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# The Development Of Constructivism Based Module For The Materials Of Composition And Inverse Function For Science Students Of Senior High School In Indonesia

Nana Sepriyanti, Yulia, and Annisa Prihartini

**Abstract:** Development a constructivism-based module for the materials of composition and invers function aims to know the validity and practicality of constructivism-based module for Natural Science Grade 11th's learners. The type of the research is Research and Development that uses 4-D model by S. Thiagarajan (1974) that consist of 4 stages, i.e. defining stage, designing stage, developing stage, and disseminating stage. The research is only conducted until the third stage. Define's stage consists of: a) the analysis front-end; b) the analysis of learners; c) the analysis of concept; d) the analysis of task; and e) specification of learning objectives. Design's stage consists of:a) design of the mathematics module; b) design of lesson plan (RPP); and c) design of research instruments. Develop's stage consists of: a) validation module and RPP by expert; b) trial; c) observation; d) questionnaire responses of teachers and learners; d) interview with learners. The research resulted a module of composition and invers function based constructivism for natural science grade 11th's learners. Result of the research indicates that based on the assessment of experts, this module have been valid with an average of 82,89%. Based on the result of questionnaire responses of teachers, questionnaire responses of students, and interviews with students indicates this module have been practical use on mathematics lesson with an average 81,14% by teachers and 90,71% by learners.

**Index Terms:** module, constructism, composition and invers function, 4D Model

## 1 INTRODUCTION

The use of learning resources that are not in accordance with the needs of learners can lead the learners into the difficulties in learning, especially if the educator explaination as the learning process and materials that are difficult and too fast or not in accordance with the speed of learning learners. This will certainly trigger the learners to become the passive learners. In addition, in the process of learning in the classroom, learners tend to only receive knowledge from educators without any process of finding or forming knowledge by learners themselves. Though there are some basic materials that can be understood by the process of constructing old knowledge learners to form new knowledge. Learners tended to focues only for the understanding against a material and able to complete the exercise questions related to the material. This causes the level of students' understanding of a math material to be low and learning becomes less meaningful. Research has shown such a constructivist-based approach to be promising [9] [11], and positive effects have been found for both student performance and motivation. Such Constructivist instruction appears to motivate students because they find it more pleasant and more challenging to study in such a manner [2]. In recent years, the question of whether such constructivist-based mathematics instruction is as effective for low-achieving students as for normally achieving students has been raised [36]. For example, Baxter studied the response of low- achieving third graders in five classrooms to reform-based mathematics instruction and concluded that the form and content of instruction must be adapted to the needs of low achievers before they can benefit from reform-based instruction [36]. In an earlier study, Woodward and Baxter also found an innovative curriculum to clearly benefit average and above-average students but to benefit students with learning disabilities and low achievers only marginally. In addition, a meta-analysis of 58 mathematics interventions showed direct instruction to be more effective than constructivist instruction for students with special needs [18]. However, in a recent study, constructivist instruction was more effective than direct instruction for low achievers [16]. Nevertheless, many researchers believe that students with learning difficulties need more direct and explicit instruction to learn basic facts and problem solving skills [14]. Explicit instruction is also one of the most popular methods for helping learners acquire greater automaticity [12]. Studies have shown that carefully constructed explicit instruction is effective for teaching computational skills [7]. Similarly, Jones, Wilson, and Bhojwani argued that, although the effectiveness of explicit instruction is questioned in current athematics reforms, students with learning disabilities and low math achievers require explicit instruction to learn math concepts, skills, and relationships; in fact, the presentation of multiple approaches and alternative strategies for the omputation and solution of problems may only lead to confusion on the part of such students [15]. Furthermore, explicit instruction can increase the motivation of low achievers in addition to facilitating their performance because such instruction enables them to handle difficult tasks and thereby motivates them, in many cases, to attempt new tasks [2]. A discrepancythus exists between the application of constructivist learning theories in general education, as promoted by the current mathematics reforms, and the application of more explicit instruction, as recommended for low achievers. In the present study, we investigated this discrepancy further, specifically, the role of students' contributions in their learning (constructivist instruction vs. explicit instruction). To evaluate the two teaching methods, we had to consider how students learn, particularly low achieving students in comparison to normally achieving students. The two most important goals of the current elementary mathematics curriculum in The Netherlands are the automatized mastery of basic operations and the acquisition of adequate problem-solving strategies. Given that children with learning difficulties generally have less than adequate memory skills, concomitant storage and retrieval problems, and limited development of the strategies needed for successful problem solving [26], they tend to have difficulties in the two aforementioned areas of mathematics.

