

How Geometer's Sketchpad (GSP) Develops Geometry Concept Understanding

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ABSTRACT

The purpose of this study is to show that the development of analytical geometric practicum module based on the application of Geometer Sketpched (GSP) is effective and practical in developing Geometry Concept Understanding. The research method used in this research is research and development. The research subjects in this study consisted of the subject of development and the subject of trials, students of the Mathematics Education Study Program IKIP PGRI Pontianak. Research Procedure: define, design, and development. Data collection tools used in the form of: (1) Validation sheets (2) Questionnaire responses (3) Tests (posttest). The data analysis technique used in this study uses descriptive statistics. Based on the results of research and discussion, in this study it can be concluded that: (1) the practicum module developed is classified as very valid, (2) the practicum module developed is very practical, and (3) the practicum module developed is effective in increasing students' understanding of concepts.

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1. INTRODUCTION.

Mathematical understanding is a translation of the term mathematical understanding. According to Kilpatrick, Swafford, & Findell (2001), conceptual understanding is the ability to understand concepts, operations and relationships in mathematics. Mathematical understanding is a basic competency in learning mathematics which includes: the ability to absorb a material, remember mathematical formulas and concepts and apply them in simple cases or in similar cases, estimate the truth of a statement, and apply formulas and theorems in problem solving (Hendriana, Rohaeti & Sumarmo, 2017). Two definitions of concept understanding written by two experts, in essence are the same, only the second definition is more detailed or the definition is an explanation of the first definition. Hendriana et al. (2017) said that mathematical understanding is very supportive of the development of other mathematical abilities, such as communication skills, problem solving, reasoning, connections, representation, critical thinking, creative thinking, and other mathematical abilities. Therefore, to develop higher-order thinking skills requires a good mathematical understanding as well.

Mathematical understanding ability is one of the hard skills that must be possessed by students (Sumarmo, 2010). According to Kilpatrick et al. (2001), conceptual understanding is the ability to understand concepts, operations and relationships in mathematics. According to Hendriana et al. (2017) mathematical understanding is a basic competence in learning mathematics which includes: the ability to absorb a material, remember mathematical formulas and concepts and apply them in simple cases or in similar cases,

estimate the truth of a statement, and apply formulas and theorems in problem solving. In this research, what is meant by mathematical understanding is the ability to absorb, remember, and apply concepts in problem solving and to estimate the wrong and correctness of a concept.

Based on the results of research conducted by researchers in improving students' mathematical communication skills in the field of analytic geometry (GAB) through problem posing learning models with a realistic approach is classified as effective (Hodiyanto and Haryadi, 2018). However, there are some things that must also be improved so that communication skills are even better. One thing that must be done is how to understand students' concepts more deeply so that it will be easier to improve/develop the communication skills that researchers have done as revealed by Hendriana et al. (2017) that to develop mathematical communication skills a good understanding of concepts is needed. Therefore, we need one way that can facilitate students in understanding the concept of GAB, namely learning/practicum using the geometer scetpche (GSP) media application. At present, the GSP application-based practicum module in the Mathematics Education Study Program of IKIP PGRI Pontianak has not been optimal and has not yet been developed so it needs to be developed to assist students in understanding GAB in depth starting from design, instructions for using GSP, and solving GAB problems using GSP. Tutorial on how to use GSP software is spread very much on the internet. However, the tutorial is generally in English so that the educators /instructors have difficulty in using the application. In

addition, the tutorial is not specific to GAB. Indonesian language tutorials are incomplete and not easy to get, especially tutorials on using the GSP application to solve problems related to GAB. According to Toh (2004) the use of GSP in improving understanding of mathematical concepts is quite effective.

Geometer Sketpched (GSP) is a computer application that can help teachers and lecturers in learning geometry. According to Carter (Santika, 2016), The Geometer's Sketcpad has the ability to do the main tasks, namely: (1) Euclid's construction; (2) transformation; (3) Geometry analytics; (4) integrating Graphics and Text; (5) change the visual properties of the displayed geometry objects; and (6) measurements.

