An Analysis of Spatial Ability and *Self-efficacy* of Students in Cooperative Learning by Using Jigsaw at Smas Muhammadiyah 8 Kisaran

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Abstract   The study aims at analyzing students spatial ability and self-efficacy by using Cooperative learning Jigsaw type, including (1) students' thinking process on spatial ability (2) students self efficacy after learning process using jigsaw type of cooperative learning (3) students' active participation level in learning process. Subjects of the study are 38 students of X-IPA2 of SMAS Muhammadiyah 8 and its objects are students' spatial ability, self-efficacy and active participation. The current study is a qualitative-descriptive study. The instrumentations used are spatial ability test, self efficacy questionnaires, students' activities observation sheet and interview guideline. The data is analyzed by using Miles-Huberman Model. Based on the data collected, students' thinking processes on spatial ability after learning by using Jigsaw type of Cooperative learning are classified into high, medium, and low. (1) Students with high spatial ability have orderly, neat and abstractly thinking skill in completing spatial ability test. Students with medium/intermediate spatial ability level have orderly thinking process and semi abstract ability in solving spatial ability test. Students with low spatial ability level in understanding the problems have uncompleted thinking process, do not have ability to concentrate, semi abstract thinking, cannot find alternative in solving the problems and have un orderly and poor thinking process. (2) Self-efficacy of students of SMAS Kisaran 8 after learning by using Jigsaw type of cooperative learning is good. (3) Whole percentage of students' active participation in teaching learning process is at tolerance interval of the ideal time set.

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1. Introduction

According to Zarkasyi (2015) spatial ability is an ability to imagine, compare, predict, and determine information got from visual in space context. [1] This definition emphasizes that spatial ability is the ability that related to spatial, three dimensional figure or more precise definition is related to geometry. Concept of spatial thinking is interesting to study because there have been many researches which showed that students had problems to comprehend a three dimensional object or geometry (Syahputra, 2013). [2] For Senior High level, geometry is known as three dimensional figure. Thus, spatial understanding is so needed that students are able to comprehend those four geometry dimensions. The understanding of three dimensional figure is known as spatial ability.

Yenilmez and Kakmaci (2015) propose that spatial visualization skill is required in many disciplines such as Math and Geometry, Physics and Chemistry and any other work field like engineering. [3] Moreover, people use

spatial ability effectively in daily life, for example in using map, exercising, and putting stuff orderly (Peng and Sollervall, 2014). [4] In *National Academy of Science* (2006), it is stated that there are many disciplines involve spatial ability, for instances astronomy, education, geography, geosciences, and psychology. [5]

Data found from SMAS Muhammadiyah 8 Kisaran showed that students' spatial ability was low; students found it hard to visualize components in Geometry. This finding was revealed by a research conducted by Siswanto (2014). He reported that inability of students to visualize the components of geometry figure causes them get problem in constructing three dimensional figure in Geometry and solving its problem. [6] Ahmad and Jaelani (2015) assert that students' spatial ability can be improved by giving them some spatial problems, asking students to do activities which involve three dimensional objects and conducting teaching process of Geometry which implicate some real-life activity; drawing and computer assisted-activities; dynamic Geometry software. [7]

Besides those factors, another point which is important to consider in learning Math is students' self-efficacy. Simanungkalit (2015) conveys that self-efficacy is a

psychological aspect which affects students' success in completing tasks significantly and solving the questions well. [8] Bandura (1997) reveal that *self-efficacy* becomes an underlying factor which encourages students to be successful in specific field and plays essential role in students' academic achievement. [9] A student who has good self-efficacy possesses better confidence as a result it will foster his curiosity in resolving math problems (Sinaga, 2014). [10] Skaalvik, Federici and Klassen (2015) assert that the relations between students' grades and motivation were partly mediated through emotional support and self-efficacy. [11]

In contrast, in reality students' self efficacy is still low. In a study conducted by Azwar, Surya and Saragih (2017), according to an interview with a teacher at SMA Negeri 1 Peureulak Senior High Math teachers rarely pay proportional attention in improving students' self-confidence. [12] In line with this finding, Sukoco and Mahmudi (2016) deliver that most of XI Science students at SMAN 1 Jetis Bantul were reluctant to answer and report their work in front when teacher asked them because the students felt they could not give a proper explanation. This finding is based on an interview conducted by researcher with students. [13]

