e-ISSN: 2548-4613

THE DEVELOPMENT OF MATHEMATICS INSTRUCTIONAL AND AUTHENTIC ASSESSMENT MODEL BASED ON CURRICULUM 2013 TO IMPROVE THE ATTITUDE QUALITY, CREATIVE THINKING ABILITY AND MATHEMATICS CONNECTIONS OF HIGH SCHOOL STUDENTS

Bornok Sinaga[1], Marabangun Harahap[2], Pardomuan NJM Sinambela[3], Lasker Sinaga[4]
Mathematics Education, State University of Medan, Indonesia
Corresponding author : bornoksinaga48@gmail.com

Abstract - This research seeks to find a new paradigm of learning mathematics in the form of development models mathematics learning and authentic assessment based on the spirit of Curriculum 2013 (based on competency, learning based on understanding the constructivist, the utilization of cultural values of local and national in building soft skills of students, demonstrated the usefulness of mathematics in solving problems authentic cultural environment and other fields). This learning model is named PMPO-SK2.The method is applied to achieve the goal (a specific target) above, applied methodology of developmental research are: (1) the initial assessment (define), (2) design (design), (3) the realization (construction), (4) Testing, Evaluation and Revision (develop), and (5) widespread implementation (experimental) by taking into account three criteria of product quality, namely: validity, practicality, and effectiveness.Research products that have been produced in first year of this study are (1) model of learning and authentic assessment valid with device support and research instruments are reliable and valid, namely: (2) book learning model mathematics in accordance with the spirit of the curriculum in 2013, (3) book model of authentic assessment, (4) guide of teacher, (5) The student book, (6) Learning Implementation Plan, (7) Sheet Activity of students, (8) an instrument of research and assessment, including assessment of the portfolio results students' work, and (9) the pattern of educational interaction Cultured Limas Triangle.

Keywords : PMPO-SK2 Model, Development of Learning Model, Authentic Assessment, The Pattern of Educational Interaction Cultured Limas Triangle.

1. INTRODUCTION

When the one hundred years of independence, Indonesia country has the advantage of demographic in which the availability of productive young generation of approximately one hundred million (Kemdikbud, 2013). This condition is both opportunities and challenges at the Asean Community in 2015th and this information era. One of the ASEAN Community 2015 pillars is the cultural-social communities of ASEAN that covering of the development of the human resources quality and education identity of ASEAN (Kemdikbud, 2013).. In the present, the graduates are required to have self adaptability, the capability to connecting knowledge with skills in the work, problem solving by creatively and capable of turning a problem into an opportunity.. These competences are difficult achieved, because the learning paradigm still applied transmission or mechanistic learning, linear problem solving, demands of a uniform pattern behavior and competitive learning based.

In the forming of attitudes, knowledge and skill of the quality Indonesian human resource, and capable to respond the future requirement, Indonesian government (Kemdikbud) is issued an important policy in the elementary school, middle school respectively. This policy is called as 2013 curriculum (National Curriculum).. The main idea of curriculum is the identity of the students including of motivation, traits, self-concepts, knowledge and skills developed through learnig process. Therefore, it is necessary the learning model and innovative authentic assessment based on spirit of 2013 curriculum and in accordance to local conditions and students culture.

Based on the above background, the problems of this research are described as below:

1. How does the product model of mathematical learning and authentic assessment is valid, practical, and effective to improve the quality of attitude, creative thinking skill and senior high school connection to mathematics learning.

2. How the book model and the learning instruments that can help students activity and teachers in implementing practically and effectively the 2013 curriculum.
3. How does the model development product of authentic assessment to assess the attitudes, creative thinking skills and senior high school connection to mathematics learning.
4. What is the pattern of educational interaction that adjusting the active participation of students during the mathematics learning process based on 2013 curriculum?

