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The Development of Student Worksheet Based on Saintific Approach on Linier Programming

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Abstract. This research is aimed to develop student worksheet based on saintific approach on linear programming for the first grade of vocational students. The report state that student mastery of linier programming is still less. Whereas, the purpose of learning linear programming is to improve the problem solving ability which is prominent for vocational students. In addition, mathematics teaching learning process in vocational school has not done well. The quality of the developed student worksheet was evaluated based on validity, practicality, and effectivity. The research type is development research using the ADDIE model which consists of analysis, design, development, implementation, and evaluation. The result of this research shows that the developed student worksheet is valid according to the average of evaluation score from content experts, which is 3.76 of 5, the average of evaluation score from media experts, which is 4 of 5, and the average of evaluation score from mathematics teachers, which is 4.2 of 5. The developed student worksheet is practice according to the average score of student responses, which is 2.92 of 4, the average score of mathematics teacher responses, which is 3.1 of 4. The developed student worksheet is effective according to the average score of student achievement test, which is 81.19 and the percentage of students mastery learning is 70.98%.

INTRODUCTION

Linier programming is one of compulsory mathematics material studied in secondary school. Linier programming is a mathematics method to solve problems related with limited resources allocation to optimize the results. It is used in economic, industry, social such as production, manufacture, banking, and market. It aims to improve problem solving ability that is important to vocational students [1]. Problem solving ability is showed from required competencies to solve linier programming problems that are problems identification and declaring the hypothesis, collecting data through comparing, grouping, and seeing a pattern, choosing and carrying out the strategy to solving the problems, and checking the results. It is appropriate with problem solving steps that are: 1) problem identification/hypothesis, 2) collecting data, 3) choosing strategy, 4) carrying out the strategy to solve the problems, and 5) checking the result/conclusion [2, 3].

Report state that student mastery of linier programming is still less than 60% as shown in Table 1 [4]. It concluded that student mastery of linier programming is still less. In addition, mathematics teaching learning process in vocational school has not done well. Based on the observation and direct interview, mathematics teaching learning process did not focus on mastery concept and student activity. Moreover, learning material such as lesson plan, books, student worksheet did not facilitate students to construct their own knowledge. Most of the material were just simply presenting formulas related to instant concept without knowing the procedure of finding concept and its application in solving problems. Furthermore, learning process was teacher centered where teacher used expository method while students had just listening explanation, paying attention, taking notes and answering questions. Besides, students had

just memorized the steps and formulas to solve the problems because many steps that should be done to solve linear programming problems.

TABLE 1. Linier Programming Mastery of Vocational School in 2014/2015

Competencies	City	Province	National
Solving linier equality and linier inequality of two variables problems	49.86	60.05	53.88
Determine the mathematical model of linier programming problems	40.31	50.32	50.98
Determine the areas of completion of linier programming problems	55.95	63.39	52.95
Determine the optimal value of linier programming problems	42.53	49.76	45.26

Indeed, to overcome these problems need an effective strategy. A strategy that could become a solution of these problems is Saintific Approach. Saintitific Approach is a learning approach based on fact and phenomena that could explained by logic and rational reasoning [1, 5, 6]. It aimed to facilitate students to construct their own knowledge about a particular concept independently or by teacher guidance [6]. Moreover, it actuates students to find, understand, apply and develop the rational thinking by saintific procedure. Saintific procedure consists of five steps that are observing, questioning, trying/collecting data, associating, and communicating [1, 6, 7]. In other word, teaching learning process become more oriented to student learning (student centered) and students actively construct their own knowledge [6]. In fact, students need learning material in which is able to facilitate them understanding linier programming. Therefore, this research was focused on developing learning material that is student worksheet based on saintific approach on linier programming.

Student worksheet is a printed material such as sheets of paper containing materials, summaries, and instructions of learning tasks that should be done by students, which refers to the basic competencies that should be achieved and useful to actuate students active in the learning process [8, 9]. Student worksheet is not just consisting of collection of problems but it consists of student activities to construct their own knowledge. Student worksheet could be a source of information, theories or guided discovery. Student worksheet is not necessarily one kind, but it could be developed a lot of variety also. Student worksheet must be able to facilitate students that is different needs, different times, different material, speed and ability of students that vary through observing, questioning, trying, associating, and communicating [6]. The quality of developed student worksheet is good if it required the criteria for validity, practicality, and effectiveness [10].

Therefore, this research is aimed to develop student worksheet based on saintific approach on linear programming and to know the quality of the developed student worksheet based on validity, practicality, and effectivity.