In order to increase students spatial ability and self-efficacy, the heterogeneous condition of the student, school' environment, learning environment and learning model used need to be considered. Susilawati, Suryadi dan Dahlan (2017) in their research show that there is an interaction between learning style and Math skills towards improvement of spatial visualization ability, so students' difficulties in solving spatial visual questions can be reduced. [14] Researchers chose an alternative; by applying cooperative learning. Slavin (Isjoni, 2011) contends that in cooperative learning methods, students work together in four member teams to master material initially presented by the teacher". [15] Cooperative learning model used is Jigsaw. Jigsaw can be used to liven up the class, empower students or make students focus on productive class.

In learning by using Jigsaw strategy, students study in small group. Every group member works together to learn and understand the content. Then, she/he returns to his/her original group to deliver and combine the discussion result with other group members. In learning model by using Jigsaw, teaching process which has been given by teacher becomes student-centered learning. Thus, students get more chances to find out and explore their own Mathematical (Syahputra and Suhartini, 2014). [16] Moreover, Juliana and Surya (2017) in their research state that using Jigsaw as learning model is effective to improve confidence and learning outcome of students at SMK N 1 Batang Toru. [17] Syaripah (2017) concludes that implementation of Jigsaw is able to increase students' active participation and it helps teacher in managing teaching and learning process. [18] Furthermore, a research conducted by Zulfahmi, Syahputra dan Fauzi (2017) revealed that average achievement of students' spatial ability in the first experiment was 3.15, and then it became 3.51 in the second experiment while students' self-concept average achievement in first experiment was 3.03, increased to 3.16 in the second experiment. [19] Dazrullisa (2015) contends that Jigsaw enables students in understanding and improving creativity and motivation

in learning Math especially for linear equation system of one variable. [20] In line with the statement above, Naibaho (2014) states that Jigsaw succeeds to improve student physics learning outcomes. [21] Based on these reasons, a study is needed to conduct with the title "analysis of students' spatial ability and self-efficacy in Jigsaw type of Cooperative Learning and Conventional Learning at SMAS 8 Kisaran".

2. Research Methods

The current study is a descriptive study by using qualitative approach. Subject of the study is 34 students of X-IPA 2 SMAS Muhammadiyah 8 Kisaran and the objective is students' spatial ability and self-efficacy and their active participation. The instruments used are spatial ability test, self-efficacy questionnaire, students' activity observation sheet, and interview guideline. After analysis of mathematical spatial ability test and self-efficacy questionnaire is obtained, the process is continued by having interview. The interviewee was chosen based on classification of students' spatial ability; they are high, intermediate and low level. Interview is conducted by using spatial ability answer sheet and students' self efficacy questionnaire sheet to have triangulation.

3. Result and Discussion

3.1. Students' Thinking Process at Spatial Ability

3.1.1. Students' Thinking Process at High Spatial Ability

After applying teaching learning process by using Jigsaw in Geometry Subject for three dimensional figure, the research process is continued by having test for students to find out their spatial ability. Then students' worksheet is checked, Table 1 shows level of students spatial ability

Table 1. Level of Students Mathematic Spatial Ability

No	Score Interval	Total of Students	Percentage	Category
1	$0 \leq SK < 65$	13	38%	Low
2	$65 \leq SK < 80$	14	41%	Intermediate
3	$80 \leq SK < 100$	7	21%	High

Based on result of Mathematic spatial ability test of 34 students, the level of students' spatial ability is deployed into three categories. 5 students of 34 students involved in the study were chosen to have interview based on their Mathematic spatial ability. Table 2 shows subject chosen for interview

Table 2. Subject chosen to have Interview of Students Mathematic Spatial

No	Code	Subject Chosen Aspect
1	S-9	Low Capability
2	S-4 and S-17	Intermediate Capability
3	S-5	high Capability

After that researcher interviewed S-5 in which the result of interview was taken to triangulate the data of S-spatial ability tests result. The following is the interview transcribe.

T : what did you think when you were answering the questions?

S : I found difficult, intermediate and easy questions.

T : look at question no 1. How did you answer this question? (*Asking question while pointing question number 1*)

S : I looked at the question Miss

T : how did you answer it?

