Schema of competencies for mathematics junior high school based in Indonesian curriculum

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Abstract. The objective of this research was to develop a Schema of Competencies for Mathematics Junior High School Based in Indonesian Curriculum, specifically for VII and VIII grades and thus, to describe the assessment results given by mathematics education experts and teachers on the product with regard to feasibility of implementation. The research method is qualitative/ descriptive using the 4D development model. The subject of this research was a Junior High School mathematics teacher in Yogyakarta and mathematics education experts. Qualitative data was obtained from development notes, suggestions from supervisors, mathematics education experts, and teachers. After that, the data were analyzed using descriptive analysis that is used to revise the products. The quantitative data collection was carried out by questionnaire and analyzed using Aiken's V. This research produces a schema of competency achievement, which is diagram that describes the order of achievement of a defined competency. There are 23 knowledge and skill basic competencies that contain 19 mathematical topics. There are 9 topics studied in 7^{th} grade and 10 topics studied in 8^{th} grade. The following things that are done in developing a scheme is calculation the number of effective weeks, translation of Indicators from basic competencies, compilation of the semester program, determine competency prerequisites, preparation of product assessment sheets, make a scheme systematics, expert validation and then revise the scheme, after that do a product feasibility assessment. The content-validity coefficient for each material in the range of 0,819 – 0,917 on very high criteria. Therefore, the schema of competency achievement is feasible to implement.

1. Preliminary

The government always makes improvements to the quality of the education system, one of which is realized in the form of curriculum development. Curriculum changes were made to prepare the young generation to be able to face challenges or problems in the present and future. In Indonesian context, the national curriculum that is called 2013 curriculum was developed based on the theory of the *competency-based curriculum* [1]. Education-based on a competency-based curriculum is designed to provide the widest learning experience for students in developing the ability to behave, be knowledgeable, be skilled, and act.

The learning objectives in the 2013 curriculum are seen in Core Competencies and Basic Competencies. Core Competency is the level of ability to achieve the Graduate Competency Standards that a student must have at each grade level or program. Basic competence is the ability and minimum learning material that students must achieve for a subject in each educational unit that refers to core

competencies. To measure the achievement of these competencies, indicators of competency achievement are made which are derived from the Core Competencies and Basic Competencies.

The concepts in mathematics are arranged in a hierarchical, structured, logical and systematic from the simplest concept to the most complex concepts. According to Kosasih [1] change as a result of learning is based on previously owned knowledge and that new knowledge also forms the basis for the acquisition of more complex subsequent knowledge. Likewise in learning mathematics, students need to understand a concept to learn further concepts that are certainly more complex.

Mathematical concepts that have been studied by students for a long time to obtain new knowledge are stored in the form of schemata. This is supported by the statement that *schemata are a mental framework that we use to organize knowledge* [2]. A new concept that students learn and the scheme matches the scheme/schemata they already have, the concept will be adapted so that new knowledge is formed. This learning process is called the assimilation stage. Meanwhile, if a new concept that students learn turns out to be somewhat different or completely incompatible with an existing scheme/schemata, then there are two possibilities that can occur: (1) forming a new scheme that matches the new concept, or (2) modifying the scheme existing so it fits into the new concept. This learning process is called the accommodation stage. To make it easier for students to learn new concepts, a good arrangement of schemes is needed and clearly, there is a bond between a concept and other concepts. This can be realized by facilitating the automation of the scheme, which is that the knowledge that has been stored needs to be trained over and over again so that it can be brought back by students automatically [3].

It is important for teachers to present learning materials systematically, and the thing that should teacher do at the beginning of lesson is giving apperception for students. According to Mansur [4], apperception is connecting old lessons with new lessons or linking what students already know and experience what they will learn. With the existence of apperception, it is expected that students can remember the prerequisite material which will certainly make it easier when they learn new material.

Retnawati [5] presents the obstacles of junior high school mathematics teachers in implementing the 2013 curriculum. Some of the teachers obstacles in implementing the 2013 curriculum include the difficulty of teachers planning and implementing learning. At the planning stage of learning, the teacher has difficulty when planning the learning process flow. While in the implementation phase of learning, students often do not master the prerequisite material so that learning activities become impeded. The results of research conducted by Maisyaroh, Zulkarnain, Setyowati, and Mahanal [6] also revealed the problems that teachers faced when implementing the 2013 curriculum, namely teachers find it difficult to prepare and develop lesson plans and develop indicators that are in accordance with basic competencies.