They frequently show motivational deficits as well [20]. In the process of learning and instructional, the learners should be actively involved and learners become centers of learning and learning activities in the classroom. To that end, educators must provide opportunities for learners to find or apply the ideas of learners themselves [3]. The constructivism approach as learning emphasizes the active role of learners in building understanding and giving meaning to information and events experienced. Thus, the development of learning resources of mathematics with constructivism-based is one solution to help learners and educators in learning mathematics that aims to make learners actively involved in learning [24]. Constructivism, derived mainly from the works of Piaget [4] [34] [35] is both a philosophical and psychological approach based on social cognitivism that assumes that persons, behaviors and environments interact in reciprocal fashion [29]. Constructivism is a doctrine stating that learning takes place in contexts, and that learners form or construct much of what they learn and understand as a function of their experiences in situation [29]. More recently, researchers have presented more qualitative documentation of learning in context [19] [28]. The constructivist perceptions of the learner and learner behaviors parallel those described above and conflict with dominant culture perspectives. Historically, in American classrooms, the learner has been viewed as "an empty vessel" or "blank slate" and learning has been thought to be a repetitious "mimetic" activity [13]. The constructivist vista is far more panoramic and elusive." Deep understanding, not imitative behavior is the goal.... In the constructivist approach, we do not look for what students can repeat, but for what they can generate, demonstrate, andexhibit ."[4] Constructivist classrooms here the teacher teaches and scaffolds; observes the learner and offers hints and feed back to guide her/his thinking. This guidance includes encouraging the student to reflect on and talk about that thinking as well as compare it with the thinking of others [6]. Constructivist classrooms are not dominated by text book oriented "teacher talk", rather, they are environments of collaborative problem solving. Teacher and text domination: "Conscientious students who are acculturated to receiving information passively and awaiting directions before acting will study and memorize what their teachers tell them is important. Robbing students of the opportunity to discern for themselves importance from trivia can evoke the conditions of a well-managed classroom at the expense of a transformation-seeking classroom"[4] Like the social interactional patterns described by Phillips above, the foundational principles on which constructivism is grounded emphasize social and cultural mediation of learning. "Constructivism is not a theory about teaching. It's a theory about knowledge and learning. Drawing on a synthesis of current work in cognitive psychology, philosophy, and anthropology, the theory defines knowledge as temporary, developmental, socially and culturally mediated, and thus, non-objective. Learning from this perspective is understood to be a self-regulated process of resolving inner cognitive conflicts that often become apparent through concrete experiences, collaborative discourse, and reflection"[4] Modules can be used as one of the learning resources that students use in learning independently with or with the guidance of educators to achieve learning goals. The module is basically a teaching material that is arranged systematically by using a language that is easily understood by learners in accordance with the level of knowledge and age so that learners can learn independently with the help or minimal guidance from educators [23]. Based on observations at SMA Negeri 1 Nan Sabaris , West Sumatera, Indonesia, on February 29th to March 5th, 2016, the availability of quality textbooks and in accordance with the Education Unit Level Curriculum (KTSP) can be mentioned as adequate. However, in the implementation of learning, it is only educators who used textbooks in teaching and learning process, while learners did not use textbooks and more likely to use Student Worksheet. Based on interviews with 11 students of grade XI IPA SMAN 1 Nan Sabaris (Senior High School 1 Nan Sabaris) Academic Year 2015/2016, textbooks available in schools are less interesting to read by the learners because the presentation of material in the form, the long description and language used was hard to understand by the learners. Therefore learners are more likely to use Student Worksheet in learning activities. On the other hand, the use of students worksheets that can be said as the only learning resource used by learners in the learning process of mathematics less able to meed the needs of learners to achieve the optimal learning objectives of mathematics. For example, when learners need an introduction to material in understanding that requires reasoning, student's worksheets does not provide the illustrations or steps that lead learners to discover the concepts of a subject matter. For example on the compositions of materials and function of inverse function. According to 11 students of class XI IPA SMAN 1 Nan Sabaris (Senior High School 1 Nan Sabaris) Academic Year 2015/2016, that material is one of the difficult materials, moreover in determine the composition of the three functions and determine the inverse of the composition function itself. One of the educators of mathematics who is teaching in grade XI Science said that learners are often confused when doing exercises about the function of composition and inverse function at the same time. The presentation of students; worksheets material which is only a summary of the material, it is certainly not enough as a reference to learning mathematics for the solution of the above problems. After a short description of the material then proceed with a sample problem and not equipped with instructions or steps that enable learners to learn. One assumption underlying the above-mentioned reforms is that the new mathematics instruction is effective for all students and therefore for low achievers. However, results of a few recently pulished studies show that this assumption is not always correct. Based on the background of the above problems, then the formulation of the problem in this research is ho is the module based on constructivism material composition function and inverse function that meets the criteria of validity and practicality ?. Based on the formulation of the problems that have been proposed, the purpose of this study is to produce a constructivism based module on the material composition function and inverse function that meets the criteria of validity and practicality.

