

DEVELOPING MATRIX AND VECTOR MATERIALS BASED ON CONSTRUCTIVISM

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Abstract

Teaching and learning process in Matrix and Vector Subject has not been requiring students to construct their knowledge and to exercise their critical thinking. That is why it is necessary to develop constructivism instruction to improve students' ability in critical thinking. This research aims at producing a valid and practical constructivism book to improve students' ability in critical evaluation and learning revision. Development research method is used by this research. The method consists of analysis, design, and revision. Data collection used observation and test. The subject in this research is students of Mathematics Education Program in FKIP Ekasakti University year 2013/2014. After conducting the research, the conclusions are: 1. The process of developing the book is only for Matrix and Vector's material which starts from analysis design and then evaluation until revision. 2. instruction materials prototype which is developed fulfills a valid and practical criterion and also has potential effect. 3. some aspects of student's activity in learning process did not effective; because restructure (58.72 %) and review (56.00 %) are just in the enough categories. The result of learning test which aims at evaluating students' ability in critical thinking is 25.34. It means the students' ability in critical thinking is in good category. The final conclusion is a constructivism Matrix and Vector's book can be used to improve students' ability in critical thinking.

Keywords: Critical Thinking Ability, Matrix and Vectors, and Development Research

INTRODUCTION

Background

The low of students' critical thinking ability in Elementary Linear Algebra subject has been caused by some factors. One of those is about learning process, for instance the method in learning, the teacher centered model, so that students think passively and do not have any chance to think by themselves. Lack of learning method causes students have tendency to be passive, unmotivated in learning, and students' abilities in critical thinking, creativity, analytic, and logical cannot be optimal. If this condition keeps happening, there will be passive and unpleasant behaviors in students themselves which lead to the undeveloped of students' critical thinking regardless of any information.

Learning based on constructivism realm is a conceptual changing which can be in the form of construction of new ideas or reconstruction of the existing ideas. Moreover, teaching in constructivism is not the activity of transferring the knowledge from teacher to students but it is a process that allows students to construct their own knowledge (Martinis 2008). Suparno (1996) affirmed that constructivism learning approach is an approach that meets the way of students' active learning and constructive. By examining the characteristics of constructivism learning, it is shown that students construct their

own understanding of the knowledge that they have learnt, so that it is expected can develop their critical thinking. Not different from other previous researches such as Sa'dijah (2006), Sutriyono (2001), Susanto(1998) and Hamzah (2001), from these results and journals, generally stated that constructivism learning approach potentially develop students' algebraic ability which involve students to be active in thinking process.

According to the description above, researchers were interested in developing a learning tool as a book for matrices and vectors based on constructivism in Elementary Linear Algebra subject. It was chosen as an effort in training students' critical thinking ability in the classroom.

Research Question

The research questions in this present study are:

1. How is the development of a valid and practical matrix and vector's book based on Constructivism for Mathematics Education Students?
2. How is the effectiveness of the use of matrix and vector's book based on Constructivism for Mathematics Education Students?

Aims

The aims of this present study are:

1. To know the development of a valid and practical mathematics matrix and vector's book based on Constructivism for Mathematics Education Students.
2. To know the effectiveness of the use of matrix and vector's book based on Constructivism for Mathematics Education Students.

METHOD

This study uses a type of research methods, namely developmental research. Developmental research on this study oriented to definition by Lesh R & Comon S. J (1992). Developmental research is a systematically study about planning, developing, evaluating of a teaching program, a process and a product which have to fulfill an interval consistency criteria and effectiveness. The design was aimed to yield a product, namely a matrix and vector's book.

This present study uses development research method with formative research (Tessmer, 1999; Zulkardi, 2002). The research was done on an odd semester year 2013/2014 in Mathematics Education Program, FKIP UNES Padang. The subject of the research is all students who have been registered in third semester.

The procedures of developing the book

The procedures of developing learning materials in this present study consists of 3 phases, namely *Self Evaluation*, *Prototyping* (validation, evaluation and revision), and *Field Test*.

