Journal of Physics: Conference Series

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To cite this article: Yerizon *et al* 2018 *J. Phys.: Conf. Ser.* **948** 012045

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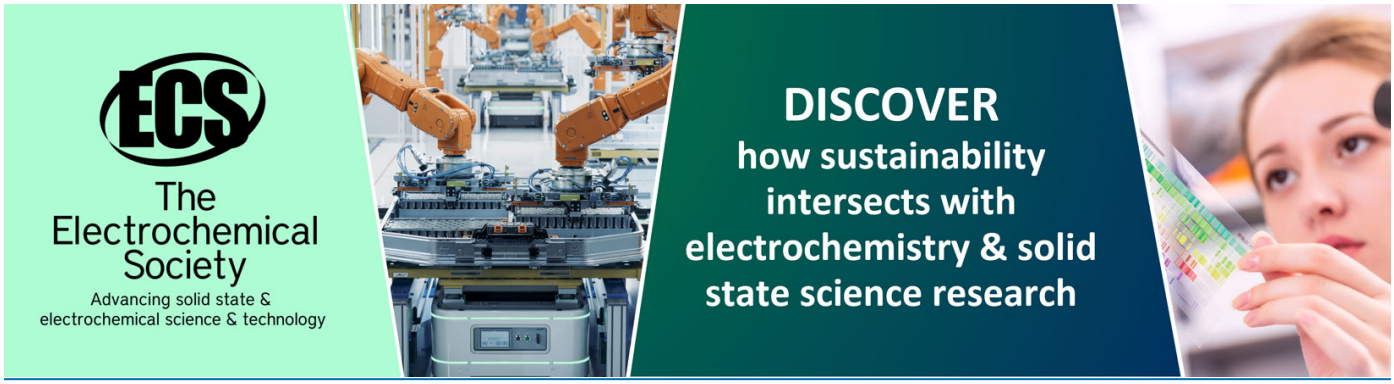

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IOP Conf. Series: Journal of Physics: Conf. Series **948** (2018) 012045 doi:10.1088/1742-6596/948/1/012045

Developing learning material of introduction to operation research course based on problem-based learning

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Abstract. Students have difficulties experience in the course Introduction to Operational Research (PRO). The purpose of this study is to analyze the requirement of students in the developing lecturing materials PRO based Problem Based Learning which is valid, practice, and effective. Lecture materials are developed based on Plomp's model. The development process of this device consists of 3 phases: front-end analysis/preliminary research, development/prototype phase and assessment phase. Preliminary analysis was obtained by observation and interview. From the research, it is found that students need the student's worksheet (LKM) for several reasons: 1) no LKM available, 2) presentation of subject not yet based on real problem, 3) experiencing difficulties from current learning source.

1. Introduction

Introduction to Research Operations is a compulsory course for students of Mathematics Education Program. One of the materials discussed is the Linear Programming. Linear programming is a mathematical method for allocating limited resources to achieve a goal such as maximizing profits and minimizing costs. Linear programming is widely applied in economic, industrial, military, social and other issues. The basic concept of linear programming has existed at the elementary level of education, which begins the introduction of the symbol of numbers represented by images of objects around us, then addition, subtraction, multiplication and comparing the number of objects. In Junior High School level, its concept is expanded through the Linear Equation System One Variable (SPLSV), then enhanced through the material of Linear Equations System Two Variable (SPLDV), and then in High School (SMA) they have been introduced the system of linear inequality and specific material of linear programming problem that presents everyday problems, and translates the problem into the mathematical model, solves the inequality system which is constraint or limiting, determining the optimum solution, answering the problem.

The method which is used is a graphical method using the point vertices test and the line of sight. At the university level, there is a special course of linear programming that discusses the method of completion of a linear programming whose goal is to maximize profits and minimize the costs. The methods given at the university are graphical methods, simplex methods, dual analytical methods, transportation methods.