According to Susanta, Rusdi & Maizora (2007) some of the characteristics of the GSP software are as follows: (1) Accuracy in painting and measuring digitally, (2) The process of visualization from the beginning with a variety of different dimension sizes is easy to understand, (3) Providing opportunities for participants students to carry out investigations, explorations, and problem solving, (4) Provide confidence and strong reasons that can provide motivation to prove, (5) Having specific characteristics, animated images, image traces, and any point that provides opportunities to simulate various situations.

The purpose of this study is to show that the development of analytical geometric practicum modules based on the application of Geometer Scetpche is effective and practical in increasing the ability to understand students' concepts so that they can help in improving higher order thinking skills such as mathematical communication skills.

The urgency (virtue) in this study are: (1) GSP-based GAB practicum modules will help students understand the GAB concept more easily and deeply. (2) The importance of understanding concepts in studying GAB because GAB is a student prerequisite for space analytic courses (GAR). (3) conceptual understanding is a pre-requisite ability to develop higher-order thinking skills, such as mathematical communication skills, problem solving, and others. (4) to date there have been no researchers or writers who have developed or written books / teaching materials related to the use of GSP in understanding GAB.

2. METHODS

The research method used in this research is research and development. The research and development design in this study is a 4-D development model. The 4-D model consists of 4 stages of development, namely Define, Design, Develop, and Desseminate by Thiagarajan (Sugiyono, 2015: 37). The shape of the 4-D model can be seen with the following pattern.

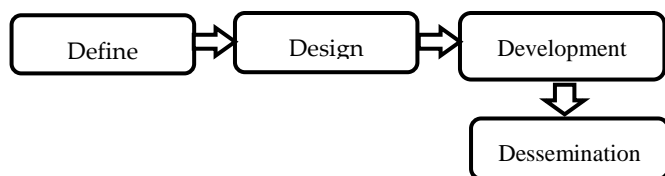


Figure 1. Development Diagram 4-D

However, due to limited time, cost, and researchers only use up to the third step, namely Develop only (without desseminate stage), so that the research development stage in this study can be seen in Figure 3 below.

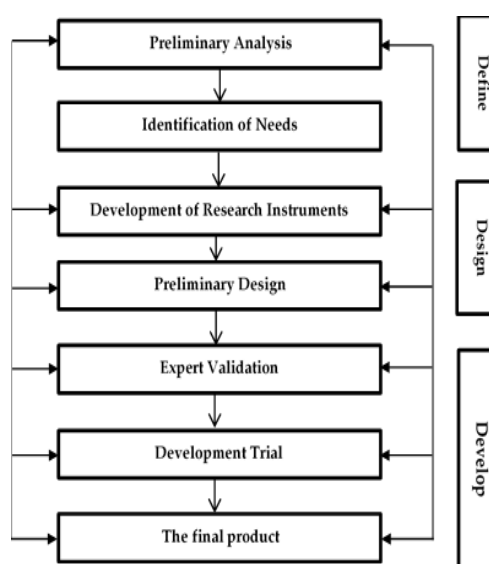


Figure 2. Research Procedure

The research subjects in this study consisted of the subject of development namely the validator (3 experts) as material experts and media experts and the subject of field trials were students of the second semester of the Mathematics Education Study Program IKIP PGRI Pontianak.

Research Procedure

Define : obtain information about problems that exist in the field, so the need to develop GSP-based GAB practicum modules.

Design : design a development product that is adjusted to the problems obtained in the field at the defining stage. At this stage instruments were also arranged. After that, the GSP-based GAB practicum module was designed with the initial design. Design in advance is adjusted to basic competencies, learning indicators, and learning objectives of GAB.

Development : improve the modules that will be developed by evaluating and revising before becoming a valid product.

Expert Validation : This validation is needed to know the validity of the modules that are made. The purpose of this validation is to determine the validity of the product before testing and validation results are used to improve or revise the initial product.

Trials : trials are conducted in one randomly chosen class and planned for semester II. Data from the field trial results were analyzed to determine the effectiveness of the module by providing posttest questions.

The final product : After a field trial, the module is then revised based on the results of the trial so that the final product is produced.