Based on the description above, the development schema of competency achievement as a basis for planning lessons can facilitate students in automating the scheme, forming interconnected schemes and facilitating students in learning new concepts. In this paper, *Schema of Competency Achievement* can be understood as diagrams that describe the order in which competencies have been determined. The framework contains indicators that can be used to measure the achievement of student competencies. The developed framework connects knowledge competencies and skills competencies. The indicators are arranged based on the level of cognitive processes. Schema of competency achievement is also expected to help teachers and students of mathematics education in developing lesson plans.

There are many competencies that must be achieved in mathematics by junior high school students. These competencies are the development of the competencies that have been obtained at the elementary school level and also new ones that have never been obtained when sitting in elementary school. The new competencies that will be studied in junior high school are certainly more complex than the competencies that have been learned in elementary school, so they require prerequisite material that can support students' ease of learning. This paper developed the scheme based on the attachment of the Minister of Education and Culture Regulation No. 21 of 2016 [7], the

scope of Mathematics for junior high school in the 2013 curriculum includes: (1) numbers, (2) algebra, (3) geometry and measurements, (4) statistics and opportunities.

Table 1. Mathematical Scope of 7th and 8th grades.

Aspect	Topics
Number	Integers and Fractions, Number Patterns, Coordinate Systems
Algebra	Sets, Algebraic Expressions, Relation and Functions, Comparisons, Social Arithmetic, Equation and Inequality of One Variable Linearity, Two-Variable Linear Equation Systems, Straight Line Equations
Geometry and Measurement	Lines and Angles, Plane Geometry, Solid Geometry, Circles, Pythagorean Theorem
Statistics and Opportunities	Statistics 1 (Presenting and Interpreting Data); Statistics 2 (Mean, Median, Mode, Quartile); Opportunities (Empirical and Theoretical)

This research development aims to 1) develop the Schema of Competencies for Mathematics Junior High School Based in Indonesian Curriculum, specifically for VII and VIII SMP classes, and 2) describe the results of the assessment from mathematics education experts and mathematics teachers about the schema of competency achievement in terms of the feasibility of their implementation.

2. Research Methods

2.1. Types of Research

This type of research is qualitative research. Using this approach, the current study attempt to provide rich descriprion on how to develop an educational product, that was named the Scheme of Competency Achievement in Mathematics Subjects.

2.2. Research Design Procedure

The used research design refers to the 4D development model developed by Thiagarajan that through 4 stages, namely *Defines*, *Design*, *Development*, and *Dissemination*.

In the define phase curriculum analysis is carried out. At the design stage Calculations effective amount of a week, outlines the basic competencies into the indicators, compiling the semester program, and determine the material prerequisites that must be mastered before studying each indicator. Together with it, a well-structured sheet product assessment to determine the feasibility of implementation.

At the development stage, researchers developed research products such as the attainment scheme using the *software* Microsoft Visio Professional 2016. Furthermore, the product will be assessed by expert Qualitative mathematics education. The results of the assessment in the form of criticism and suggestions are used to revise the product. The revised competency scheme will be reviewed quantitatively to mathematics education experts and mathematics teachers so that the feasibility of implementing the product is known. The last stage is the dissemination on a small scale that is distributed to mathematics teachers for VII and VIII grades at schools or in seminars.

2.3. Object of Research

The object of research is the Schema of Competencies for Mathematics Junior High School Based in Indonesian Curriculum, specifically for VII and VIII grades.

2.4. Location and Time of Research

The research is conducted in two Yogyakarta junior high schools and on 31 August 2018 to 30 November 2018.

2.5. Research Instrument

The research instrument used to obtain data consisted of instruments for qualitative data and instruments for quantitative data.

2.5.1. An instrument for Qualitative Data. Researchers use development notes, input from supervisors, mathematics education experts and teachers as qualitative data from the first stage to the last stage of research.

2.5.2. The instrument for Quantitative Data. The instrument for quantitative data in the form of a Schema of Competency Achievement assessment sheet containing assessments from various aspects. There are five aspects in the assessment sheet, namely the completeness of the components of the scheme, aspects of the flexibility of the appearance of the scheme, aspects of the suitability of the contents of the indicators with Basic Competence, aspects of the suitability of the indicators of competency achievement, and aspects of the readability of the scheme / diagram. Products developed are assessed by experts. On the product assessment sheet, experts are asked to give an assessment from 1 to 5. Value 1 if the statement is very inappropriate or very inappropriate with the product being developed. While the value of 5 if the statement is very appropriate or very precisety. On the last page, there is a comment column and suggestions that assessors can use to provide evaluations.