RESEARCH METHODS

Type of this research is research and development (R&D) to develop a student worksheet based on saintific approach on linier programming for the first grade of vocation students. It conducted from February to April in SMK Muhammadiyah 1 Sleman 2015/2016. The subject of this research was thirty-one students of first grade in SMK Muhammadiyah 1 Sleman.

The development model of this research is ADDIE model which consists of five stages: analysis, design, development, implementation, and evaluation. Analysis aimed to analyze the need of development and feasibility requirements. Analysis consists of needs analysis, curricula analysis, and analysis of the characteristics of students. Design aimed to design the worksheet based on a preliminary draft according to analysis. Design consist of creating a prototype of student worksheet, deciding assessment instrument, arranging the material, and creating the structure of student worksheet. In addition, it created some instrument to assess the quality of student worksheet. Development aimed to produce the student worksheet based on design of student worksheet. Then, developed student worksheet was validated by content expert, media expert, and mathematics teacher to know the validity of developed student worksheet. Implementation aimed to carry out the developed student worksheet in school. In the end of

implementation, students is tested to know the effectiveness of student worksheet. Then, teacher and students completed the questionnaire to know the practicality of developed student worksheet. Evaluation aimed to revise the developed student worksheet based on the suggestions and comments obtained from questionnaire or implementation notes. As a result, developed student worksheet is exactly required to be implemented in schools [11].

The data of this research consists of validity, practicality, and effectivity data. Data of validity is gotten from the average of evaluation score from content experts, the average of evaluation score from media experts and the average of evaluation score from mathematics teachers. Data of practicality is gotten from the average score of student responses and the average score of mathematics teacher responses. Data of effectivity is gotten from the average score of student achievement test. Besides, there are some data gotten from suggestions and comments obtained from questionnaire or implementation notes.

Instruments are established by considering three aspects of quality that are validity, practicality and effectiveness. Instruments of validity that are evaluation sheet of worksheet by content expert, media expert, and mathematics teacher. Validity is assessed by five aspect of validity, that are 1) student worksheet appropriateness to saintific approach, 2) content validity of linier programming, 3) student worksheet appropriateness to didactic, 4) student worksheet appropriateness to construct, and 5) student worksheet appropriateness to technic [11, 12]. Instruments of practicality that are student responses questionnaire and teacher responses questionnaire. Practicality is assessed by the usefulness and easily of developed student worksheet [11]. Instruments of effectiveness that is student achievement test [11]. Student worksheet is effective if the average score of students were higher than or equal to minimum completeness criteria which is 75.

Data analyzes is used to know the quality of the developed student worksheet based on validity, practicality, and effectivity. The validity and practicality of the developed student worksheet can be analyzed by several steps such as data tabulation, calculate the average score, and convert the average score into qualitative criteria based on Table 2 [13].

TABLE 2. Data Conversion Criteria of Validity

Interval Score	Criteria
$X > \overline{Xi} + 1.8\ x\ SDi$	Very Good
$\overline{Xi} + 0.6\ x\ SBi < X \leq \overline{Xi} + 1.8\ x\ SDi$	Good
$\overline{Xi} - 0.6\ x\ SBi < X \leq \overline{Xi} + 0.6\ x\ SDi$	Enough
$\overline{Xi} - 1.8\ x\ SBi < X \leq \overline{Xi} - 0.6\ x\ SDi$	Less Good
$X \leq \overline{Xi} - 1.8\ x\ SDi$	Very Less

with,

$\overline{Xi}$ = mean score = $\frac{1}{2}$ (maximum score + minimum score)

SDi = standard of deviation = $\frac{1}{6}$ (maximum score − minimum score)

X = actual score

According to Table 2, it can be determined the interval of evaluation of developed student worksheet as shown in Table 3 and Table 4.

TABLE 3. The Interval of Validity

Interval Score	Criteria
$\bar{X} > 4.2$	Very Valid
$3.4 < \bar{X} \leq 4.2$	Valid
$2.6 < \bar{X} \leq 3.4$	Enough
$1.8 < \bar{X} \leq 2.6$	Less Valid
$\bar{X} < 1.8$	Very Less Valid

TABLE 4. The Interval of Practicality

Interval Score	Criteria
$\bar{X} > 3.4$	Very Practice
$2.8 < \bar{X} \leq 3.4$	Practice
$2.2 < \bar{X} \leq 2.8$	Enough
$1.6 < \bar{X} \leq 2.2$	Less Practice
$\bar{X} < 1.6$	Very Less Practice

The developed student worksheet fulfills the validity and practicality if it can achieve the minimum criteria are valid and practice.