2. LITERATURE REVIEW

2.1. Mathematics Learning Models Based on 2013 Curriculum Spirit

Development of mathematics learning model based on 2013 curriculum is adopts the constructivistic and pay attention to the characteristics of mathematics. The 2013 curriculum is based on competency, utilization to local cultural values and national to build of students soft skill, demonstrating the usefulness of mathematics in solving of culture environmental problems and other fields.. Utilization of cultural aspects in the mathematics learning is very important with several priciples (1) humans are processing the information that is active and appear in a social matrix, where the way of thinking, perception and action are influenced by culture, environmental and the nearby people (Davis, 2003; Cobb, 2001, Skemp, 1982; Solso, 1995, Taylor, 1993); (2) mathematics are a cultural product, the social construction result, troubleshooting tools (Cobb, 2001; Wheeler, 1970; Bishop, 1988; Ernest, 1991); (3) the adequacy of the local and national cultural aspects to improve the attitudes, knowledge and skills through the learning process of mathematics

The rediscovery process of several concepts and rules of mathematics are achieved by the process of observing, asking, reasoning, tring, communicating, and building of mathematical connections. This can be represented in the following figure:

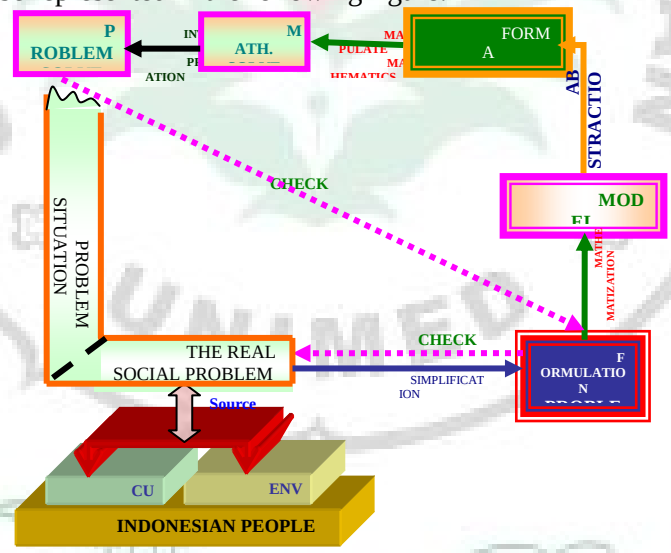


Figure 1. Overview of Mathematics as Culture Product and Problem Solving Tools (Bornok, 2007)

In the mathematics learning model based on 2013 curriculum were modified by way construction of knowledge as a result of the integration of Piaget's and Vygotsky's theory (Slavin, 1994:4). The modification result of both theory is represented as follow:

e-ISSN: 2548-4613

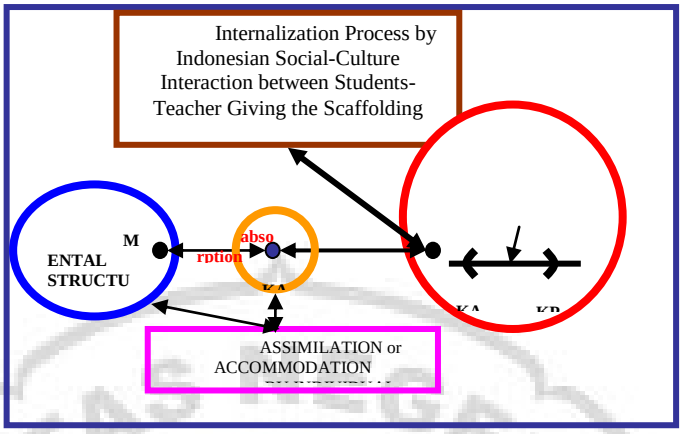


Figure 2. The representation of knowledge by Modified Piaget and Vygotsky theory (Bornok, 2007)

The effectiveness of a learning model can be measured from the effectiveness of the learning implementation in the real. According to Eggen & Kauchak (1988: 1),

> *Effective teaching occur when students are actively involved in organizing and finding relationships in the information they encounter rather than being the passive recipients of teacher-delivered bodies of knowledge. This activity results not only in increased learning and retention of content but also in improved thinking skills.*

The effectiveness of learning could be occure if students are actively involved in organizing and discovering of correlation between of information

2.2. Creative Thinking

In the implementation of the 2013 curriculum, teachers are required to train the students to think creatively. Torrance (1976) and Eden (2006) are reveal that creativity is the process of feeling and observing the problems, making allegations, collecting of concepts and rules that needed, examining the conjecture or hypothesis, then changed the strategy and re-exam and finally is finding the results of the problem solving, There are four indicator of the ability creative thinking, including (1) fluency, (2) flexibility, (3) detail, and (4) authenticity. **Mathematical Connections**

