbook to assist students in mastering theory and then applying it in learning mathematics.

The development of Innovative Learning II textbook containing student-centered learning models will greatly assist students in the learning process of these subjects. The use of textbook in learning can improve mathematical problem-solving ability [21] and improve learning outcomes [22], also students gave positive responses to the satisfaction and usefulness [3]. Therefore, the development is one of step to facilitate students, so that the goal of constructing a pedagogical scientific foundation on student-centered learning models can be achieved since the availability of complete textbooks will make it easier for students to study these subjects.

2. METHODS

This study is using design research by Plomp that consists of three stages: preliminary research, prototyping phase, and assessment phase [23]. The discussion is restricted only in preliminary phase with activity description as explain in Table 1 as follows.

Table 1. Preliminary Research in This Paper

Phase	Details	Activity Description
Preliminary research	Needs and context analysis	The initial review of the need of textbook for Innovative Learning II containing SCL models based on teachers' experiences and questionnaire. Analysing the objectives and contents of Innovative Learning II course.
	Review of literature	Analysing theories and concept of the models, assessments, and examples of their applications in learning mathematics.
	Development of a conceptual or theorical framework for the study	Designing a conceptual framework and theorical framework for the development.

3. RESULTS AND DISCUSSION

3.1 The Need and Context Analysis

Innovative learning is one of the main assets for teachers to carry out their professional tasks. One of the characteristics of innovative learning in the 21st century is SCL. Innovative Learning II course which contains learning models using student-centered approach is one of the compulsory courses for students of the mathematics education study program. Based on teachers' experiences, Innovative Learning course has been going on for several years, but the learning resources used by students from several separated sources and have not adapted to the latest yet.

Besides, from seventy-one questionnaire responses from ninety-two students of mathematics education program academic year 2019 we got that majority of students (64.8%) thought that Innovative Learning II course is easy to understand. But, they found difficulties in their learning, such as (1) PBL is difficult since not all materials in mathematics are suitable for this model; (2) PBL needs authentic, complex, and contextual problems so that students needed more effort in creating them; (3) creating scheme of DL model is tough; (4) giving stimulation in DL model is not easy; (5) feeling puzzled in devising a plan in DL model that material can be understood well; (6) innovating learning, because when in class there will be definitely a different condition than as planned; (7) feeling confused in searching material or creating problem of inquiry (student felt that suitable problem for inquiry is limited); (8) inquiry need to be

discussed in depth; (9) having difficulty in distinguishing cooperative learning and DL; (10) hardship in gathering references for presentation and availability of valid references is limited. It implied the material is hard to understand; (11) even though every model has certain characteristic, choosing the right model for a certain subject and class condition for heterogenous class is complicated; (12) also, since every model is having similarity of each other, if students don't understand well, they will face puzzling situation in creating students' worksheet.

From the questionnaire, 73.2% felt that references were given by the teacher had helped them to understand the course. 52.1% didn't have textbook for Innovative Learning II and 82.9% of them felt like they need textbook to support their learning. The reasons students felt need textbook of Innovative Learning are (1) often student's notes were not complete so they need other reference, (2) textbook facilitates learning become easier and structured, (3) from references they searched; they found different syntax, (4) as reference to enhance knowledge and to confirm information from other sources, also to complete material from recommended reference, (5) as guide to learn before the teacher explain in class; so that students understand more, (6) sometimes it is difficult to find suitable reference and internet sources sometimes are not valid, and (7) easier to learn from printed book rather than e-book.

Other 47.9% who already have book used in Innovative Learning, told the way the book help students to understand the course i.e., (1) the book gives detail and clear explanation of definition, characteristics, and syntax so it helped students to understand a learning model but, sometimes one of the components is not described so students need other source; (2) not only contains syntax, but also classroom management and the assessment; (3) the contents of the book is complete, except DL and inquiry; (4) students prefer learning using printed textbook rather than power points or pdf file, since student can underline important or not yet known information then ask it when presentation time; and (5) need more time to understand material served in English and there is latest edition of the book. From this description although some students already have book to support Innovative Learning II course, they need more features to assist their learning such as more explanation about DL and inquiry and printed textbook in Bahasa Indonesia. Therefore, it is necessary to develop Innovative Learning II textbook to assist students in mastering theory and then applying it in learning mathematics. By considering the benefits of books that is being used by students, the development of the textbook will include it as reference to enrich the textbook of Innovative Learning II.