The effectivity of the developed student worksheet can be analyzed by several steps such as data tabulation, and the percentage of student mastery learning by test. The developed student worksheet fulfills the effectivity if the average score of student achievement test is higher than or equal to minimum completeness criteria which is 75.

RESULT AND DISCUSSION

Developing student worksheet of this research using ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation. First, analyzing the need of development and feasibility requirements. Analysis consists of needs analysis, curricula analysis, and analysis of the characteristics of students. The results of need analysis identified that 1) mathematics teaching learning process did not focus on mastery concept and student activity, 2) student worksheet did not facilitate students to construct their own knowledge. For instance, most of the material were just simply presenting formulas related to instant concept without knowing the procedure of finding concept and its application in solving problems. 3) learning process was teacher centered where teacher used expository method. The results of curricula analysis consists of identified standard of competencies, basic competencies, mastery of standard competencies, learning process, assessment and evaluation, and learning resources of linier programming. Student characteristic analysis identified that 1) students commonly used learning method as explanation, example, notes, and exercise, 2) students just memorized the steps and formulas to solve the problems, 3) students disliked long type question such as story problems, 4) students was more interest to group discussion.

Second, designing the worksheet based on a preliminary draft according to analysis. Design consist of creating a prototype of student worksheet, deciding assessment instrument, arranging the material, and creating the structure of student worksheet. In addition, it created some instrument to assess the quality student worksheet. It resulted the title of student worksheet, the concept of linier programming, student achievement test, components in the student worksheet, and instruments of evaluation of student worksheet.

Third, developing or producing the student worksheet based on design of student worksheet. Developing student worksheet considered 1) student worksheet appropriateness to saintific approach, 2) content validity of linier programming, 3) student worksheet appropriateness to didactic, 4) student worksheet appropriateness to construct, and 5) student worksheet appropriateness to technic. It produced based on the title of student worksheet, the concept of linier programming, and components in the student worksheet. Then, developed student worksheet was validated to know the validity and to revise the developed student worksheet. Data of validity was gotten from the average of evaluation score from content experts, the average of evaluation score from media experts and the average of evaluation score from mathematics teachers using evaluation sheet. The validity result was shown in Table 5.

TABLE 5. Validity Result of Student Worksheet

Aspect	Average Score	Criteria	Average	Validity
Saintific Approach	4.5	Very Valid	4.05	**VALID**
Linier Programming	3.56	Valid		
Didactic	4.2	Valid		
Construct	4	Valid		
Technic	4	Valid		

Based on the result, the student worksheet was valid and it could be implemented in learning.

Fourth, carrying out the developed student worksheet in school. Student worksheet was implemented in school to thirty-one of first grade students in SMK Muhammadiyah 1 Sleman which was chosen using simple random sampling

[14]. In general, the learning process begins with preliminary activities that teacher opens and prepares students to start learning (apperception). Learning activities began with a prayer. Then the teacher gives LKS to the students. It provided information about the subject matter to be learned, learning objectives, and activities to be followed by the students. In main activity, students were created some groups and discussing problems in the worksheet. Main activity had done using saintific approach learning activities, that are observing, questioning, trying/collecting information, associating and communicating. The example of problems or activities used in the worksheet were shown in Table 6.

TABLE 6. Student Activities in Worksheet

Phrase	Activity
Observing	Aktivitas Kelas 5.1 Mengamati Perhatikan permasalahan berikut! Seorang pedagang sepatu berencana membeli dua jenis sepatu, sepatu pria dan sepatu wanita. Tiap sepatu terdiri atas 2 merk, merk A dan merk B. Harga beli sepatu ditampilkan pada tabel berikut. Ia akan membelanjakan uangnya paling banyak Rp2.000.000,00 untuk sepatu merk A dan Rp1.800.000,00 untuk sepatu merk B. (Harga (Rp): Sepatu Pria, Sepatu Wanita; Modal (Rp)) Merk A: 200.000, 160.000, 2.000.000 Merk B: 150.000, 200.000, 1.800.000 Berdasarkan informasi yang kamu peroleh, tentukan: Perbandingan harga antara sepatu pria dan wanita yang ber-merk A adalah … : … . Modal untuk membeli sepatu merk A paling banyak adalah … Perbandingan harga antara sepatu pria dan wanita yang ber-merk B adalah … : … . Modal untuk membeli sepatu merk B paling banyak adalah …
Questioning	Menanya Berfikirlah kritis dan ajukan pertanyaan-pertanyaan yang ada dalam pikiranmu mengenai permasalahan tersebut! Jawab:
Trying	Mencoba Buatlah model matematika dari permasalahan tersebut! Jawab:
Associating	

Phrase	Activity
	Mengasosiasi Dari aktivitas kelas yang kamu lakukan, buatlah kesimpulan menggunakan kata-katamu sendiri, bagaimana langkah-langkah mengubah soal cerita atau permasalahan nyata menjadi model matematika! Jawab:
Communicating	Mengkomunikasikan Presentasikan dan diskusikan hasil yang kamu dapatkan di depan kelas!