Research Instruments

The instruments for collecting data used in this study are:

1. Observation. This instrument was used to know the practicality of the book designed. The observation was a students' observation to see the activeness and participations of students during the learning. The approach of the Elementary Linear Algebra

learning was constructivism using students' activities observing paper which was done by two observers.

2. Test. This instrument was used to get the data about the effectiveness or having *potential effect* from the book and measure students' critical thinking ability after joining Elementary Linear Algebra based on constructivism class. The test was given in every end of lesson. The test consists of one essay problem which refers to 3 indicators of critical thinking ability. In this present research, the critical thinking indicators used are (1) Focusing on the questions; (2) Analyzing the arguments; and (3) Making induction and considering the result of the induction.

Data Analysis Technique

Data analysis technique used in this study is qualitative descriptive analysis. A short explanation about analysis technique follows by its criteria which refer to analysis results of each type of data as seen as follow:

- Data analysis of expert validation. To analyze the expert validation data, a descriptive analysis was used by revising the valuator's notes from 3 characteristics, namely content, construct, and language. The result of the analysis would be used to revise a lesson tool and test instrument.
- Data analysis of students' activities observation. To know about students' activeness during the classes then it was held an observation; the observing aspects were based on students' observation paper designed. Data result from observation was then counted for each indicator by determining each frequency of each activity, and was then counted as percentage, as follow.

Table 1. Students' activeness categories during the learning process

| Score(%) | Categories |
|----------|------------|
| 81-100 | Very good |
| 61-80 | Good |
| 41-60 | Enough |
| 21-40 | Less good |
| < 20 | Bad |

(Modification from Arikunto, 2003:245)

- Data analysis of test result. Data of the test result was aimed at measuring students' critical thinking ability from students' scores in doing the critical thinking ability test problem. Students' scores were then counted in percentages to know their critical thinking ability. Data of test result from this present study also analyzed in qualitative descriptive. The scoring system about the ability was made as this table below.

Table 2. Scoring system of students' critical thinking ability.

| Score | Criteria |
|-------|----------------------|
| 4 | Seeing 3 descriptors |
| 3 | Seeing 2 descriptors |
| 2 | Seeing 1 descriptors |
| 1 | Seeing 0 descriptors |

Score of critical thinking ability from every student is the sum of scores from the number of descriptors seeing when solving critical thinking ability problem test. Maximum score is 12 while the minimum score is 3, so that the mean of students' critical thinking ability

score interval is 9. The researcher divided the interval into 4. Data of test result was then analyzed to determine the mean of the final score for every meeting and the converted into qualitative data to determine students' critical thinking ability level of category. The category of students' critical thinking ability was determined as follow:

Table 3. Critical thinking ability's level of category.

| Student's grade | Level of student's critical ability |
|-----------------|-------------------------------------|
| 9,9 – 12,0 | Very critical |
| 7,6 – 9,8 | Critical |
| 5,3 – 7,5 | Enough critical |
| 3,0 – 5,2 | Less critical |

After that, it is counted the mean score of students' critical thinking ability per indicator to measure students' critical thinking ability for each indicator. The formula used here is:

$$\text{Activity's score per indicators} = \frac{\text{Mean of frequency}}{\text{Frequency maximum}} \times \text{Maximum activity's score.}$$

RESULT AND ANALYSIS

Description of the Result of a Learning Tool Development

Based on frame of mind mentioned before, there are 3 big phases in this present research, namely Self Evaluation, prototyping (Validation, evaluation and revision), and field test. In Self Evaluation (analysis and design) phase, matrices and vector's book based on constructivism was designed as the first prototype. In prototyping phase, the book was validated by the experts. Expert validation was done to see the content, construct, and language validity. Generally, the result of expert validation towards the lesson tool developed had good category and could be used with little revision. The result of this revision was called second prototype.

The second prototype was revalidated by the experts and was tested on One-to-one evaluation. In this phase, a student and a lecturer who handles the subject were asked to comment the product. The result of one-to-one and expert review was made as the basis to revise the second prototype.