2.6. Data Analysis Technique
The following are qualitative and quantitative data analysis techniques that have been obtained.

2.6.1. Qualitative Data. Qualitative data is most often obtained during development and evaluation by experts. The data is then analyzed descriptively. This descriptive qualitative analysis technique is used to process data on the results of an assessment of mathematics education experts. This data analysis technique is done by grouping information from qualitative data in the form of input, responses, criticisms, and suggestions for improvements contained in the questionnaire. The results of the analysis are then used to revise the developed product.

2.6.2. Quantitative Data. Quantitative data were obtained from the Schema of Competency Achievement assessment sheet by mathematics education experts and teachers. Schema of Competency Achievement assessment sheet contains aspects for assesing the schema. The score data provided on a scale of 1-5. From the results of the assessment, the data is processed using the Aiken's V formula to calculate the content-validity coefficient based on Azwar [8].

Eligibility criteria based on Basrowi & Koestoro [9], if the feasibility value exists at 0.8 – 1.000 intervals than the product has very high criteria, at 0.6 – 0.799 intervals has high criteria, at 0.4 - 0.599 intervals has high enough criteria, at 0.2 – 0.399 intervals has low criteria, and if the feasibility value < 0.200 the product has very low criteria. The product is declared to be feasible to be implemented if it has minimum criteria of High.

3. Results and Discussion

Description of the results of developing the Competency Achievement Scheme using the 4D model, namely *Define, Design, Development,* and *Dissemination*. The results of each stage are described as follows.

3.1 Define.
Activities at this stage are carried out to determine what products will be developed. At this stage, a curriculum analysis is carried out which is used as a benchmark for product development. The results of the curriculum analysis are described as follows.

Student learning for mathematics class VII and VIII is 5 hours per week, with a duration of 40 minutes for every 1-hour lesson. The learning objectives of mathematics in the 2013 curriculum are contained in the form of Core Competencies (KI) and Basic Competencies (KD). Core Competencies and Basic Mathematics Competencies in SMP / MTs are contained in the Minister of Education and Culture Regulation Number 24 Year 2016. The basic competencies that must be achieved in class VII are 12 knowledge competencies and 12 skills competencies, while for class VIII there are 11 knowledge competencies and 11 skills competencies.

Twenty-three basic knowledge competencies and skills learned in grades VII and VIII contain 19 mathematical topics, of which 9 topics are studied in class VII and 10 topics are studied in class VIII. Each topic has at least one basic competency of knowledge and skills, but some have up to three basic competencies of knowledge and skills. Following are 19 topics studied in grades VII and VIII, namely 1) Integers and Fractions; 2) The set; 3) Algebra; 4) Linear and Inequality of One Variable Linear; 5) Comparison; 6) Social Arithmetic; 7) Lines and Angles; 8) Squares and Triangles; 9) Statistics 1 (Presentation and Interpretation of Data); 10) Number Patterns; 11) Coordinate System; 12) Relationships and Functions; 13) Straight-line Equations; 14) Two-Variable Linear Equation System; 15) Pythagorean Theorem; 16) Circles; 17) Build a Flat Side Room; 18) Statistics 2 (Size of Centering Data); and 19) Opportunities. Competency Achievement scheme was developed based on the basic competencies that include those 19 math topics.

3.2 Design.

The following is an elaboration of the design stages.