There are two general types of mathematical connections by NCTM (2003: 146), including modeling connections and mathematical connections. There are three (3) the mathematical connection purposes in schools, namely: (1) broaden the students' knowledge, by demonstrate the usefulness of the various concepts and rules of mathematics in the real problems solving and other scientific fields, (2) Find out of mathematics as a structure in which the topics is mutual related, rather than being partially separated, (3) mathematics is not a science that stands alone among other disciplines. Mathematics is a tools in problem solving.**Authentic Assesment** Authentic assessment has strong relevance to the scientific approach in the learning of 2013 curriculum. Authentic assessment is flexible and more varied and tend to focus on complex tasks or contextual, allowing the students to demonstrate their competence in a more authentic setting (Davidson, 2003; Permendikbud Nomor 104 tahun 2014).

3. METHOD

Development of PMPO-SK2 model is follow the development phase as a modified result of the development model proposed by Plomp (1997) with attention to three aspects of product quality Nieveen (1999: 127-128), such as validity, practicality, and effectiveness. The development steps have five stages PMPO-SK2 model development are presented in the following flowchart.

e-ISSN: 2548-4613

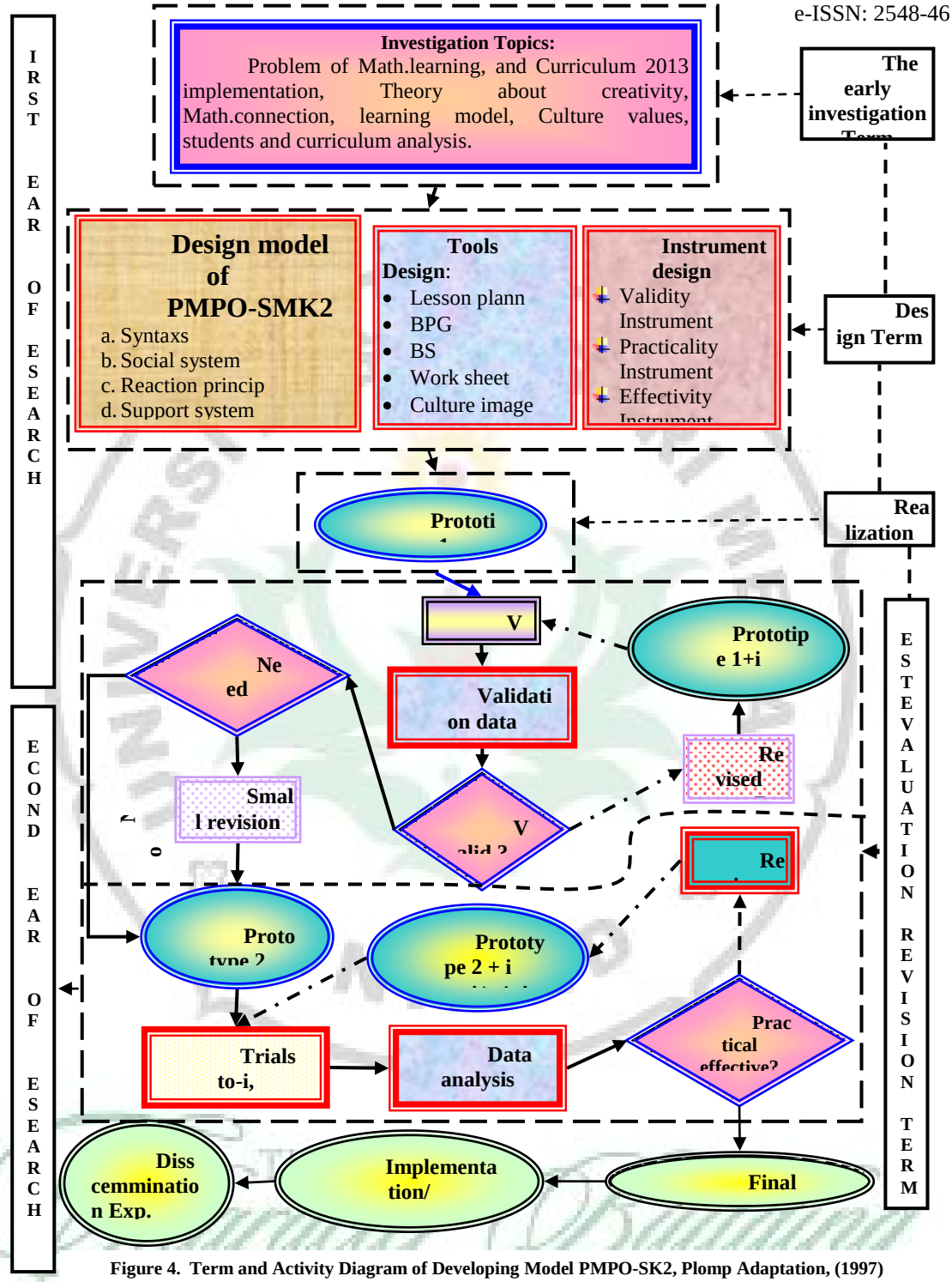