Draft of a lesson plan in the second prototype was tested in a small group which consists of 5 students. A student and a lecturer who handles this subject was asked again to observe and give correction, and also do the problems in the book and test or evaluation instrument which was given gradually. The result of a small group and expert review in the second prototype is the basis to revise the second prototype.

Description of the Analysis Result of Students' Activity Observation Data

This observation was conducted during learning process which based on constructivism approach. It was done in 3 meetings and the observation paper consists of 5 indicators which refer to learning based on constructivism. During the observation, researchers were helped by 2 teachers to observe 20 students who were divided into 2 observed groups. Each observer observed the activity of 10 students. The table below is a result of the observation of students' activities during learning process.

Table 4. Percentage of students' activity observation result during the lesson

| Observed Aspects | Meeting | | | Mean | Category |
|------------------|---------|-------|-------|--------------|------------------|
| | I | II | III | | |
| Orientation | 73,75 | 81,25 | 82,5 | 79,17 | Good |
| Elicitation | 85,8 | 89,17 | 91,33 | 88,77 | Very good |
| Restructuring | 54 | 56,16 | 63 | 58,72 | Enough |
| Using Idea | 100 | 100 | 100 | 100 | Very good |
| Review | 53 | 55 | 60 | 56 | Enough |

The book made was categorized as a practical book since all students can learn from the book without the help of the lecturers. According to observation result in learning process, it was gained percentages of each indicator as follow, Orientation (79,17%), elicitation (88,77%), restructures (58,72%), using ideas (100%) and review (56%). From 5 indicators observed, in first, second, and third meeting, students were inconvenient speak about their ideas and gave arguments in classroom discussion. It can be seen from percentages of students' activity in restructures phase (57,92 %) and review (56 %) namely, students were hesitate in making conclusion and check the correctness of the concept, whether in fact, exercising to train critical thinking is important in this phase. However, in every meeting the percentages of this phase increased slowly. It is expected that by conducting regularly this kind of learning process, students will be able to reveal clearly their ideas by comparing, collecting ideas, telling the arguments, and drawing conclusion by themselves without any help from lecturers. Here, researchers had roles as facilitators by guiding students to be motivated to use their thinking process.

The analysis result of students' critical thinking ability

In every end of the mathematics learning process based on constructivism, it was conducted a test to evaluate students' critical thinking ability. Students were asked to solve the test problems made by lecturers especially to measure critical thinking ability consisting of 1 to 2 problems and 3 indicators of critical thinking ability, namely focusing on questions, analyzing arguments, making induction, and considering the result of induction. Data from students' critical thinking ability test result was analyzed in order to determine the average of final score in every meeting. After that, it was converted into qualitative data to match the category of students' critical ability level. The percentages of critical thinking ability levels was concluded after doing 3 tests during 3 meetings, as can be seen on the table below,

Table5. Distribution of the average score of students' critical thinking ability

| Score interval | Frequency | Percentage (%) | Category |
|----------------|-----------|----------------|-----------------|
| 9,9 – 12 | 2 | 10,80 | Very critical |
| 7,6 – 9,8 | 13 | 51,30 | Critical |
| 5,3 – 7,5 | 7 | 35,10 | Enough critical |
| 3,0 – 5,2 | 3 | 4,30 | Less critical |
| Sum | 20 | | |

After given exercises regardless to critical thinking using constructivism approach, it can be seen from the table above that more than 50% of students included into students who had critical ability, 75% of students included into students who had enough critical

ability in minimum level. That means more than 50% of students in experiment class had good critical ability eventhough there were more than 35% of students included into enough or less critical. Researchers believe that if the designed book will be developed continuously then the result of students' test will be better.

Based on percentages of students' critical thinking ability test result from the first meeting to the third was concluded that a learning tool and the test instruments which were developed have already had potential effect. It can be seen from the improvement which is not really high but significant.

CONCLUSION AND SUGGESTIONS

According to development process, it was obtainable that a prototype of a learning tool developed has not effective yet in improving students' learning activities. It was seen from the result of students' activities observation analysis during teaching learning process for restructuring phase there was 58,72% of students' activity. It consists of clarification of ideas contrasted with others ideas or other students through discussion or through collecting ideas, building new ideas, evaluating the new ideas by experimenting. In review phase, there was 56% of students' activity, namely drawing conclusion. After that, in development process, a prototype of a learning tool developed has already had potential effect regardless to students' critical thinking ability where the classically test result of students' critical thinking ability had score 25, 34. This score was included in the good critical thinking ability category.

