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Developing group investigation-based book on numerical analysis to increase critical thinking student's ability

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Abstract. Critical thinking is very important in Mathematics; it can make student more understanding mathematics concept. Critical thinking is also needed in numerical analysis. The Numerical analysis's book is not yet including critical thinking in them. This research aims to develop group investigation-based book on numerical analysis to increase critical thinking student's ability, to know the quality of the group investigation-based book on numerical analysis is valid, practical, and effective. The research method is Research and Development (R&D) with the subject are 30 student college department of Mathematics education at Universitas PGRI Madiun. The development model used is 4-D modified to 3-D until the stage development. The type of data used is descriptive qualitative data. Instruments used are sheets of validation, test, and questionnaire. Development results indicate that group investigation-based book on numerical analysis in the category of valid a value 84.25%. Students response to the books very positive, so group investigation-based book on numerical analysis category practical, i.e., 86.00%. The use of group investigation-based book on numerical analysis has been meeting the completeness criteria classical learning that is 84.32 %. Based on research result of this study concluded that group investigation-based book on numerical analysis is feasible because it meets the criteria valid, practical, and effective. So, the book can be used by every mathematics academicians. The next research can be observed that book based group investigation in other subjects.

1. Introduction

Education has a very important role in this world. One of the factors of success of a country can be seen from the quality of education in that country. Indonesia is one of the developing countries in the world; education is need for her to face the challenges of the time. Mathematics education has been given from elementary school until the highest degree of education. Mathematical knowledge and the ability to solve quantifiable problems and utilize critical thinking skills enhance the abilities of students to think and make decisions [1]. Critical thinking is one aspect of ways of thinking [2] who have important to develop [3]. Critical thinking process is very needed in mathematics. The critical thinking is mental process that is organized and play a role in decision-making process to resolve the problem [4]. Critical thinking is very important in mathematics [5-7], it can measure the student's ability to problem solving. There is importance to cultivating critical thinking for all community college students [6]. Critical thinking can enhance creative problem solving options by encouraging students to seek new strategies when solving mathematical problems. Basically, every student has the ability to think critically about mathematics [7,8], but we must appearing it in mathematics learning especially. Mathematics teachers know the importance of mathematical reasoning, for it builds the



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skills required for higher-level mathematics [1]. Without using critical thinking, students can make a wrong decision. The critical thinking disposition stage of Indonesian prospective mathematics teachers is mostly at the lowest stage, namely Non-Critical Thinker level [9]. The critical thinking disposition scores of prospective teachers are in medium level [10]. Supported by the result of the research, the prospective teachers did not possess adequate conceptual understanding, critical thinking, problem solving, and mathematical communication skills before their exposure to the lecture-discussion approach and the reflective learning approach [11]. So, there are need to increase the critical thinking of Indonesian prospective mathematics teachers.

In mathematics, the ability to think critically can be applied to the numerical analysis. This is because in the numerical analysis students are required to analyze a mathematical formulation from another angle, namely numerical. The learning model who has a relation with critical thinking is Group Investigation. In assessing learning in Group Investigation, the teacher evaluates students' higher-level thinking about the topic they studied. Investigation of mathematics as an approach to learning is able to give a positive response to the increasing of critical thinking [12]. Based on the research by [13] that said learning with ILSC models can be used to enhance students' mathematical critical thinking ability. ILSC (Interactive Learning Setting Cooperative Model) is cooperative learning that requires active students and can help improve learning achievement and attitudes toward mathematics. So, cooperative model can be increasing the student's critical thinking ability. Based on those statements, this research aims to develop group investigation-based book numerical analysis to increase student's critical thinking ability. The novelty of this paper is developing a book based group investigation learning model that can be increasing the critical thinking student's ability.