Based on the questionnaire responses above, some features that may help prospective mathematics teacher to design learning that support student-centered approach are providing tips or step-by-step in shifting mathematics classroom from TCL to SCL as described in [10] and serving samples of group task that can be applied in learning process. Terwel also gave suggestion in designing assignment based on philosophy of mathematics education, such as (1) starting point should be based on students' present experience and prior knowledge, (2) from the point towards the concept, structures, and methods in mathematics, (3) utilize rich contexts from real life situations and move forward to mathematical contexts, (4) design 'multi-ability assignments' that allow students from different levels to participate, and (5) assignments should be special designed for learning in cooperative groups [9].

The curriculum of the mathematics education study program explains the description of the Innovative Learning II course, i.e., studying the theoretical underpinning, stages, classroom management, and evaluation in cooperative learning models, scientific approach-oriented learning such as: problem-based learning, inquiry-discovery learning, and contextual learning accompanied by its implementation in learning through individual and group assignments with discussion and reflection. The objectives of the course are students be able to demonstrate theorical underpinning, syntax, classroom management, and its assessment of cooperative learning, scientific-oriented approach, such as PBL, inquiry-discovery, and contextual learning in designing, implementing, and evaluating mathematics learning; and students be able to design, implement, also evaluate learning process and cooperative learning, scientific-oriented approach, such as PBL, inquiry-discovery, and contextual learning materials using information and communication technology (ICT). Before the students can program Innovative Learning II, the have to take Innovative Learning I as prerequisite. Innovative Learning I discusses learning theories, theories about learning strategies, indicators, lesson plan, and supporting instruments. These materials then will be used in Innovative Learning II as students design, demonstrate, and evaluate learning process using learning models that compatible with SCL.

3.2 Review of Literature

In this review of literature, some literatures are based on references in semester learning plan and is added with some references that support the development of Innovative Learning II textbook. Furthermore, some references that will be used to develop the textbook are shown in the Table 2.

Table 2. References that will be used to develop the textbook

References	Cooperative Learning	PBL	DL	PjBL
Learning to Teach by Arends (2012/2015)	√	√	√	
Educational Psychology, Windows on Classrooms by P Eggen & D Kauchak (2016)	√	√		
Educational Psychology, Theory and Practice by R E Slavin (2017)	√			√
Project-Based Learning (PBL) In Practise: Active Teachers' Views of Its' Advantages and Challenges by M. Aksela dan O. Haatainen (2019)				√
Project-Based Learning by Stivers (2010)				√
The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students by Nizwardi (2017)				√
Materi Pelatihan Guru Implementasi Kurikulum 2013 Kemendikbud (2014)				√

Besides using the references above, we will use relevant articles to support the development to make the textbook more comprehensive.

3.3 Development of A Conceptual or Theorical Framework for the Study

This textbook that will be developed in the research are materials of each learning model, i.e., the characteristics, the objectives, theorical underpinning, management of learning which includes planning and implementation, and its assessment, accompanied by sample of its application in learning mathematics so that students will easily apply it to teach mathematics of cooperative learning, PBL, DL, and PjBL with valid, practical, and efficient criteria.

4. CONCLUSION

Based on the preliminary research, it is necessary to develop Innovative Learning II textbook since the resources using now is separated and outdated. Also from questionnaire, about half of the students don't have textbook to assist their learning. The other half who had already have, felt that they need more features to assist their learning such as more explanation about DL and inquiry, and printed textbook in Bahasa Indonesia. This textbook is expected can give clear explanation about models using SCL approach by serving complete material (from characteristics, the objectives, theorical underpinning, and assessment), also accompanied by sample of its application with valid, practical, and efficient criteria.

AUTHORS' CONTRIBUTIONS

All authors discussed the research design. Pradnyo Wijayanti: data analysis, reviewing and editing the manuscript. Nina Rinda Prihartiwi: data analysis, drafting manuscript. Mega Teguh Budiarto: reviewing and editing the manuscript. Ismail: reviewing and editing the manuscript. Ika kurniasari: drafting the manuscript, proofreading.

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