Figure 4. Term and Activity Diagram of Developing Model PMPO-SK2, Plomp Adaptation, (1997)

4. RESULTS AND DISCUSSIONS

a. In the second year of this research has been carried out the initial investigation phase, design, realization, and calibration the validity of the content and construct of PMPO-SK2 models and the first trial were presented as follows.The PMPO SK2 model syntactic is : (1) apersepsi culture, (2) the representation and problems solving with the interaction patterns "**Cultured Triangle Pyramid"**, (3) presentation and developing of the work result, (4) the findings of mathematical objects and strengthening of the new schemata, (5) evaluating of the problem solving

b. Social System in PMPO-SK2 model. The activities to be carried out of the students during learning are the following of Cultured Triangle Pyramid social interaction. The pattern of

Cultured Triangle Pyramid is a learning strategy that is consciously designed to be the pattern of educatif interaction to engage students actively participate in the learning process.

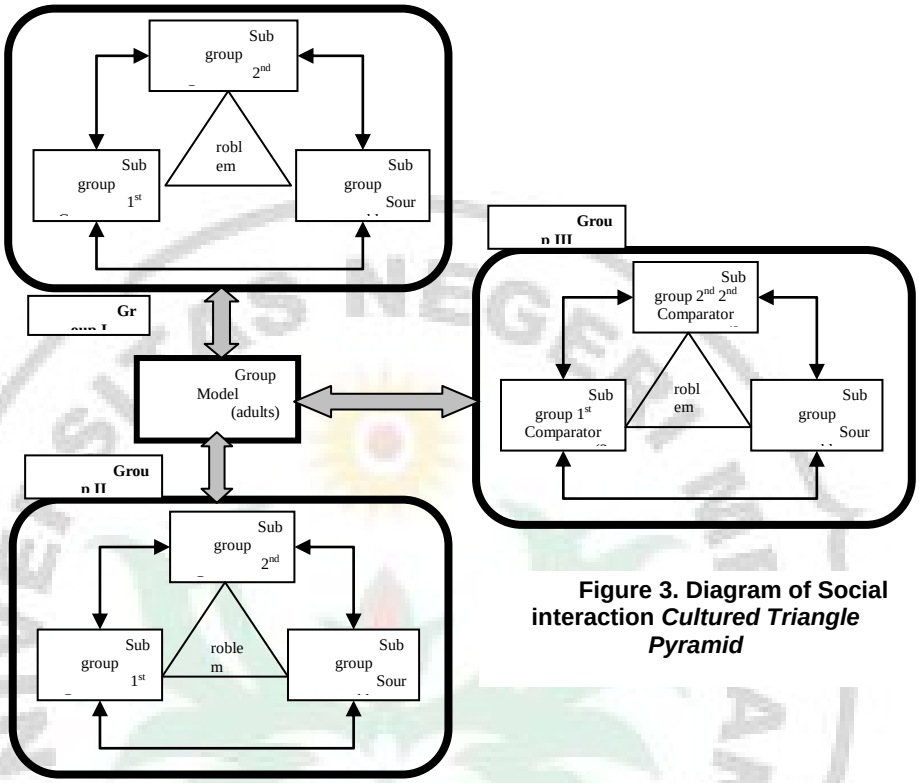
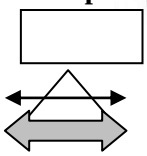


Figure 3. Diagram of Social interaction *Cultured Triangle Pyramid*

Description:



: Student sub group as embodiment of social interaction *Cultured Triangle Pyramid*
: Problem solved process by three student sub-group
: Reciprocal interaction among two sub-group
: Reciprocal interaction between student sub-group with role model group.