S : down pattern (*while appointing black picture at the first and second picture*) then at the top pattern (*while pointing at the third picture*), thus for top pattern is the same as third pattern. (*so student answered* B)

T : ok, I will continue, there is a question here (pointing at question number 9) your answer is correct; it is 90 degree. This is about rotation (mentioning the question and student's answer). Why did you answer 90 degree?

S : because ABCD base is a rectangle. All rectangels will form 90 degree of edge when they are rotated.

The following pictures (Figure 1) are the work result of S-5.

Interview transcribe above shows that student as a subject of the study is able to understand and complete the questions. The subject of the study follows the question patterns in order to answer them. This can be noticed from how the students are able to determine enough requirements (what is known) and needed requirement (what is asked). It can be concluded that student is capable to comprehend facts, concepts, principles, and procedures the student was even able to think creatively, flexible and smoothly in completing spatial ability tests. Research subject (S-5) has orderly and neat thinking process in resolving spatial ability tests.
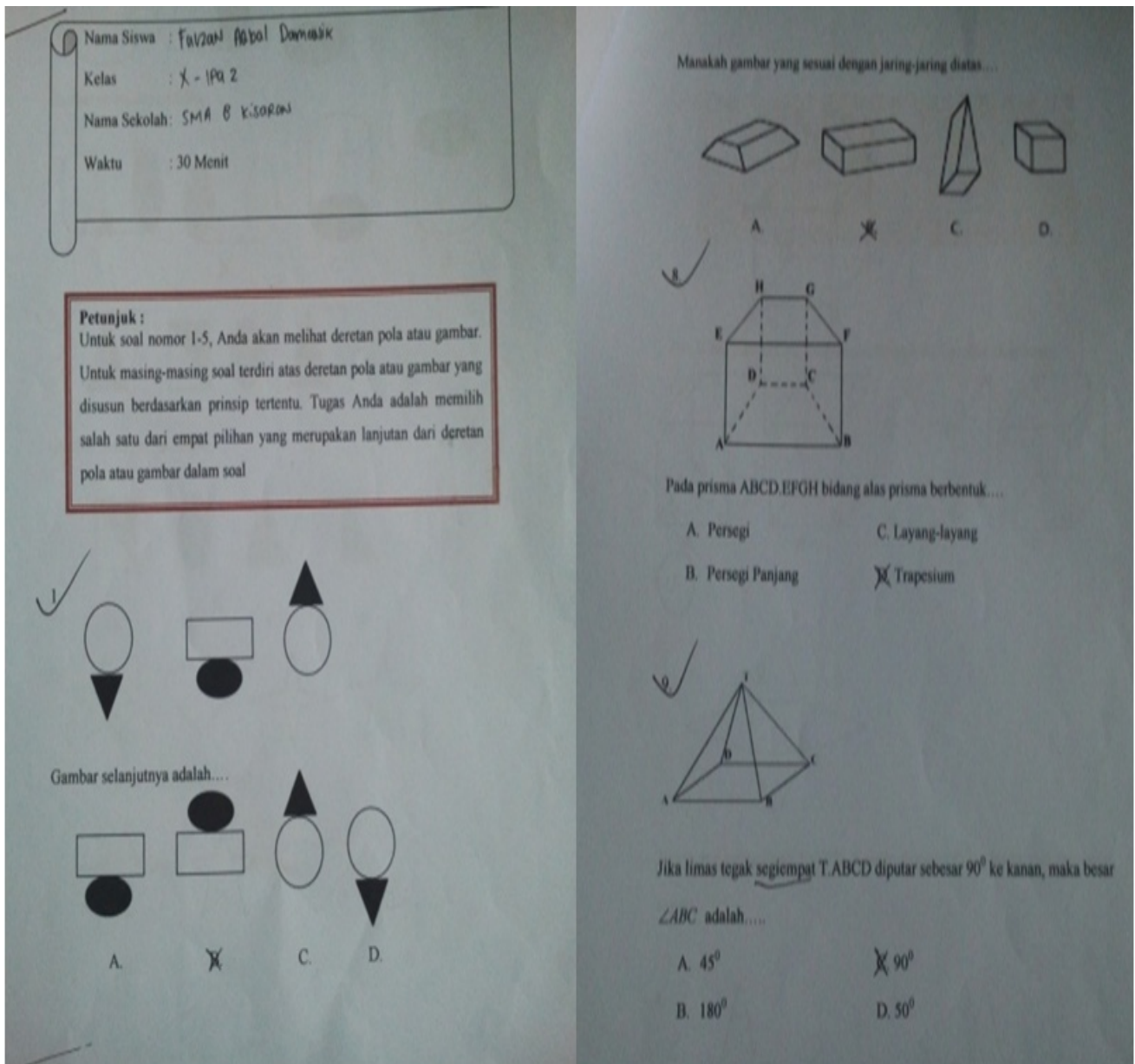