1. Calculation of Number of Effective Weeks. The Calculation is done by reviewing the education calendar issued by the Office of Education to determine the number of effective weeks in each month. If within 1 week there are 3 or more effective days, then count 1 effective week. In the 2017/2018 school year, there were 37 effective weeks for teaching and learning activities.
2. Translation of Indicators from Basic Competencies. Indicators of Competency Achievement are the results of the elaboration of basic competencies that are used to show the achievement of certain basic competencies so that they can be a reference for subject assessment. The operational verb of competency achievement indicators refer to the revised Bloom Taxonomy. Indicators of competency achievement are linked from the simple to the more complex. Simple indicators of competency achievement can be a prerequisite for more complex achievement indicators.
3. Compilation of the Semester Program. The preparation of the semester program is important because it will be used as a basis for developing the Competency Achievement Scheme. There are several things to be considered in the preparation of the semester program, namely the annual program, the allocation of time each week, the number of indicators of achievement of competencies that must be mastered and the frequency of examinations adjusted to the educational calendar.
4. Determine Competency Prerequisites. In developing the Competency Achievement Scheme, the ability to analyze competencies is needed and then used to achieve the competencies to be learned. The researcher analyzes the prerequisite competencies that is needed to study each competency achievement indicator. Some prerequisite competencies have been studied at the previous level, but it also does not rule out the possibility that there are prerequisite competencies that were studied in the previous material or even in one material. For example at this stage, based on the results of the analysis there are basic competencies that require prerequisite material from the previous level, namely basic competencies 3.4 regarding sets and 3.5 about algebra. Students who will learn the set should have mastered the kinds of numbers they have learned in elementary school. Likewise, when students will learn algebra, especially algebra simplification, they need to recall the properties of arithmetic operations such as commutative, associative and distributive.
5. Preparation of Product Assessment Sheets. The preparation of the product assessment sheet is needed to assess the Competency Achievement Scheme. The product will be assessed by mathematics education experts and mathematics teachers to determine the feasibility of its implementation. There are five aspects to be assessed, the first aspect component of the completeness of the scheme includes writing identity, basic competencies to be achieved, page numbers, and instructions for reading the scheme. The second aspect displays a flexibility scheme, namely proportionality size chart, use of the total size of the letters on each component of the scheme, and using in a parody of the arrow to connect between the competence to frame/outline of the diagram. The third aspect of the suitability of the content of

the indicator with the basic competencies include: write the statement of contents of indicators of achievement of competencies based on competency basis , translation number of indicators of achievement of competencies based on competency basis, the using of verb on competence achievement indicator, choose the competencies most relevant necessary as *prior knowledge* to build a chain of cognitive, the depth of learned competencies tailored to the allocation of time , and presentation of many indicators of achievement of competencies learned in every meeting . The fourth aspect of the suitability of the sequence indicator-indicator achievement of competencies, including creases competence controlled and numbering competence achievement indicator. The fifth aspect of legibility schematic/diagram, include: easy to find information about when the competence of the prerequisites to learn and differentiate competencies and competency requirements are studied.

Assessment is done through two stages, the first stage is a qualitative assessment by a mathematics education expert. In this stage, the researcher will find out whether the research product is feasible or not. Researchers also gather criticisms, suggestions, and input from experts to make revisions if needed. After that the second stage of assessment is carried out by a quantitative assessment by a mathematics education expert and a mathematics teacher. The second stage of assessment uses a scale from 1 to 5 to determine the validity criteria for the revised product contents and the feasibility of their implementation.

3.3 Development

This stage contains the activities of making a design into a product and assessing the product in terms of the feasibility of its implementation. Competency Achievement Scheme developed consists of 1) Cover, 2) Table of Contents, 3) Instructions for Reading Competency Achievement Flow, 3) Reading Competency Achievement Scheme, 4) Identity Competency Achievement Scheme, 5), Translation of Indicators 6) Competency Achievement Flow, and 7) Competency Achievement Scheme. Below is an example of a product that was developed.