The learning process with educational interaction pattern of Cultured Triangle Pyramid is begins by teachers (role) to condition the student can openly dialogue. Then the teacher asked a math problem raised from the fact of cultural or cultural environment of students. Furthermore, given the time for each subgroup of students to observe a problem, asking, reasoning, trying to solve problems, and communicate the results of problem solving to the other subgroups. When the students can not find the problem solving, teachers provide assistance in the form of giving examples analogy, recall the various mathematical concepts and principles that have been studied, helping students find their way out of problem solving.

4.1. The Content Validation and Construct of PMPO-SK2 Model

The results of the content validation and construct of PMPO-SK2 model is shown in Table 1 and Table 2.

Table 1. Average of indicator for every aspect of the content validation of PMPO-SK2 Model

No.	Aspect	Average of indicator values for each aspect from validator						Aspect values
		I	II	III	IV	V	VI	
I.	Supporting theory	3.82	4.09	4.18	4.45	4.18	4.82	4.26
II.	Syntax	3.67	4.08	4.58	4.17	4.00	4.58	4.18
III.	Social system	3.60	4.40	4.00	4.60	5.00	4.40	4.33
IV.	Management reaction principle	4.00	4.00	4.33	4.33	4.00	4.33	4.17
V.	Supporting system	3.25	4.25	4.25	4.50	4.50	4.75	4.17
VI.	Instructional and accompanist effect	4.25	4.50	4.25	4.00	4.00	4.75	4.29

e-ISSN: 2548-4613

No.	Aspect	Average of indicator values for each aspect from validator						Aspect values
		I	II	III	IV	V	VI	
VII.	Implementation of learning	3.36	4.09	4.55	4.00	4.18	4.27	4.08
VIII.	Learning environment and management work	4.33	4.17	4.00	4.00	4.50	4.00	4.17
IX.	Evaluation	4.00	4.00	**5.00**	4.00	4.00	4.50	4.17
The averages value								**4.20**

The level of the content validity of PMPO-SK2 model is a valid category **Table 2. Average of indicator for every aspect of the construct validation of PMPO-SK2 Model**

No.	Aspect	Average of indicator values for each aspect from validator						Aspect values
		I	II	III	IV	V	VI	
I.	Components Model	3.80	4.40	4.60	4.80	4.20	5.00	4.47
II.	Supporting theory	3.50	4.50	4.00	4.00	4.00	5.00	4.17
III.	Syntax	3.86	4.14	4.71	4.14	4.14	4.43	4.24
IV.	Social System	3.00	4.33	4.67	4.67	4.17	4.50	4.22
V.	Management reaction principle	3.75	4.50	4.00	4.75	4.00	5.00	4.33
VI.	Supporting system	2.60	4.20	4.00	4.80	4.00	5.00	4.10
VII.	Instructional and accompanist effect	2.33	4.67	4.67	4.33	4.00	4.67	4.11
VIII.	Implementation of learning	3.00	4.38	4.00	4.38	4.13	5.00	4.15
IX.	Learning environment and management work	4.40	4.20	4.00	4.20	4.00	4.80	4.27
X	Evaluation	3.33	4.00	4.00	4.00	4.00	5.00	4.06
The averages value								**4.22**

The level of the construct validity of PMPO-SK2 model is a valid category

4.2. Analysis of the Limited Trial of PMPO-SK2 Model

1) Description of creative thinking skill of students

The results of description of creative thinking skill of students are presented at table and diagram below.