Figure 1. Mathematic Spatial Ability Test Worksheet of S-5

3.1.2. Analysis of Students' Thinking Process at Intermediate Spatial Ability

Students who have intermediate spatial ability level, students with S-4 and S-17 code, told that by using Jigsaw they become motivated and enthusiastic in understanding the material therefore they could solve spatial ability tests well. The following is transcript of interview of the students (T= teacher, s=student):

T : ok Eva, I would like to have interview with you. We will discuss about Jigsaw Learning model, especially related to three dimensional figures. What do you think about Jigsaw learning model which I have applied in our classroom?

S : in my opinion, the process in Jigsaw learning model can easily be understood and I have never learned by using this Learning model before.

T : when you answer the question, do you know what is asked and what is known in question number 1? (Showing worksheet done by)

S : what is asked in question number 1 is a figure and then I continued pattern of the picture with a figure beside. (*Explaining question Number 1*)

T : what are you thinking when you were answering that question?

S : I am certain that I am able to answer question number 1 because it is easy.

T : OK, Great. What makes you have satisfying grade?

S : I think it is because I am thorough when I am doing questions given.

T : what number of question do you consider is easy, fair, and difficult?

S : I think question number 2 is easy because it does not only require me to find out the picture in that question. Meanwhile number 7 is a fair question,

yet it force me to imagine folding nets provided in the question, while question number 9 is a hardest question because I did not know the formula to solve the problem.

T : but, for the question number 9 you got 90°, and it is the correct answer.

S : because I have… hmm… (The student thinks for awhile), I think ∠ABC is rotated 90° because it is Perpendicular

T : do you think it was the angle which was Perpendicular?

S : yes, Mam

T : why don't you think it was 180°?

S : I assumed that Perpendicular shows 90° angle.

T : Ok, out of 20 questions you had number 19 and 20 be wrong while for question number 18 you answered it correctly.

S : I don't understand the picture in question number 19 and 20.