In closing activity, teachers guided students to reflect on the activities and make a conclusion of material that have been learn, doing the exercise and collecting worksheet, providing information about the next activity and praying together and greeting.

Learning was conducted in seven meetings and one test. While the implementation in learning, students found a difficulty because they did not usual by learning using saintific approach. Students prefer to use a quick/instant method to solving the problems. Students were not diligently to solve the problems saintific approach steps also. Some students were reluctant to write questioning and communicating part in the worksheet. Eventually, by teacher guided, students could learn using saintific approach learning steps slowly. During the lesson, the students was very active to ask the teacher about the material that they were not understood yet. Besides, students preferred to learn in groups rather than individually. Students were pleased after being able to solve the problem and took the initiative to teach their classmate. Students understand that to find the optimum value of linear programming problems, they could use a corner point method and line method.

In the end, students was tested to know the effectiveness of student worksheet. Data of effectivity was gotten from the average score of student achievement test. The effectiveness result was shown in Table 7.

TABLE 7. Effectiveness Result of Student Worksheet

Aspect	Result
Highest Score	99
Lowers score	64
Average of Test Score	81.19
Standard Deviation	8.95
Passing Students	22
Not Passing Students	9
Percentance of Mastery	70.96%

Based on the result, the student worksheet was effective with percentance of mastery is 70.96% and the average score is 81.19. In addition, standard deviation is 8.95, hence the data is in normal distribution.

Then, teacher and students completed the questionnaire to know the practicality of developed student worksheet. Data of practicality was gotten from the average score of student responses and the average score of mathematics teacher responses. The practicality result was shown in Table 8.

TABLE 8. Practicality Result of Student Worksheet

Aspect	Teacher Questionnaire	Student Questionnaire	Average
Average of Usefulness	3.3	3.19	3.25
Average of Easiness	2.9	2.75	2.83
Average of Questionnaire	3.1	2.92	3.01
Practicality	Practice	Practice	**PRACTICE**

Based on the result, the student worksheet was practice.

Evaluation aimed to revise the developed student worksheet based on the suggestions and comments obtained from questionnaire or implementation notes. As a result, developed student worksheet was exactly required to be implemented in schools.

In summary, the developed student worksheet based on saintific approach was a worksheet arranged by referring to learning activities in saintific approach. It consists of five learning activities that are observing, questioning, trying/collecting data, associating, and communicating. In addition, it was arranged of several components that are problems, solution, class activity, exercises and tests. The development model of this research is ADDIE model which consists of five stages: analysis, design, development, implementation, and evaluation. The data of this research consists of validity, practicality, and effectivity data. The developed student worksheet based on saintific approach on linier programming for first grade of vocational school was required validity, practicality, and effectivity.

CONCLUSION

Based on the result of research, it concluded that 1) the development of student worksheet based on saintific approach on linier programming for the first grade of vocational students using ADDIE model consists of five stage that are analysis, design, development, implementation, and evaluation. Analysis stage consist of needs analysis, curricula analysis, characteristics of student analysis. Design consist of creating a prototype of student worksheet, deciding assessment instrument, arranging the material, creating the structure of student worksheet, and created some instrument to assess the quality student worksheet. Development stage consist of developing student worksheet, validating developed student worksheet, and revising developed student worksheet. Implementation stage consist of carrying out the developed student worksheet and analyzing implementation result data. Evaluation stage consist of revising the worksheet based on the suggestions and comments obtained from questionnaire or implementation notes. 2) the developed student worksheet based on saintific approach in linier programming for first grade of vocational school was required validity, practicality, and effectivity.

RECOMMENDATION

The developed student worksheet based on saintific approach on linier programming for first grade of vocational school was required validity, practicality, and effectivity. Therefore, it can be used for students or teachers to support learning activities in the classroom, and for other researchers can perform a similar learning material development in accordance with procedures similar to the procedure used in this research with another subject.

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