## 2. METHOD

### Research methodology

Based on the problems mentioned earlier, the type of the research conducted is development research. Development Research is a research method used to produce a particular product, and test the effectiveness of the product. The development model used is a 4-D model developed by S.

Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel consists of four stages: define, design, develop, disseminate. However, in this development only limited to the develop stage, because the researchers did not examine the effectiveness of the module[20].

### Time And Setting

Time and Setting of this research development research was conducted from November 2016 - January 2017 at Senior High School1 Nan Sabaris (Senior High School 1 Nan Sabaris), West Sumatera, Indonesia.

### The Test Subjects

The test subjects in this study were 7 students consisting of two students with high ability, three students with moderate ability, and two students with low ability in grade XI IPA (science) Senior High School Nan Sabaris of Padang Pariaman of West Sumatra.

### The Procedure Of The Research

The procedure of the research performed in this study which is consists of 3 stages: The define stage consists of: a) the final preliminary analysis; b) analysis of learners; c) conceptual analysis; d) task analysis; and e) the formulation of learning objectives. The design phase consists of: a) module design; b) designing RPP; c) the manufacture of research instruments. The development stage consists of: a) self evaluation; b) assessment of modules by experts / experts; and c) one-to-one evaluation. Here is a flow chart of the research procedure.

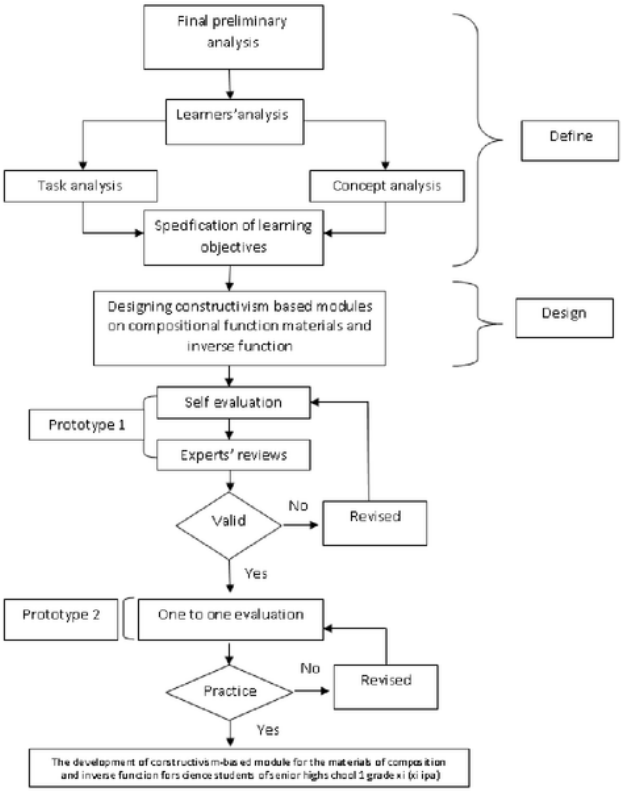


***Figure 1**. flow chart of the research procedure.*

The constructivist-based mathematical module was validated by validators consisting of 2 lecturers of mathematics, 1 linguist, 1 educational technologist, and 1 mathematics educator. A valid module is then performed one to one evaluation in order to know the module's practicality.

### Data, Instruments, and Data Collection Techniques

In this study the instruments used are validation sheet and practicality test sheet. The validation sheet consists of the instrument validation sheet and module validation sheet. Practicality test sheets consist of questionnaires, observation sheets, and interview guides.