Additionally, in answering spatial ability test student thinks by following question patterns so that they can complete all questions in the test. In this case the interviewee understands what is known (sufficient condition) and what is asked (needed condition) in the test. Yet for question number 9, interviewee reveals that she/he consider the question it difficult if the question required to have 90° rotation; she/he did not know formula to solve the problem. However, the interviewee assumed that ∠ABC which is rotated 90° will be Perpendicular. Moreover, question number 19 and 20 showed the pictures which are difficult to understand, so the interviewee could not give correct answer. For the remaining questions the interviewee felt certain to answer the questions and could understand them. The following picture presents work of interviewee S-4.
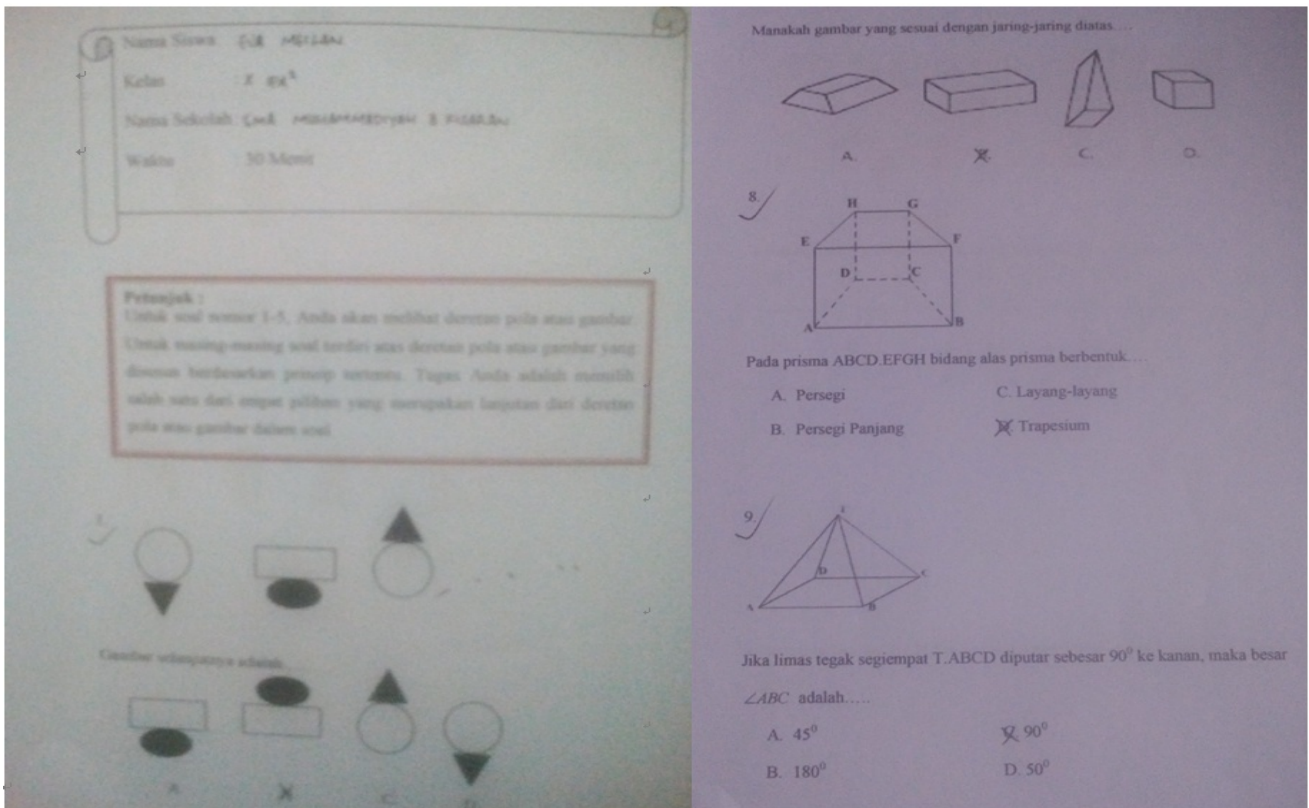

Figure 2. Spatial Ability Test Completed by S-4

3.1.3. Analysis of Students' Thinking Process at Low Level of Spatial Ability

Student who has low level of spatial ability is a student with code S-9. The student told that she/he did not understand the learning material but the student enjoyed instructional process by using Jigsaw. The following shows transcription of interview between teacher and student S-9. (Note: Teacher=T and Student=S).

T : Ica, I want to interview you. Firstly, I would like to ask what you think about teaching learning process by using Jigsaw especially for three dimensional figure.

S : I enjoyed it,

T : Do you feel motivated following the process by using Jigsaw?

S : I enjoy learning by using Jigsaw in classroom

T : when you are answering those questions, do you know what is asked and what is known? Because I can see here that you got the correct answer for question number 1

S : circle shapes, trapezoid, hmm… rectangle. In this picture, the black side is below (pointing at third picture) thus I made assumption that that black side is on top (next picture), so the answer is B

T : what makes your mark is not satisfying?

S : I think it was because I could not focus well.

T : what makes you cannot focus?

S : because they disturb me

G : it was your friends?