However, students have difficulties in understanding the method. The main difficulty of students is to change the real problem into the mathematical model. They also difficult in making verbal

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representations into mathematical notations or models. This ability is called the ability of mathematical communication. One of the suitable ways to overcome this problem is developing lectures of Introduction to Research Operations course using Problem Based Learning approach for students in improving student's mathematical communication skills. This paper will reveal the difficulties experienced by students in the course of Introduction to Research Operations. This is a preliminary study in order to develop subject matter tools Introduction to Linear Programming based on Problem Based Learning which is valid and effective to improve students' understanding.

Problem Based Learning (PBL) is a learning model which is oriented to problem-solving. According to [1], PBL is a series of learning activities that emphasize the process of solving problems scientifically. Arends [2] states that PBL consists of presenting an authentic and meaningful situational problem to students that can be used as a springboard for investigation and discovery. Furthermore, Wena [3] tells that problem-based learning strategy or PBL is a learning strategy that begins by giving problems to the students, and then they learn through the problems given. In implementing the PBL, the teacher must be able to choose the learning material that contains problems that will be solved by the students. The selection of problem should come from the student's environment. PBLs can also be applied to develop students' thinking skills such as: the ability to analyze situations, apply their knowledge to new situations, recognize differences between facts and opinions, develop their ability to write a hypothesis objectively and problem-solving skills

Savoie and Hughes [3] tell that the PBL learning model has several characteristics: (1) Learning begins with a problem; (2) The given problem must have related to the real world of the students; (3) Organize learning around issues, not around disciplines; (4) Give great responsibility in forming and running their own learning process directly; (5) Using small groups; and (6) Prosecute students to demonstrate what they have learned in the terms of products and performance. In line with that, Sanjaya [1] suggests that there are three main characteristics of PBL are (1) PBL is a series of learning activities, which on the learning process students will carry out activities that are the learning stages of PBL. PBL does not expect students to just listen, record, and then memorize the subject matter, but through this PBL, students will actively think, communicate, search and process data, and finally conclude it; (2) Learning activities are directed to solve the given problem. PBLs place the problem as the focus of learning to determine the solutions; and (3) Problem-solving is done by using scientific thinking approach. The thinking process is done systematically and empirically. Systematic means scientific thinking is done through the stages that have been determined, while empirical means the process of problem-solving is based on facts and clear data. According to Rusman [4] the characteristics of PBL learning are (1) the problem becomes a starting point in learning; (2) the chosen problem is the unstructured real world; (3) problems require multiple perspectives; (4) problems, challenging learners' knowledge, attitudes, and competencies that require the identification of learning needs and new areas of learning; (5) learning self-direction becomes the main thing; (6) the utilization of diverse sources of knowledge, their use, and the evaluation of information resources is an essential process in the learning process; (7) learning is collaborative, communication and cooperative; (8) the development of inquiry skills and problem-solving is just as important as mastering the content of knowledge to find solutions to a problem; (9) the openness of processes in the learning process includes the synthesis and integration of a learning process; and (10) learning process involves evaluating and reviewing learners' experiences and learning processes.

The advantages of PBL Liu [4] are: (1) students are encouraged to have problem-solving skills in real situations, (2) students have the ability to build their own knowledge through learning activities, (3) students accustomed to using the resources (4) studens have the ability to assess their own learning progress, (5) students have the ability to communicate in the discussion activities or presentation of their work results, and (6) Learning difficulties of students individually can be overcome through group work in the form of peer teaching.

From the results of previous research indicating that PBL can improve students' mathematical ability, Rokhmawati [5], Supriyatin [13], and Prawiro [9] found that learning of PBL can improve problem-solving ability and self-efficacy of student. Kazemi [10] found that PBL learning helps reduce student misconceptions about mathematics. The results of Uzel's study [8] Padmavathy [11] show that the achievement and attitude of prospective teachers who study with PBL are significantly

better than prospective teachers who learn with traditional learning. Novikasari [12] and Supraptinah [13] reports that prospective elementary school teachers who are studying with PBL have better mathematical content knowledge than prospective elementary teachers who are learning with conventional learning.