Data collection techniques used in this study are: (1) Indirect communication techniques and measurement techniques. Data collection tools used in the form of: (1) Validation sheets are module validation sheets and posttest validation sheets. Validation sheets are made to meet the objectives of the validity research module (media and material aspects) and posttest validity. (2) Questionnaire of student responses to modules. Student response questionnaire was made to meet the module practicality research objectives. (3) The test (posttest) referred to in this research is a test of understanding the concept in the form of a description item. Posttest questions are made to meet the objectives of the module effectiveness research.

Data analysis techniques used in this study used descriptive and inferential statistics. In this study, the module developed was stated to have good validity and practicality if the percentage of validation and response indexes reached a minimum criterion above 60%, while the module's level of effectiveness could be seen from the results of the tests to be tested with inferential statistics.

3. RESULTS AND DISCUSSION

Research Results

Activities in this research have succeeded in developing an analytical geometric practicum module in the field of geometer's sketchpad (GSP) to improve students' concept understanding skills in the Mathematics Education Study Program IKIP PGRI Pontianak. The process of developing a GSP-based analytic geometry practicum module using the 4-D design, as follows:

Define : The first step that researchers do in this study is to establish the basic problems experienced by students in learning mathematics. Based on the results of research conducted by researchers in improving students' mathematical communication skills in the field of analytic geometry (GAB) through problem posing learning models with a realistic approach is classified as effective (Hodiyanto and Haryadi, 2018). However, there are some things that must also be improved so that communication skills are even better. One thing that must be done is how to understand students' concepts more deeply so that it will be easier to improve/develop communication skills that researchers have done as revealed by Hendriana *et al.* (2017) that to develop mathematical communication skills a good understanding of concepts is needed. Therefore, we need one way that can facilitate students in understanding the concept of GAB, namely learning/practicum by using the GSP application media.

Design: This stage is carried out to design development products that are tailored to the problems obtained in the field at the defining stage. This product design is called the initial design or draft I. (1) Development of Research of Instruments: At this stage, the researcher arranges the questionnaire lattice and the posttest question grid. After that, researchers compile validation sheets, questionnaires and posttest questions. (2) Preliminary Design: This initial design or draft I will be validated with the aim of revising and refining the practicum modules before being piloted. The initial design of the practicum module has the following design: cover, preface, table of contents, chapter i introduction (in the introduction the material description will be carried out in the practicum, prerequisites to be had in the practicum activities, instructions for using the practicum (to make it easier for students to follow the learning activities in the module), and the final purpose of practicum implementation), introduction to geometer's sketchpad (gsp) application, chapter iii contents of the practicum, and bibliography.

Develop: As a follow up to the design that has been carried out in the design phase, development steps are taken to produce a revised draft II based on comments and suggestions from the validator. Activities at this stage of development are expert validation and development trials as follows:

Expert Validation: In this study, the validation process was carried out by 3 validators who understood the module preparation and competent in their fields, namely three lecturers in the mathematics education study program. Suggestions from the validator are used as input to revise the Module so that the Module is valid and ready to be trialed to students as research subjects.

Following are the validation results from the experts:

(1) Material experts provide an assessment of the aspects of the appropriateness of content, the appropriateness of presentation, assessment of language, and assessment. The results of expert material assessment:

Percentage index of material expert 1 = 86,92 %

Percentage index of material expert 2 = 82,30 %

Percentage index of material expert 3 = 85,38 %

The average rating of the material experts on the module can be seen in the following table 1.

Table 1. Results of Module Validation by Material Experts

No	Material Experts	Assessment (%)	Category
1	Material Expert 1	86,92 %	Very Valid
2	Material Expert 2	82,30 %	Very Valid
3	Material Expert 3	85,38 %	Very Valid
	Average	84,87 %	Very Valid

Based on table 1 the results of the validation of three material experts obtained an average percentage of 84.87% with very valid criteria so that the module is suitable for use as a learning medium. There are some comments and suggestions given by experts for revision. After a revision, this module can be used in research. As for the comments and suggestions given by experts of the material used as improvements, there is an incorrect language and the problem needs to be added.