Table 3. The Value Of Creativity Mathematical Skills Of Students

NO	CRITERIA	CATEGORY	STUDENTS	PERCENTAGE
1	3.85 ≤ A ≤ 4.00	A	0	0
2	3.51 ≤ A- ≤ 3.84	A-	0	0
3	3.18 ≤ B+ ≤ 3.50	B+	1	2,94
4	2.85 ≤ B ≤ 3.17	B	4	11,76
5	2.51 ≤ B- ≤ 2.84	B-	11	32,35
6	2.18 ≤ C+ ≤ 2.50	C+	5	14,71
7	1.85 ≤ C ≤ 2.17	C	12	35,29
8	1.51 ≤ C- ≤ 1.84	C-	1	2,94
9	1.18 ≤ D ≤ 1.50	D	0	0
10	1.00 ≤ D- ≤ 1.17	D-	0	0

e-ISSN: 2548-4613

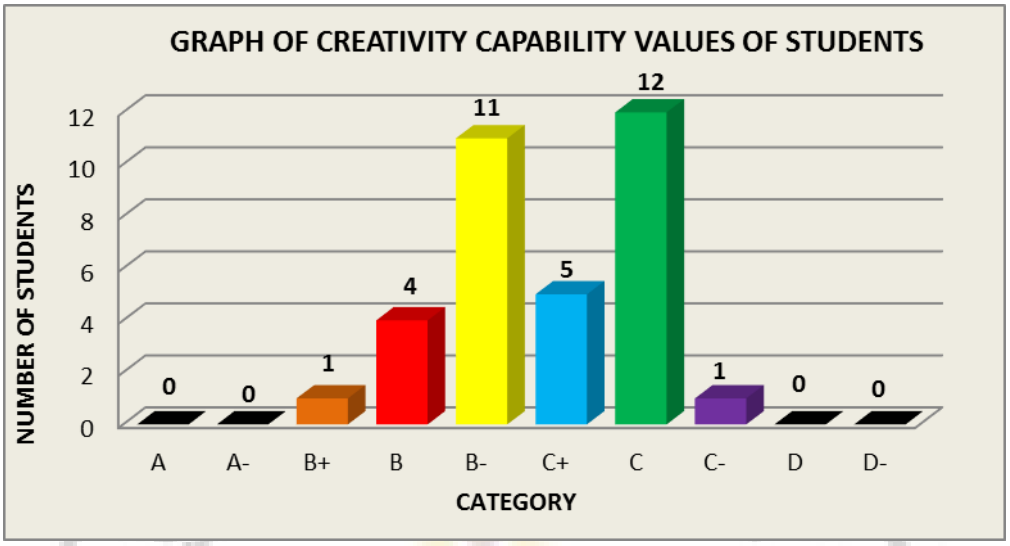


Figure 4. The number of students for each category of creative thinking skill of the students

2) From the Figure 4 is reflected that the implementation of the PMPO-SK2 model with supporting authentic assessment can well to build creative thinking skill of the students. Whereas previously known that the creative thinking skill of the students is in the low category.Description of Mathematical Connection Skill of Students

The analysis results of description of mathematical connection skill of students are shown in the Table 4

Table 4. The Value Of The Mathematical Connection Skill Of Students

No.	Criteria	Category	Number of Students	Percentage
1	3.85 ≤ A ≤ 4.00	A	1	2,94
2	3.51 ≤ A- ≤ 3.84	A-	3	8,82
3	3.18 ≤ B+ ≤ 3.50	B+	3	8,8
4	2.85 ≤ B ≤ 3.17	B	3	8,82
5	2.51 ≤ B- ≤ 2.84	B-	7	20,59
6	2.18 ≤ C+ ≤ 2.50	C+	7	20,59
7	1.85 ≤ C ≤ 2.17	C	9	26,47
8	1.51 ≤ C- ≤ 1.84	C-	1	2,94
9	1.18 ≤ D ≤ 1.50	D	0	0
10	1.00 ≤ D- ≤ 1.17	D-	0	0

From the diagram in Figure 5, the Iimplementation of the PMPO-SK2 model to support authentic assessment can establish a connection mathematical ability of students on the category of excellent, good, and pretty, who previously connection capabilities math students, including low category.