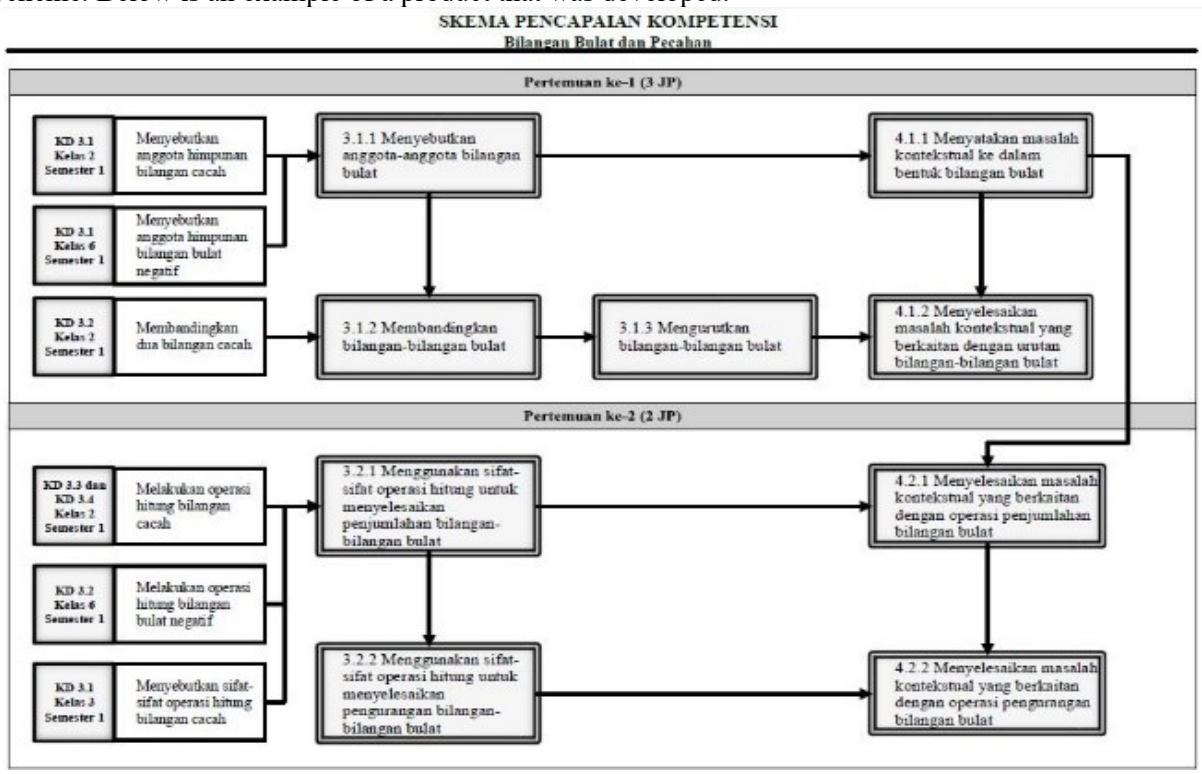

Figure 1. Schema of Competency Achievement.