### Technique of Data Analysis

Data analysis of validation results using the criteria of validity by determining the category of validity by calculating the validity of data value (total number of scores / maximum score). The following validity criteria are: 85<NV≤100 (very valid), 75<NV≤85 (valid), 55 <NV≤75 (valid enough), and 0 <NV≤55 (invalid). Likewise, the analysis of practical data also uses the criteria of practicality pursuant from Purwanto (2009: 82) by determining the category of practicality by calculating the data of practicality value (total number of scores / maximum score) multiplied by 100%. The following validity criteria were: 85<NA≤100 (very practical), 75<NA≤85 (practical), 55<NA≤75 (practical enough), and 0<NA≤55 (not practical)). Furthermore, the analysis of practical data by using observation sheet and interview guideline is done by three stages: data reduction, data presentation, and data verification.

## 3. RESULT AND DISCUSSION

The results of this study are described based on the development of constructivism based modules that were tested in grade XI IPA 4 SMAN 1 Nan Sabaris ( Senior High School, sience). The development of this module uses a 4D model (define, design, develop, disseminate, limited only to develop) The following will be described in 4D stages. In the define stage 5 analyzes, namely the initial analysis, the analysis of learners, concept analysis, task analysis, and the formulation of learning objectives. In the final analysis, mathematics curriculum was analyzed on compositional function material and inverse function for SMA XI IPA science) which refers to KTSP curriculum 2006 (the Education Unit Level Curriculum). The result of early preliminary analysis is contained in the syllabus of mathematics subjects on the subject of compositional function and inverse function which have been available in KTSP 2006's curriculum. In the analysis of learners, the object of analysis is the students of class XI IPA 4 SMAN 1 Nan Sabaris (Senior High School 1 Nan Sabaris). This analysis is conducted to determine the level of intellectual ability of learners, cognitive development, learning motivation, and language style. In the concept analysis, standard competency and basic competency analysis, as well as analysis of relevant learning resources are performed. The result of this analysis is identification of concepts to be taught systematically arranged and detailed. In the task analysis, this is must be mastered by learners to achieve minimal competence. All these tasks are presented in the module. In the formulation of goals of learning, it was made formulation of behavioral changes that are expected after learning with operational verbs based on the results of concept analysis and task analysis. After passing through the