3) Analysis of Attitudes Observations of Students

Based on the data obtained by the observation, it is known that the attitude of cooperating students categorized as less caused, students have not been used to learning and teacher groups still tend to dominate the students to learn and not involve the active participation of students in the learning process. Furthermore, information obtained contained 84% with a quality attitude is very good category.

e-ISSN: 2548-4613

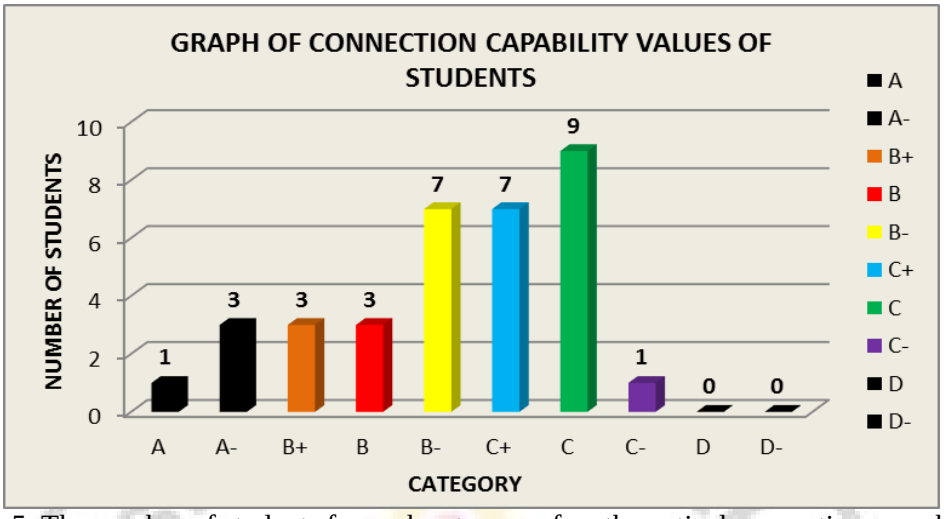


Figure 5. The number of students for each category of mathematical connections capabilities

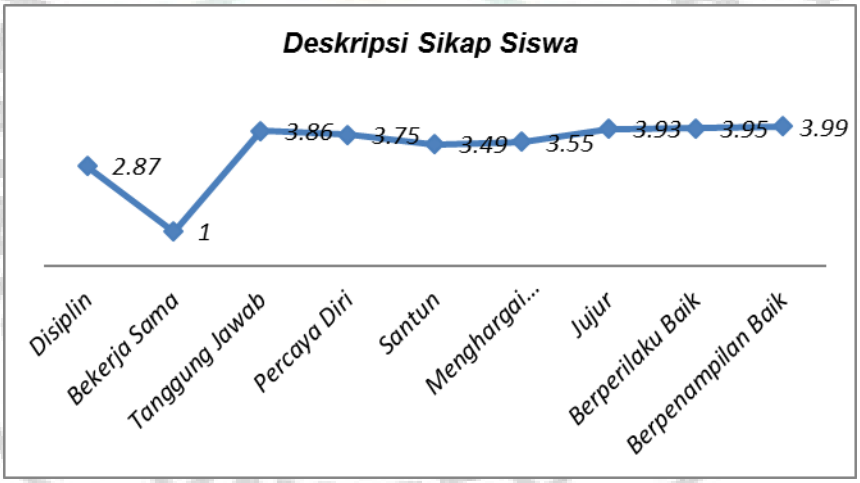


Figure 6. Diagram of the attitude scor average lines of students

5. CONCLUSIONS

1. The early prototypes of PMPO-SK2 models have been obtained with a valid result with the syntax: (1) apersepsi culture, (2) the representation and solving problems with the interaction patterns Limas Triangle Cultured, (3) presentation and develop the work, (4) the findings of the object mathematics and strengthening new schemata, (5) evaluating the results of problem solving. Patterns of social interaction found educative interaction patterns Limas Triangle is cultured to involve the active participation of students during the learning process.
2. The limited implementation of PMPO-SK2 models is indicated that the quality of attitude, creative thinking skills, and the ability to connect math students can be upgraded to the excellent category

REFERENCES

[1] Bishop, A. J. 1988. *The social construction of meaning: A significant development for mathematics ducation. For the learning of mathematics*. New York: Mc Graw Hill.