S : yes, Miss

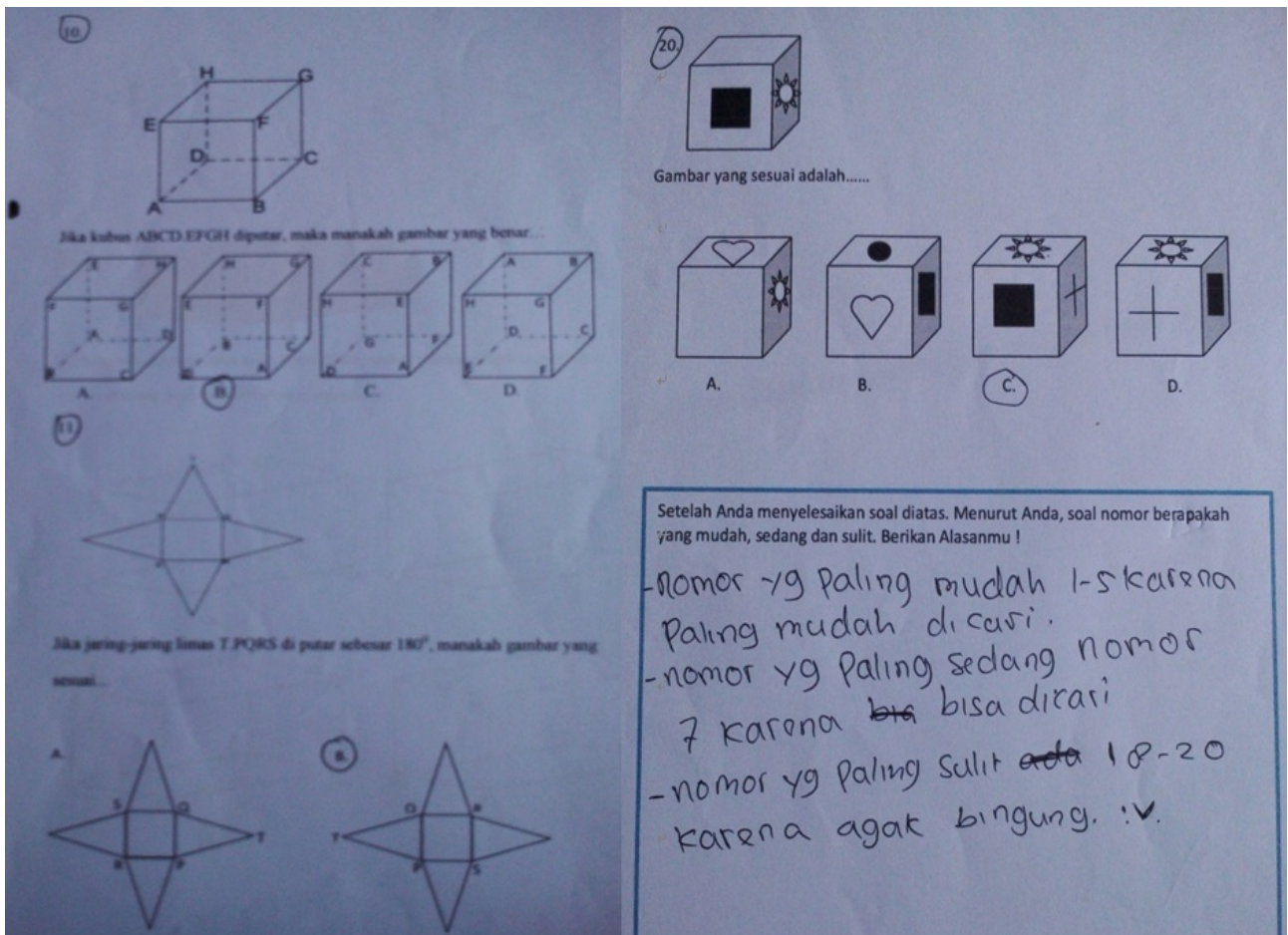The following pictures present work of student S-9.

Figure 3. Mathematic Spatial Ability Test by S-9

Presented in the interview transcribe above, subject of the study revealed that lack of understanding about the issue being learned complicate the students to have good spatial ability. Besides, peer-disturbance affected him/her to concentrate in finishing the tests. As a result he/she could not think and solve the tests well. In short, from the transcribe above in can be inferred that student as a subject of the study has not comprehend the questions and how to solve them well, the student only did some questions which were easier for him/her. Students who have lower spatial ability have incomplete thinking process, have difficulty to concentrate, and they did not own alternative to solve the questions presented for them. In addition, they think not in well order and organization.

3.2. Analysis of Self-Efficacy Questionnaire

The questionnaire is presented to find out students self-efficacy after teaching learning process has been done. The following table offers analysis result of students self efficacy questionnaire.

Table 3. Percentage of Students Self-Efficacy

No	Score Interval	Total of Students	Percentage	Category
1	$0 \leq SK < 65$	4	11,76%	Low
2	$65 \leq SK < 80$	21	61,67%	Intermediate
3	$80 \leq SK < 100$	9	26,47%	High

Table 3 provides information about students' self-efficacy after they joined teaching learning process by using Jigsaw Learning Model. There are 9 students have high self-efficacy level, 21 students are at intermediate level and 4 students have low level of self-efficacy. It can be concluded generally that self-efficacy of students at SMAS Muhammadiyah 8 Kisaran after having Jigsaw Learning Model is considered good.