2. Methods

2.1. Research and Development

This study is a research and development. Research development refers to the Four-D development model that consists of four steps: (1) define, (2) design, (3) develop, and (4) disseminate. The products developed in this study is a group investigation-based book on numerical analysis to increase critical thinking student's ability. The quality of products consists of three following criteria: validity, practicality, and effectiveness. The subject of this research is prospective mathematics teacher in Department of Mathematics Education, Universitas PGRI Madiun, East Java province, Indonesia. The procedures of research in this study use the 4-D development model who finished at the third stage. The first stage is define. The activity in this stage is start-final analysis, students analysis, concept analysis, task analysis, and the purpose specification. The second stage is design, the preliminary design of the product, that is the draft of group investigation-based book on numerical analysis to increase critical thinking student's ability. This stage consists of four step, drafting instrument, media selection, format selection, and preliminary design. This study requires validation sheet, student questionnaire, and sheet of test. The third stage is develop, this stage is the developing stage of preliminary design to the group investigation-based book on numerical analysis to increase critical thinking student's ability. The activities of this stage are product validation, limited testing, field testing.

2.2. Data, Instrument, and Data Collection Technique

The type of data collection in this study is qualitative and quantitative. The qualitative data obtained from the feedback and suggestions from validators and students. The quantitative data obtained from the scores of test of students achievement. Data collection techniques in this study consist of questionnaires, validation, and sheet of test. The questionnaires techniques were applied to collect the student's responses. The validation technique was applied to collect the validation data on group investigation-based book on numerical analysis to increase critical thinking student's ability from expert validators. The sheet of test to collect the student's achievement.

2.2.1. group investigation-based book on numerical analysis validity analysis

Valid means the instrument can be used to measure what is meant to measure. Evaluation technique or test can be called as having a high validity level if it is able to measure what is actually meant to measure. Every aspect of teaching equipment is validated by validator with scoring range from 1 to 4. The criteria of validity can be seen in Table 1.

Table 1. Validity criteria

Answer percentage (%)	Meaning
85,01 – 100,00	Very valid or can be used without revision
70,01 – 85,00	Quite valid or can be used with minor revision
50,01 – 70,00	Not quite valid or need major revision
01,00 – 50,00	Not valid and can't be used

The group investigation-based book on numerical analysis can be called as valid after being validated by three validators. If the result of validation obtained criteria quite valid or very valid, the process of developmental research could be continued to the next stage, but the researcher has to revise the draft if the result of validation shows that it has fulfilled the criteria of a valid.

2.2.2. group investigation-based book on numerical analysis Practicality Analysis

The data to be analyzed in order to know the practicality of the book is the students' response questionnaire. The analysis of students' questionnaire can be called as practical if the positive response of the students reaches up to $\geq 70\%$. The formula used to measure the practicality level is:

$$RS_{students} = \frac{A}{B} \times 100\%$$

Note :

$RS_{students}$ = students' response percentage/students' response mean

A = the number of students who response

B = the number of students who give their response

2.2.3. group investigation-based book on numerical analysis effectiveness analysis

The data used to see the effectiveness of the book is students' score obtained from the task given after the teaching process using the students' workbook. The lesson can be called as effective when the number of students who completed the subject classically fulfill the effective criteria or very effective criteria. To get a better understanding of lesson plans implementation affectivity, the researcher presents the illustration in the Table 2.

Table 2. Effectiveness criteria

No	Effectiveness Criteria	Effectiveness Level
1.	85.01% - 100.00%	Very valid or very effective, can be used without revision
2.	70.01% - 85.00%	Quite valid or quite effective, can be used with minor revision
3.	50.01% - 70.00%	Not quite valid or not quite effective, needs major revision
4.	01.00% - 50.00%	Not valid and not effective, can't be used

The book can be called as effective when students' completeness is $\geq 75\%$ classically. The classical completeness percentage can be measure through this formula.

$$\text{completeness percentage} = \frac{\text{the number students who complete}}{\text{the total number of students}} \times 100\%$$

The book can be called as acceptable if it is fulfilled the criteria of validity, affectivity, and practicality.