[2] Bodner, G.M. 1985. *Constructivism. A theory of knowledge. Journal of Chemical Education*. 1985 October; 12(5): 315-324.

[3] Bornok, Sinaga. 1998. *Efektifitas model pembelajaran berdasarkan masalah (Problem-Based Instruction) Pada Kelas I SMU Dengan Bahan Kajian Fungsi Kuadrat. (TESIS)*. Surabaya: PPs IKIP Surabaya.

[4] ..... 2007. *Pengembangan model pembelajaran matematika berdasarkan masalah berbasis budaya Batak*. Surabaya: Unesa University Press.

[5] Borich, Gary, D. 1990. *Observation skills for effective teaching*. Englewood Cliffs: Merrill Publishers.
[6] Cobb, P. 2001. *Constructivism in mathematics and science education*. *Educational Research.* 2001 October; 23(7): 4.
[7] Confrey, Jere. 1992. *What constructivism implies for teaching*. *Journal for Research in Mathematics Educations*. Monograph NCTM, Inc. 1992 June; 4:107-122.
[8] Davidson, L. *Portofolio Assessment and Exhibit: moving from recall to reflective understanding*. *Journal of Teacher Education*, V.6, No 44.
[9] Davis, Robert, B. 2003. *Learning discovery and constructivism*. Rutgers University: *Journal of Teacher Education Mathematics.* 2003 June; 3(23): 12.
[10] Eggen, Paul D & Kauchak. 1979. *Strategis for teachers teaching content and thinking skills*. New Jersey: Prentice Hall.
[11] Ernest, Paul. 1991. *The Phylosophy of mathematics education*. Rasing Stroke, Hamshire: The Falmer Press.
[12] Goffree, F. HF. 1993. *Working on mathematics education. Educational Studies in Mathematics.* 1993 June; 25 (1-2): 21-58.
[13] Hailu, N. W & Solomon T. A. 2014. The effect of an historical perspective on prospective teachers'beliefs in learning mathematics. *Journal of Mathematics Teacher Education*. 2014 August; 17(14): 303-330.
[14] Joyce, Bruce R., Weill. 1992. *Model of Teaching (fourth Edition)***.** Boston-London-Toronto-Sydney-Singapore: Allyn and Bacon Publishers.
[15] Kemdikbud. 2013. *Pendidikan Demokratis dan Humanis*. Pidato Mendikbud Pada Konferensi Asean Council of Teacher (ACT). Bali: Kemdikbud.
[16] Kemendikbud. 2014. Peraturan Menteri Nomor 104 tahun 2014, tentang penilaian proses dan hasil belajar. Jakarta: Kemdikbud.
[17] NCTM. 2003. *Defining problem solving and connections mathematics*. Focus on learning problems in mathematics. 2003 August; 17(15):2-3.
[18] Nieveen, Nienke. 1999. *Desaign approaches and tools in education and training*. Boston: Kluwer Academic Publisher.
[19] Plomp, Tjeerd. 1997. *Educational and training system desaign.* Enschede, The Netherlands: Univercity of Twente.
[20] Silver, Edward A. 2015. *Fostering creativity through instruction rich in mathematical problem solving and thinking in problem posing* [Internet]. 2015 [updated 2015 August 6]. Available from: http://www.fiz.karlsruhe.de/fiz/publications/zdm.
[21] Skemp, Richard R. 1982. *The psychologi of learning mathematics*. London: Penguin Books Ltd.
[22] Slavin, Robert, E. 1994. *Educational psychology, theories and practice*. Fourth Edition. Masschusetts: Allyn and Bacon Publishers.
[23] Taylor, Lyn. 1993. *Vygotskyan scientific concepts*: Implications for mathematics education. Focus on Learning Problems in Mathematics. 1993 August; 15 (3): 2-3.
[24] TIMSS (*Trens in Mathematics Sciens Study*). 2009. [updated 2015 August 6]. Available from: *http://nces.ed.gov/timss/table03.asp*.
[25] Torrance, E.P & Khatena, J. 1976. *Creative perception inventory*. Chicago: Stoelting Company.
[26] Wheeler, D. D. 1970. *Proceses in word recognition. Cognitive psychology*. England: Penguin Books.