2. Methods

The type of this research is the *development research* that is used to develop a student worksheet product. Development research is research used to produce a particular product, and test the effectiveness of these products. The purposes of development research according to [14] are: (1) Better the understanding of the implementation problems of the teachers; (2) Development of prototypical project intervention (training, material, support), Including empiric evidences of Reviews their quality; (3) Generating methodological direction for the design and evaluation of such products or intervention; and (4) Increased (both individual and collective) expertise of the various participant

The first phase is Development and Prototyping Phase. In this phase self-evaluation and expert reviews to examine the validity of the worksheet that has been designed. Self-evaluation is to evaluate its own prototype that has been designed. From the evaluation results, it revised. Once the prototype is believed to be good, and as expected, the next stage is expert reviews. Revision continues until the worksheet is valid. If the worksheet is valid then it followed by one-to-one evaluation. Evaluation of individuals does by asking the three students who provide commentary on the worksheet. Based on the evaluation, revision held to the worksheet. After the worksheet was revised based on feedback on a one-to-one evaluation, it tryout to small group. This tryout is performed on conditions similar to actual conditions. Field trials conducted to look at the practicalities of the worksheet that have been designed. Practicalities of the worksheet are the level of used of the worksheet by the user. Practicalities can be seen during the implementation of learning through observation, interviews and questionnaires.

The second development phase is the assessment phase. In the assessment phase, we tested the effectiveness of the worksheet. The effectiveness of a product means a measure to know whether or not the effect or influence of the developed products. The effectiveness of the materials can be seen from the test results of students' mathematical communication skills after learning. In this paper, we only discuss the first stage.

3. Results and Discussion

The development of metacognition skills assessment instruments based on science literacy on dynamic electrical materials applied Dick and Carey development model with the data collection instrument were in the form of validation sheet, metacognition ability test, and student response questionnaire. This study produced primary and secondary data. The primary data were assessment instrument development process, theoretical validity, empirical validity, reliability, difficulty level, distinguishing factor, and distractor index. The secondary data were in the form of student responses to instrumental assessment of metacognition ability developed.

Based on the facts in the field, we found that the students have difficulty in learning Introduction to Operations Research course. The difficulties experienced of students can be reviewed from several factors, including: 1) during the learning process, 2) lecturers who teach its course, 3) materials discuss, 4) references, and 5) supporting facilities.

In general, difficulties experienced by students is lack of time in solving problems. They are less fluent in doing the steps that must be done. The material in this course must follow certain algorithms. If one stage of error occurs, then the process must be repeated from the beginning. This makes the student takes a lot of time in solving a problem. The other difficulty is in understanding the steps that must be done in solving a problem. Students also experience errors in writing data to be used. If the data is false, then it will result in the result error obtained. The fatal error is the mistake in constructing a mathematical model of a problem. The reason is that students use less appropriate logic in interpreting the language in the given problem.

In general, students do not have significant difficulties during the teaching process given by the lecturer but she/he not use a variety methods in giving lectures. The method used is very monotonous that explains the material, gives examples, and gives exercise. In the presentation, the lecturer gives

the material too quickly so difficult for them to follow. This happens because the lecturers are often late, so the lack of time in providing all the material that must be learned.

Difficulties factor of students studying this course is based on content material. Difficult for them to understand the formula. As a result, they have difficulties in applying it to a given problem.

Students have difficulty obtaining an easy-to-understand source book. The books in library are still difficult to understand by the students. This happens because the book is in English and the presentation is still too short. The presentation of matter is still deductive, ie, by defining it followed by giving a theorem and ending with an example. The examples given are not given in detail and are less varied. The book used is not the latest and hard to get the latest book.

Another difficulty experienced by students is during the exam. In general, students lack the time in solving the given problem. It requires high accuracy. If a mistake occurs at the beginning of the work it will be fatal to the final settlement.

4. Conclusion

Based on the result of the research, it can be concluded that the students have difficulties in learning the Introduction to Operation Research course. The difficulties are: 1) lack of time in solving problems or problems given, 2) difficulty in understanding the steps to be done in solving a problem, 3) difficult to understand the contents of the book because the book is in English and the presentation is too short, and 4) less thorough in the algorithm. We recommend that lecturers provide teaching materials that are more easily understood and use a variety of methods.

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