3.3. Data Analysis of Students' Active Participation

Observation of students activities covers observing and recording of students activities in a selected group during teaching learning process. The observation is established by an observer in every meeting for every teaching subject which uses Jigsaw learning Model. The following table represents data of students' active participation.

The biggest proportion of time in teaching learning process is used by students to taking notes of teacher's explanation, taking notes from a book or friend's explanation, completing questions in students' worksheet, summarizing group work. These activities take 36, 2% of time available in every meeting. Overall, this students' activities percentage is still in tolerant interval of ideal time set, so teaching by using Jigsaw is effective to apply as a model in teaching.

Table 4. Percentage of Students Active Participation

No	Observation Indicators	Activity Percentage of Meeting				Average
		1	2	3	4	
1	Listening to/paying attention to what teacher /peer is explaining actively	23.9	26.1	30.0	24.1	26.0
2	Reading/understanding Students'(LAS)	16.1	33.3	14.4	19.8	20.9
3	Taking notes of teacher explanation, of a book, and friends, answering questions in students' worksheet, summarizing group work	27.8	56.7	33.3	27.2	36.2
4	Discussing/giving questions between student-student, student-teacher, drawing a conclusion of a procedure or a concept	30.6	57.8	21.1	27.8	34.3
5	Doing unrelated activities to teaching learning process	1.7	0.0	1.1	1.2	1.0

4. Conclusion

Based on some theories, research findings, and research discussions, it can be concluded that:
1. Students' thinking process at spatial ability after instructional process by using cooperative Learning Model Jigsaw Type is classified into three classifications; high, intermediate and low. The classification can be explained as:

- Students who have high spatial ability level have orderly, neat and abstractly thinking process in completing spatial ability test.
- Students who have intermediate of spatial ability level have orderly and semi abstractly thinking skill but it is not organized well in completing spatial ability test.
- Students with low level of spatial ability level have uncompleted thinking process, concrete thinking, cannot concentrate and use alternative way to answer the questions

2. Out of 34 students in the study, 26.47% has high self-efficacy, 61.76% of students have intermediate level, and 11.76 % of students are on low level of self efficacy. Generally, 73.31% of students are on intermediate level of self efficacy. It can be inferred that self efficacy of students of SMAS Muhammadiyah 8 Kisaran after learning by using Jigsaw is improving.

3. Overall percentage of students active activities used during teaching and learning process is on tolerance interval of ideal time set

5. Suggestion

Based on conclusions above, it can be suggested that:
1. For implementing cooperative Model Jigsaw Type, teachers have to keep paying attention to students activities in learning based on ideal time proportion
2. Future and in-depth research is needed to dig more about how to improve Mathematic spatial ability in line with characteristics of students' spatial ability in this current study.
3. It is hoped that this current study can be essential source for conducting some related researches to gain better results.

References

[1] Zarkasyi, W. Lestai, K. E &Yudhanegara, M. R. 2015. *Penelitian Pendidikan Matematika*. Karawang :PtRefika Aditama.

[2] Syahputra, E. 2013. Peningkatan Kemampuan Spasial Siswa Melalui Penerapan Pembelajaran Matematika Realistik. *Cakrawala Pendidikan*. Th. XXXII, No. 3:353-364.

[3] Yenilmez, K & Kakmaci, O. 2015. Investigation of the Relationship between the Spatial Visualization Success and Visual/Spatial Intelligence Capabilities of Sixth Grade Students. *International Journal of Instruction*. Vol. 8, No. 1, 189-204.

[4] Peng, A &Sollervall, H. 2014.Primary School Students' Spatial Orientation Strategies in an Outdoor Learning Activity Supported by Mobile Technologies.*International Journal of Education in Mathematics Science and Technology*. Vol. 2, No. 4, 246-256.

[5] National Academy of Science. 2006. *Learning to Think Spatially*, Washington DC: TheNational Academics Press.

[6] Siswanto, R. D. 2014. Pengembangan Bahan Ajar dengan Pendekatan Saintifik pada Materi BangunRuangSisiDatar Kelas VII SMP. Tidak diterbitkan: Bandung: UPI.