For other researchers, this matrix and vector's book can be a source to assess more the learning tool for mathematics education subject based on constructivism approach in higher education in order to train students' critical thinking ability.

REFERENCES

- Akker, J. Van den. 1999. *Principle and Methods of Development Research*. In: J. Van den Akker, R. Branch, K. Gustafson, N. Nieveen and Tj. Plomp (Eds), *Design Methodology and Development Research*. Dordrecht: Kluwer.
- Arikunto, S. 2005. *Dasar-Dasar Evaluasi Pendidikan*. Jakarta : Bumi Aksara.
- Ernest, P. 1991. *The Philosophy of Mathematics Education*. London : Falmer.
- Ennis, R.H. 1996. *Critical Thinking*. USA : Prentice Hall, Inc
- Ennis, R.H. 1985. *Critical Thinking*. USA : Prentice Hall, Inc
- Hadi, Sutarto. 2005. *Pendidikan Matematika Realistik dan Implementasinya*. Banjarmasin: Tulip.
- Hamzah. 2001. *Pembelajaran Matematika menurut Teori Belajar Konstruktivisme*. tersedia : http://www.depdiknas.go.id/Jurnal/34/pendekatan_sains_tekno_masyarakat. Edisi 40.htm. Diakses 21 Oktober 2008.
- Martinis, 2008. *Paradigma Pendidikan Konstruktivistik*. Jakarta : Press
- Sa'dijah, C. 2006. *Pengembangan Model Pembelajaran Matematika Beracuan Konstruktivisme untuk Siswa SMP*. *Jurnal Pendidikan Matematika (MATHEDU)* 2(1), 111—122. Surabaya : PPs UNESA.

- Sumardiyono.2006. *Karakteristik Matematika dan Implikasinya terhadap Pembelajaran Matematika*. Makalah hasil penelitian. Jakarta.
- Suparno, P. 1996. *Filsafat Konstruktivisme dalam Pendidikan*. Yogyakarta: Kanisius.
- Suryadi,D.2005. *Penggunaan Pendekatan Pembelajaran Tidak Langsung serta Pendekatan Gabungan Langsung dan Tidak Langsung dalam rangka Meningkatkan Kemampuan berpikir Matematik Tingkat Tinggi Siswa SLTP*. Disertasi, Bandung: PPs UPI. Tidak diterbitkan.
- Susanto,Y.1998. *Efektivitas Model Pembelajaran Konstruktivisme melalui Pendekatan STS (K-SB) dalam Meningkatkan Kemampuan Memahami Konsep dan Kepedulian terhadap Lingkungan Sekitarnya pada Pembelajaran Listrik Statis di SMU*. Tesis. Bandung : PPs UPI. Tidak diterbitkan.
- Sutriyono.2001. *Konstruktivisme dan Pembelajaran Matematika*.Jurnal vol.2 no.2. Desiderata.
- Suyitno, Amin, dkk. 1997. *Dasar dan Proses Pembelajaran Matematika*. Semarang: FMIPA Unnes
- Syukur,M.2004.*MengembangkanKemampuanBerpikirKritismelaluiPembelajaranMatematika dengan Pendekatan Open Ended*. Tesis pada PPS UPI. Bandung: Tidakditerbitkan.
- Sukmadinata, N.S. 2006. *Pengendalian Mutu Pendidikan Sekolah Menengah : Konsep, Prinsip dan Instrumen*.Bandung : Refika Aditama
- Tessmer, M. 1993. *Planning and Conducting Formative Evaluations*. London, Philadelphia: Kogan Page.
- Thomas. R., et. al. 2004. *Assessing Higher Order Skills using Simulations*, tersedia: (<http://www.caaconference.com/pastConferences/2004/proceedings/Thomas R. pdf>).diakses tanggal 23 September 2008).