3. Result and Discussion

Group investigation-based book on numerical analysis development model in this research is a four-D model (4-D models), which consists of 4 stages. The fourth stage is defined, design, development, and disseminate. However, in this research only covered about three stages of development of the book, namely the definition, design, and stage development. In the define stage, researchers conducted direct observations in the Universitas PGRI Madiun; researchers obtain some information, among others: 1) the student motivation in learning numerical analysis still low, 2) lack of innovation supporting books that belong to the student. In this analysis, the researchers obtained information that the average value of the test numerical analysis student is still low, at the 60. The task analysis is used to identify the steps necessary to achieve the purpose of research. The purpose of this research is to produce group investigation-based book on numerical analysis. In the design stage, the initial step of making lesson plans that make core competencies, basic competencies, indicators and purpose of learning, then learning steps. While the making of Book begins by collecting the material, collecting pictures, create a cover, preface, table of contents, and make the contents Book. In the development stage, a group investigation-based book on numerical analysis which has undergone several revisions based on input from the validator and the data obtained from the limited testing to determine its quality. Once the design is created and then began to make of group investigation-based book on numerical analysis. The book developed made it interesting that the students are interested in the next lesson.

3.1. Development Results

The validation results of the book by validators have average value is 84.25%, so that book included in the valid criteria because it has met the criteria of validity that is 70.01% - 85.00%. The Practicality analysis the book obtained by filling the response questionnaire for the students after using the book. The results of responses questionnaire for the student on limited testing were obtained practicality percentage of 88,46%, it can be concluded that the use of the book on a limited test met the criteria of practicality because of the percentage positive respondents more than 70%. The results of responses questionnaire for the student on field testing by 30 students on field trials obtained practicality percentage of 86,00%, it can be concluded that the Book met the criteria of practicality because of the percentage positive respondents more than 70%. The book efficacy data obtained from achievement test scores in a limited test and field test. Based on student test results obtained on a limited test completeness learning percentage of 80.00%, it can be concluded that learning using Group investigation-based Book has fulfilled the classical completeness. Based on field test results, students meet in classical learning completeness is 84.33%. So, the Group investigation-based Book on numerical analysis can be declared effective because it has met the criteria of classical learning completeness in field test.

3.2. Discussion of Final Products

Based on the results of research, book can be said to be feasible if it meets three criteria, namely validity, practicality, and the effectiveness. The validity of Book learning device can be measured from the aspect of instructions, preparation of feasibility aspects, aspects of the content and language aspects. After the researchers to test the validity of the book obtained with a percentage of 84.25%. Thus, the percentage included in the criteria valid. The group investigation-based book on numerical

analysis can meet the criteria of practicality learning device if the percentage of student responses to more than 70%. The data used is the result of questionnaires by students. Filling the questionnaire on a limited test resulted in the students' response by 88.46%, while in the field test result of 86.00% student response. Based on these results, the group investigation-based book on numerical analysis can be expressed practically. Learning device the book can be said to be effective if all students complete in classical learning and meet the minimum completeness criteria for the implementation of the results of tests of learning. All students must meet the minimum completeness criteria, namely the total score of $\geq 75\%$ of the maximum score of 100. Based on the analysis of research data obtained as students in the limited test class achieve an average score of 80% total achievement test, students in the field test class achieve an average score of 84.33% total achievement test, Based on the data, all the students can be said to be completed by learning classical. It can be concluded that the group investigation-based book on numerical analysis learning developed effectively meet the criteria.

4. Conclusion

Based on the research development of group investigation-based books on numerical analysis can be concluded that the book decent used as valid criteria, practical, and effective.

Based on the results of research and development has been done, can be summed up as group investigation-based books were developed as valid, as data validation results that have been made by the three validators scored 84.25%. Group investigation-based books developed to meet the criteria of practicality because the general assessment made by the three validators concluded that the book could be used without revision. As well as the response of students in the class test and a field test with a percentage of 88.46 % and 86%. Group investigation-based books developed effective criteria, for an average total score of student learning outcomes in the classroom testing and field testing class scored 80% and 84.33%. Research result of this study concluded that group investigation-based book on numerical analysis is feasible because it meets the criteria valid, practical, and effective. So, the book can be used by every mathematics academician. The next research can be observed that book based group investigation in another subject.

Some suggestions are given in this research, namely: (1) the data obtained in the limited test still needs to be tested in another class with a variety of different conditions in order to obtain a higher quality learning device. (2) Group investigation-based book on Numerical analysis subject only, so it needs to give in other subjects.

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