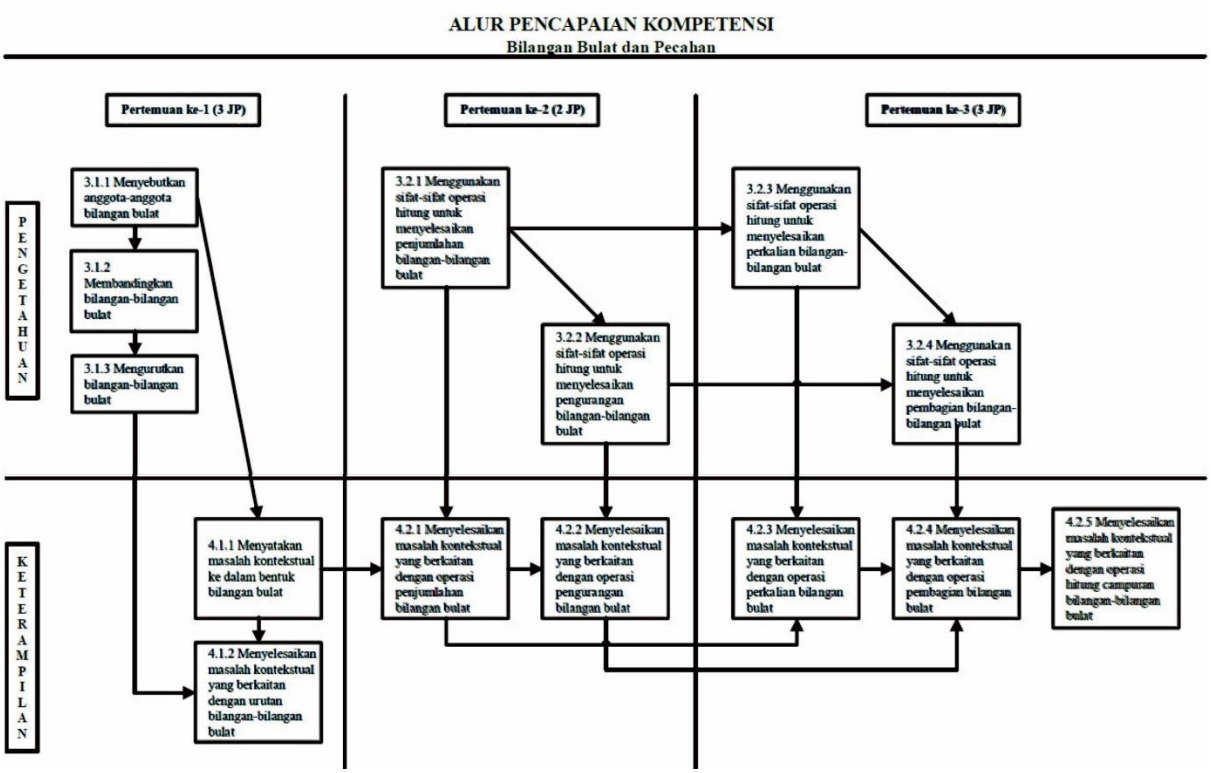

Figure 2. The flow of Competency Achievement.

The difference between the two figures above, figure 1 is a shema of competency achievement which includes the order of competency achievement along with its prerequisite material. Whereas, for figure 2 is the flow of achieving competencies which only includes the competencies learned at JHS.

The Schema of Competency Achievement that has been developed will go through an evaluation process by a mathematics education expert. The results of the assessment and revision are used to evaluate the scheme developed so it is feasible to be implemented. Validation data is obtained by providing a Schema of Competency Achievement and assessment instruments to mathematics education experts. Then the expert will provide an assessment of whether the product is feasible to be implemented or not, criticism, and suggestions/ input as a consideration in revising the research product. The assessment is done by filling out the product quality assessment sheet. With this assessment the researcher knows the shortcomings of the research product and then revises the product. Based on suggestions and criticisms by experts, revisions made by researchers include (1) clarify the instructions for reading the schema of competency achievement and make the directions for reading the competency achievement flowchart; (2) creating a of competency achievement; (3) change some verbs as indicators of competency achievement so that competency is more easily measured; and (4) compact indicators of competency achievement in two topics, because there are too many.

After the schema of competency achievement has been revised according to the advice of mathematics education experts, the next step is a quantitative assessment by mathematics education experts and mathematics teachers for grades VII and VIII using product assessment sheets. This assessment using a scale from 1 to 5 to determine the validity criteria of product content. The results of the validation assessment data analysis, the content validity coefficient for each topic of the Scheme of Competency Achievement is in the range 0.819 - 0.917 which is in the very high criteria. Therefore, the product that has been developed is declared feasible to be implemented.

3.4 Dissemination

Dissemination is carried out on a small scale. The Schema of Competency Achievement that is already feasible to be implemented is distributed to teachers who teach mathematics subjects in VII and VIII grades at schools or in seminars.

4. Conclusion and Suggestion

4.1 Conclusion

The Scheme of Competency Achievement was developed using the 4D model (Define, Design, Development, and Dissemination). In the define phase curriculum analysis is carried out. Products are developed based on the basic competencies of knowledge and skills in the 2013 Curriculum. There are 12 basic competencies of knowledge and skills that must be mastered by VII grades students, and 11 basic competencies of knowledge and skills for the VIII grades. The basic competencies contain 19 mathematical topics, with the division of 9 topics studied in VII grades and 10 topics for the VIII grades. In the design phase researchers calculate the number of effective weeks in one year and obtained 37 effective weeks for teaching and learning activities. Furthermore, each basic competency is translated into indicators and then arranged according to the level of cognitive processes. The compiler of the semester program is used as a basis for product development by considering several previous stages. To determine the prerequisite competencies needed the ability to analyze the competencies that have been possessed so that they can be used to achieve the competencies to be learned. The next step is to compile a product assessment sheet to determine the feasibility of its implementation. At the development stage, researchers developed the products and then will be assessed by mathematics education expert. The results in the form of criticism and suggestions are used to revise the product. The revised schema will be reviewed quantitatively to mathematics education experts and mathematics teachers so that the feasibility of implementing the product is known. The last stage of this research is the dissemination done on a small scale.

The results of the assessment of 19 topics developed into scheme of competency achievement are in the range 0.819 - 0.917 and are included in the very high criteria. Therefore, the product that has been developed is declared feasible to be implemented. In addition, based on the results of the validation, experts and teachers stated that the schema of competency achievement was feasible to be used after the revision.

4.2 Suggestion

Schema of Competency achievement can be implemented by teachers making it easier to develop lesson plans. Learning in schools can refer to schema of competency achievement that begin with apperception so that they are better prepared in learning new material. Further development of schema of competency achievement can be carried out on mathematics subject matter at other levels of education.

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