Published every February and August ISSN 1979-7877

EDUCARE
International Journal for Educational Studies

ANGGUN BADU KUSUMA & RENI UNTARTI

The Identification of the Students' Mathematical Communication Skills Error in Form of Pictures on the Geometry of Space Subject

***ABSTRACT**: The space geometry is one of the major subjects, which must be taken by the students of the mathematics education. The aim of the courses is to make students are able to master the form geometry in three dimensions. Competencies must be mastered include the ability to draw space, the ability to draw the slice field, and the ability to determine the extents of the slice field. Based on the competencies, the material of the space geometry was not an easy matter to be mastered by students. Students needed their imagination to visualize the shape, which came from the two-dimensional images shaped into a three dimensional or vice versa. These difficulties did not only occur on the students, but also the mathematics teachers, who had the learning process in the schools. This research belonged to qualitative descriptive study, in which the subject of this research was the class A second semester students of Mathematics Education Study Program of UMP (Muhammadiyah University of Purwokerto) in Central Java, Indonesia, in academic year 2015/2016, which belonged to the class of the shape geometry. The instruments which were used were the observation sheet and the documentation in the form of photographs or videos. The research procedures consisted of the steps in the lesson study in 3 cycles. Each cycle consisted of plan, do, and see steps. The result of the study was that the students' error of mathematical communication ability was in the form of pictures on the space geometry subjects occurred on the drawing procedure in the determination of the slice field; the concept of an image in three dimensions; and the students' concept in the fields analysis.*

***KEY WORDS:** Mathematical Communication Skill; Lesson Study; Geometry of Space; Form of Pictures; Students' Concept.*

INTRODUCTION

The space geometry is one of the major subjects, which must be taken by the students of the mathematics education (TA, 2016). The aim of the courses is to make students are able to master the form geometry in three dimensions. Competencies must be mastered include the ability to draw space, the ability to draw the slice field, and the ability to determine the extents of the slice field (Reilly, 1998; and TA, 2016).

Based on the competencies, the material of the space geometry was not an easy matter to be mastered by students. Students needed their imagination to visualize the shape, which came from the two-dimensional images

About the Authors: **Anggun Badu Kusuma** and **Reni Untarti** are the Lecturers at the Departement of Mathematics Education, Faculty of Education and Teacher Training UMP (Muhammadiyah University of Purwokerto), Jalan Raya Dukuhwaluh, Purwokerto City, Central Java, Indonesia. E-mails: anggunbadu@ump.ac.id and reniuntarti@gmail.com

Suggested Citation: Kusuma, Anggun Badu & Reni Untarti. (2018). "The Identification of the Students' Mathematical Communication Skills Error in Form of Pictures on the Geometry of Space Subject" in *EDUCARE: International Journal for Educational Studies*, Volume 10(2), February, pp.87-94. Bandung, Indonesia and BS Begawan, Brunei Darussalam: Minda Masagi Press owned by ASPENSI and BRIMAN Institute, ISSN 1979-7877.

Article Timeline: Accepted (December 13, 2017); Revised (January 15, 2018); and Published (February 28, 2018).

shaped into a three dimensional or vice versa. These difficulties did not only occur on the students, but also the mathematics teachers, who had the learning process in the schools (*cf* Eryaman, 2009; Kariadinata, 2010; and Evbuomwan, 2013).

This condition based on the results of research, which shows that teachers of mathematics often had problems when drawing three-dimensional slice field (Budiarto, Koespono & Nindyo, 1998; and Lee & Zeppelin, 2014). Other studies had also shown that the problems, which happened in the space geometry were in the construct the form of geometry (Pressman, 1997; and Kariadinata, 2010).

The problems experienced by students above was closely associated with one of mathematical ability, that was mathematical communication ability. Communication is the process of submitting an idea or ideas to others (Shadiq, 2009; and Chun, 2015). The delivery of this idea can be done by using a variety of ways, either oral or written.

The communication in mathematics learning focused on the importance of the ability to speak, write, draw, and describe various mathematical concepts (Bold, 2001; and Van de Walle, 2007). With these conditions, the communications required the interactions, so that it created the understanding and the changing in common (Dansereau & Markham, 1987; and Soekamto *et al*., 1993).