(2) Validation by media experts. Media experts provide an assessment related to three indicators, namely: module size, module cover design, and module content design. The results of the assessment of media experts:

Percentage index of media expert 1 = 86,15 %

Percentage index of media expert 2 = 75,38 %

Percentage index of media expert 3 = 86,15 %

The average evaluation of media experts on the module can be seen in table 2 below:

Table 2. Results of Module Validation by Media Experts

No	Media Experts	Assessment (%)	Category
1	Media Expert 1	86,15%	Very Valid
2	Media Expert 2	75,38%	Valid
3	Media Expert 3	86,15%	Very Valid
	Average	82,56%	Very Valid

Based on table 2 the results of the validation of three media experts obtained an average percentage of 82.56% with very valid criteria making it feasible to be used as a learning medium. There are several comments and suggestions given by media experts to revise. One comment from a media expert is that the picture is too big and too small. After revision, this module can then be used in research.

(3) Expert Validation Results

Based on the calculation of the results of the validation of the material expert and the media expert, the validity level of the Module that is used to answer the first problem statement is shown in Table 3 as follows:

Table 3. Expert Validation Results

No	Experts	Assessment (%)	Category
1	Material Expert	84,87%	Very Valid
2	Media Expert	82,56%	Very Valid
	Average	83,72%	Very Valid

Table 3 shows that the validity level of GSP-based analytic geometry practicum modules has very valid criteria with an average percentage of 83.72%.

Trial

After the Module has been validated and revised, the next step is conducting a limited trial for students. This trial aims to determine student responses and the ability to understand student concepts after applying the practical module. The results of limited trials conducted in this study are as follows:

(1) Student Response Questionnaire

In this study, the response questionnaire was filled by 30 students regarding their responses to the modules that have been used during the learning process. In addition, student suggestions and comments as a response to the module will be considered in revising the module to draft III. Scores obtained from student response questionnaires will be calculated: Percentage index % = 86,14 % (very practical).

Based on these results the questionnaire results obtained by students' responses to the module have very good response criteria with an average percentage of 86.14% with a very practical category.

(2) Concept Understanding Ability

In this study, the ability to understand concepts in students is seen from the results of the posttest. The results of the posttest were obtained by 20 students who obtained above 60 and 10 students whose grades were below 60. In this study, the practicum module was said to be effective if the percentage of students' concept understanding ability was above 60%.

Percentage index % = 67%

Based on these results it was found that the percentage of students understanding of concepts by 67% so that it can be concluded that the practicum module is quite effective.

The final product. After a limited trial, the researcher evaluates the module that has been tested. The results of this revision become the final product of the study. The results of this evaluation, only a few sentences were corrected but without reducing and adding to the substance of the module contents.

Discussion

The development of analytic geometry practicum modules based on geometer's sketchpad (GSP) in the Mathematics Education Study Program of IKIP PGRI Pontianak uses the 4-D model development model recommended by Thiagarajan (Sugiyono, 2015: 35), which consists of define, design, develop, and disseminate. Define phase aims to define the needs that exist in the field. So that researchers know what problems are faced and the solutions. The design phase aims to make the initial design of the product to be developed according to the needs in the field. The develop phase aims to develop revised products based on expert input and limited trials. But in this study only reached the development stage (develop) only because of the limited time and energy of the research team.

The validity of practicum modules is known through the validation stage by material experts and media experts who use the "Likert scale" and use a range of values "81% -100% showing very good criteria" (Widoyoko, 2009: 242). The material expert and media validation sheets use the appraisal grid, namely on the appropriateness of content, appropriateness of presentation, language appraisal, graphics, appearance of material presentation and benefits (BSNP, 2007).

The validation analysis of the practical module material aspects of content eligibility obtained an average percentage of 84.72% with very valid criteria. The results are obtained from the suitability of the material with basic competence, accuracy of the material, material expertise and supporting material. The feasibility aspect of the presentation of practicum modules obtained an average percentage of 83.34% with very valid criteria. Through technical presentation indicators of the material, supporting the presentation of material, presentation of learning, and completeness of the presentation.