[7] Ahmad &Jaelani, A. 2015. Kemampuan Spasial: Apa dan Bagaimana Cara Meningkatkannya. *Jurnal Pendidikan Nusantara Indonesia*. Vol. 1, No. 1, 1-12.

[8] Simanungkalit, R. H. 2015. Pengembangan Perangkat Pembelajaran untuk Meningkatkan Kemampuan Representasi Matematis dan Self-Efficacy siswa SMP Negeri 12 Pematang Siantar. Tesis tidak diterbitkan. Medan: PPs Unimed.

[9]   Bandura, A. 1997. *Self Efficacy: (The Exercise of Control)*. New York: W. H. Freeman and Company.

[10] Sinaga, Y. F. 2014. Peningkatan Kemampuan Berpikir Kritis Dan Self-Efficacy Matematis Siswa Smp Dengan Pendekatan Pembelajaran Savi Berbantuan Wingeom. Tesis tidak diterbitkan. Medan : Program pascasarjanaunimed.

[11] Skaalvik, E. M. Federici, R. A &Klassen, R. M. 2015. Mathematics achievement and self-efficacy: Relations with motivation for mathematics. *International Journal of Educational Research*. Vol. 72, 129-136.

[12] Azwar. Surya, E &Saragih, S. 2017. Development of Learning Devices Based on Contextual Teaching and Learning Model Based on The Context of Aceh Cultural to Improve Mathematical Representation and Self-Efficacy Ability of SMAN 1 Peureulak Students. *Journal of Education and Practice*. Vol. 8, No. 27, 186-195.

[13] Sukoco, H. & Mahmudi, A. 2016. Pengaruh Pendekatan Brain-Based Learning terhadap kemampuan komunikasi matematis dan self efficacy siswa SMA.phytagoras: *Jurnal Pendidikan Matematika*.Vol.11, No, 1. 11-24.

[14] Susilawati, W. Suryadi, D &Dahlan, J. A. 2017.Mathematical Spatial Visualization Ability of Student through Cognitive Conflict. *IEJME-Mathematics Education*. Vol. 12, No. 2, 155-166.

[15] Isjoni. 2011. Cooperative Learning Efektivitas Pembelajaran Kelompok. Bandung: Alfabeta.

[16] Syahputra, E &Suhartini, I. 2014.Increasing of Students' Achievement in Polynomial by Using Jigsaw Method.*Journal of Education and Practice* .Vol. 5, No.5, 175-182.

[17] Juliana, M & Surya, E. 2017. An Analysis Of Jigsaw Cooperative Effectiveness To Improve The Self-Confidence And Learning Result Of Vocational High School Students. *IJSBAR*. Vol. 3, No. 2, 2395-4396.

[18] Syaripah. 2017. Penerapan Pembelajaran KooperatifTipe Jigsaw Dalam UpayaMeningkatkanPengelolaan Pembelajaran Dan Aktivitas Siswa Kelas V MIS Guppi NO.13 Tasik Malaya Curup Utara. *Ar- Riayah : Jurnal Pendidikan Dasar*. Vol. 1, No. 1, 67-87.

[19] Zulfahmi, Syahputra, E &Fauzi, K. M. A. 2017.Development of Mathematics Learning Tools Based Van Hiele Model to Improving Spatial Ability and Self-Concept Student's of MTs. S Ulumuddin. *American Journal of Educational Research* (online). Vol. 5, No.10, 1080-1086.

[20] Dazrullisa.2015. Penerapan Model Pembelajaran KooperatifTipe Jigsaw Dalam Meningkatkan Kreatifitas Dan Motivasi Pada Materi Persamaan Linear Satu Variabel Di Kelas Vii Smp Negeri 19 Percontohan Banda Aceh.*Jurnal Pendidikan Matematika*. Vol. 2, No. 1, 1-9.

[21] Naibaho, D. G. T. 2014. Penerapan Model Pembelajaran Kooperatif Tipe Jigsaw Untuk Meningkatkan Hasil Belajar Fisika Pada Konsep ZatDikelas VII SMP N 3 Hinai Tahun Ajaran 2010/2011. *Jurnal Pendidikan Fisika*. Vol.3, No.1, 59-64.