define stage, subsequent design of the constructivism based module on compositional function and inverse function, RPP (the syllabus and lesson plan), and the assessment of the instrument will be used to assess the module and the lesson plan. In the module design, the steps are taken to arrange the module needs map, define the module structure, and write the module. Preparation of module needs map is done by taking into account the standard competences and basic competence as well as indicators of achievement of competence to facilitate researchers in ordering the materials that will be presented in the module. The designation of the module structure refers to the expected product specifications, so as to assist learners in knowing the elements contained in the module. Writing modules adapted to KTSP 2006 and refers to the characteristics of constructivism learning, as well as making the module needs and module structure that has been designed as a guide in module writing. In the design of RPP (Lesson Plan and syllabus) , the sequence of writing Lesson plan in accordance with Lesson Plan and syllabus for components in Permendikbud (The Standard Program in The Minister of National Education Regulations); Number 65, Year 2013, namely the identity of Lesson Plan, standard competences, Basic Competence , Indicators of achievement of competence, learning objectives, teaching materials, time allocation, learning methods, step-learners, tools and learning resources, and assessment of learning outcomes. After the module and syllabus are completed, the design of the research instrument is used to assess the validity and practicality of the module. Instrument made in this research consists of 5 kinds, namely self evaluation sheet, module validation sheet, syllabus of validation sheet, module lecturer test questionnaire by learner, and questionnaire of module practicality test by educator. Furthermore, the pre-made instrument is dividend by 5 validators before being used to assess the module. After all instruments are judged and declared valid by the instrument validator, further evaluation of the module using the instrument is performed. This module assessment is done at the development stage. The Development stage is done to know the validity and practicality of the module. This stage consists of prototyping stages, namely self evaluation, expert reviews, and one-to-one evaluation. Self evaluation stage is the stage of module assessment conducted by the researchers themselves using self evaluation guidelines. If the module is deemed valid and in accordance with the aspect of the assessment, the next stage of ill be the expert reviews. In the Experts reviews stage, the module and the lesson plan were assessed by 5 experts consisting of 2 lecturers of mathematics, 1 educational technologist, 1 linguist, and 1 mathematics educator. At this stage revision of the module and lesson plan is in accordance with expert advice. Revisions are made until the module and lesson plan are declared valid by the 5 experts before. After the module is declared valid by the assessor, then the next stage ill be done is stage one-to-one evaluation in order to know module practice. At the one-to-one evaluation stage, 7 students from grade XI IPA 4 SMAN 1 Nan Sabaris academic year 2015/2016 were asked to use the module and comment on the module. The 7 students were selected based on the mid term test semester's even range of scores and used the standard of deviation. 7 students are divided into 2 people with high math skills, 3 moderate math skills, and 2 people with low math skills. The commenting by learners is done by filling out the response and interview questionnaire. In addition, two mathematics educators were also asked to comment on the module by completing a practicality questionnaire. After doing these stages, then analyzed the validity sheet, questionnaire, interview, and observation of the module's implementation. The results of validity analysis and module practice are described as follows.

***Table. 1*** *Analysis of The Validity*

| N | Aspect of assessment | Value of the Validity (%) | Criteria |
|---|---|---|---|
| 1 | Eligibility of the content | 79,68 | Valid |
| 2 | Language | 83,00 | Valid |
| 3 | Presentation and graphics design | 86,00 | Very Valid |
| | Total | 248,68 | |
| | Average Validity of Value (%) | 82,89 | Valid |

Based on Table 1 above, it is known that the average validity of the module is 82.89%. According to Purwanto (2009: 82), if 75% <Value Validity ≤85% then said the module is valid. Thus, the validation results generally indicate that the composition function module and inverse function based on constructivism are categorized as valid.

***Table 2.*** *The Total of Lesson Plan and Validation Results*

| N | Aspects of Assessment | Validity value (%) | Criteria |
|---|---|---|---|
| 1 | Identity of Lesson Plan | 99,16 | Very Valid |
| 2 | Formula of competency, Indicators, and Learning Objectives | 82,50 | Valid |
| 3 | Learning Materials | 77,50 | Valid |
| 4 | Time allocation | 85,00 | Valid |
| 5 | Learning approach and methods | 80,00 | Valid |
| 6 | Learning activity | 81,66 | Valid |
| 7 | Source of Learning | 95,00 | Very Valid |
| 8 | The result of the learning | 79,00 | Valid |
| | Total | 679,82 | |
| The Average of Validity Value (%) | | 84,97 | Valid |

In Table 2, it is known that the average of validity value of RPP is 84.97%. if 75% <Validity Value ≤85% then the RPP is said to be valid. Thus, the validation results generally indicate that constructivist based RPP is categorized as valid. After the module is getting valid by validator, then do one to one evaluation. One-to-one evaluation is done by asking learners to comment on constructivism-based modules on compositional function and inverse functions that have been designed. There are three stages performed during the one to one evaluation of observation, filling in questionnaires by educators and learners, as well as interviews with learners. Based on the observations on one-to-one evaluation, learners are interested and able to use the module. But in solving the problems in the module, learners have encountered several obstacles. Furthermore, filling in questionnaires by educators and learners. Here are the results of module practice by educators and learners.