The presentation technique of the use of instructional media that is said by Dale (Arsyad, 2017: 27) suggests that the benefits of learning media are bringing freshness of students and learning varies to student learning experiences. Aspects of language assessment obtained an average percentage of 84.67% with very valid criteria. Through straightforward, communicative, dialogic and interactive indicators, and suitability with the level of student development.

The expert module validation sheet consists of aspects of feasibility practicum. The graphic aspect has three indicators, namely media size, media cover design, and media content design (BNSP, 2007). For the feasibility aspects of graphics obtained an average of 83.64% with very valid criteria. The calculation results from media experts and material experts obtained an average percentage of 83.72% with very valid criteria, so that the practicum modules developed can be used very well in the learning process.

After completing the validation, the next step is a limited trial. This limited trial aims to determine the response of students to the practicum modules that were developed at the same time want to find out the practicality of the modules developed and the effectiveness of the practicum modules by looking at students' concept understanding skills after using the practicum modules that were developed.

To find out the response of students is done by giving questionnaires to the test subjects, namely undergraduate students in the Mathematics Education Study Program IKIP PGRI Pontianak, amounting to 30 people. Components assessed from the student response questionnaire included aspects of interest, language and material. From the calculation of the overall aspects obtained an average percentage of 86.14% with a very good response. Based on these results, it shows that the practicum module is very useful and helps students in understanding the concept of geometry. Practicum modules are printed media that are arranged to be understood and studied independently by students. Based on the results of these calculations it can be concluded that the module developed is classified as very practical.

In addition, based on the results of the study showed that the results of the posttest students' ability to understand the concept of being effective with a percentage of 67%. This shows that the practicum module has an effect on the ability to understand student concepts. This is because the analytical geometric practicum module in this field is based on geometer's sketchpad (GSP) so that it will help students in illustrating geometry especially in learning analytic geometry of fields (GAB). Besides learning visualization GAB learning also requires accuracy in measuring such as distance, midpoint, gradient, or equations. Susanta, Rusdi & Maizora (2007) revealed that the characteristic of GSP is the accuracy in measuring digitally and the process of visualization from the beginning with a variety of different dimension sizes is easily understood. Thus, understanding students' concepts in learning GAB concepts with GSP will help students understand and illustrate GAB concepts. Improved understanding of the concept of GAB after learning by

using GSP-based practicum modules in accordance with the research results of Leong & Lim-Teo (2003) and Gecü & Özdener (2010) that learning outcomes of students taught by learning using GSP are better than learning outcomes of participants students without using GSP. The results of this study are also consistent with the results of research conducted by Abumosa (2008), Meng & Idris (2012), Idris (2009), Idris (2012) and Meng & Sam (2013) who say that learning by using GSP can improve geometry thinking. Learning by using GSP can improve understanding of geometry concepts and learning outcomes of geometry (Toh, 2004; Almeqdadi, 2000; Dimakos & Zaranis, 2010; Idris, 2009; and Idris, 2012). In addition, the results of research by Meng & Sam (2011), Meng & Sam (2013) and Abdullah (2005) show that GSP can be an innovative tool to improve learning geometry. that learning by using GSP can improve geometry thinking. Learning by using GSP can improve understanding of geometry concepts and learning outcomes of geometry (Toh, 2004; Almeqdadi, 2000; Dimakos & Zaranis, 2010; Idris, 2009; and Idris, 2012). In addition, the results of research by Meng & Sam (2011), Meng & Sam (2013) and Abdullah (2005) show that GSP can be an innovative tool to improve learning geometry. Thus, it can be concluded that the analytical geometric practicum module based on the Scetpche geometer application is classified as effective in improving students' understanding of concept skills.

4. CONCLUSION

Based on the results of research and discussion, in this study it can be concluded that: (1) the practicum module developed is classified as very valid, (2) the practicum module developed is very practical, and (3) the practicum module developed is effective in increasing students' understanding of concepts. This can be seen from the results of the posttest given after learning by using a GSP-based practicum module.

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