***Table 3.*** *Detailed Practical Assessment Module by Educator*

| N | The assessment aspects | Practicality value (%) | Criteria |
|---|---|---|---|
| 1 | Benefits | 72,50 | Quite Practical |
| 2 | Eficiency | 81,25 | Practical |
| 3 | Easy to use | 87,50 | Very Practical |
| 4 | Attractiveness | 83,33 | Practical |
| | Average (%) | 81,14 | Practical |

Based on Table 3 above, it can be seen that the composition function module and inverse function based on constructivism obtained the average practicality value of 81.14%. If 75% <Practical Value ≤85% then the module is said to be practical. Thus, the results of questionnaire modular test questionnaires by mathematics educators show that the composition and function module of constructivism-based inverse function is practically categorized. At the one-to-one evaluation stage it is concluded that during the learning of each learner is actively involved and enthusiastic in following the learning process with the module. Pressure in the learning process lies in the learner, while the module acts as a substitute educator who served as a facilitator learners in learning. In addition, the learning process using a constructivist-based module emphasizes the learning process rather than the outcome. Thus, the principles of constructivism learning have been achieved using constructivism-based modules develop in the learning process. Based on the results of interviews with 7 students at the one-to-one evaluation stage, it was concluded that the use of modules in learning can help learners independently. However, module can improve learners' learning spirit and maximize learners' learning time as according to learners' learning speed. The language used and the sentences in the module are easily understood learners. Module design is also interesting so that learners do not quickly bored in the learning process by using this module. Based on the analysis of the results of the observation, interview, and questionnaire response of learners and educators, it can be concluded that the module functions of thr compositions and constructivism-based inverse function developed categorized practical for all aspects have been assessed. Based on the results of data analysis validity test and module practicability that has been stated above, it can be concluded that the composition function module and constructivism based function is categorized as valid and practical for use in mathematics learning activities. The validity and practicality of the modules indicate that the module already has four functions, namely as independent teaching materials, substitution of educator function, as an evaluation tool, and reference material for learners [23].

### Limitations of Research

The research of development of constructivism-based modules on the material of compositional function and inverse function has the following limitations.

1) The module is developed only until the develop stage.
2) Limitations of research time so that research can only be done until the module meets the practical criteria seen from the one-to-one evaluation.
3) Modules designed only for material composition functions and inverse functions. The truth of the questionnaire given to learners can not be fully controlled by the researcher. Especially the aspect of honesty and seriousness in filling in the questionnaire. At the time of filling the questionnaire, there can be a response that is not in accordance with the actual situation. There is a possibility that there is a subjective element or particular consideration by the respondent that is unknown to the researcher.

## 4. CONCLUSION

The result of the research of the development of constructivism based module on compositional function and inverse function which has been described in result and discussion, it can be concluded that the function module of composition and inverse function based on constructivism for students of grade of XI science majority fulfill valid criterion with mean of 82,89% and meet practical criteria seen from observation result of module, interview, and questionnaire test of module practicality by learners and educators with the average of practicality score 90,71% and 81,14% respectively.

## 5. SUGGESTION

Based on the research development that has been done, researchers have suggestions as follows: 1) Research development of this module is only done until the development stage only. For that, in order to get more satisfactory results other researchers should do research development to stage disseminate. 2) The modules developed in this study are still limited to one material, namely the function of composition and inverse function, so it is possible for other researchers to develop math modules with other materials. 3) The function modules of composition and inverse functions developed using the constructivism approach, so it also does not close the possibility for other researchers to develop modules with the same material but using different learning approaches.

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