In this three dimensional problems, the more specific communication and corresponding to the context of the problem capabilities were the ability of mathematical communication. Mathematical communication is an activity for organizing, communicating, analyzing, and evaluating a mathematical idea, and using mathematical language appropriately (NCTM, 2000). Another definition said that the ability of mathematical communication was the ability to connect real objects, images or diagrams into mathematical ideas that was orally spoken or written through real objects, images, diagrams or algebra, and to declare everyday events using mathematical language (Syaban, 2006). In other words, the components in the mathematical communication included vocabulary, symbols of algebra, a representation of the visual forms, tables, and charts (Morgan, 2002).

Based on these definitions, the ability of mathematical communication was a prerequisite for the development of ideas or mathematical ideas (Kilpatrick, Hoyles & Skovsmose, 2005). It was because without any mathematical communication, the mathematical idea would be kept only in one's mind. In education, this condition was very dangerous, because students could not develop and convey the knowledge they had to others (Flevares & Schiff, 2014). In addition, lecturers also could not know the ability of the student.

Communication problems within the students could not be solved quickly, but this required a kind of process and practice. With this process and practice, students were expected to be accustomed to communicate mathematically. To find out the students' mathematical communication abilities, we could see from their ability to express ideas. The expression of the idea could be: expenditure of mathematical ideas orally, written, demonstration, or visual; and proper use of language, notation, and mathematical structure (NCTM, 2000).

In this study, the focus of the learning is the lesson study. Lesson study is an approach that can improve the quality of learning and it comes from Japan (Susilo *et al*., 2009). Lesson study aims to improve knowledge of the concept of learning community (Syamsuri & Ibrohim, 2009). By using the lesson study, teachers can learn from conditions that occur in the classroom (Kemendiknas RI *et al*., 2012).

Based on the explanation above, the researchers intended to do the research about the Identification of the Students' Mathematical Communication Skills Eror in Form of Pictures on Class A of UMP (Muhammadiyah University of Purwokerto) Mathematics Education Student of Second Semester in Academic Year 2015/2016 in the Geometry of Space Subject Based on Lesson Study.

METHODS

This research was a descriptive qualitative research, and the implementation was based

ISSN 1979-7877 *and* ***www.mindamas-journals.com/index.php/educare***

on the stage of the lesson study (Jacobs, Lee & Ball, 1996; Creswell, 1998; and Elliott & Timulak, 2005). Stages of the lesson study included a plan (planning), do (execution), and see (reflection and evaluation). The plan started with doing the preparation against technical and needs that wold be made in learning. "Do" was the implement activities which were planned in the action plan. "See" was the reflection and evaluation of the activities of learning activities (Jacobs, Lee & Ball, 1996).

This research was done on the even semester academic year 2015/2016 in mathematical education courses at the UMP (Muhammadiyah University of Purwokerto) in Central Java, Indonesia. The subject of this research was the class A semester II students of Mathematics Education Study Program at the UMP in academic year 2015/2016, which belonged the space geometry class.

The data collection techniques used in this study were the observation and the documentation (Creswell, 1998; and Kawulich, 2005). The data in this study was done with the observation which was made by 3 professional observers, they were: Anggun Badu Kusuma, M.Pd.; Reni Untarti, M.Pd.; and Wanda Nugroho Y., M.Pd. The observation was guided by the observation sheets of questions related mathematical communication skills of the students. The documentations which were obtained in this research in the form of videotapes and photograph of each the activities of the plan, do, and see, as well as the results of the work of the students.

After the data was retrieved, then, the data was analyzed in qualitative descriptively, such as following here (*cf* Creswell, 1998; Pope, Ziebland & Mays, 2000; Attride-Stirling, 2001; and Elliott & Timulak, 2005):

Firstly, *Data Reduction.* This step was done to choose the data whether it was appropriate in accordance with the research issues or not. For this research, the data which used was the data which supported the communication skills of students.

Secondly, *Presentating the Data*. After the appropriate data was selected, then, the data was presented in the form of pictures or the explanation of descriptions.

Thirdly, *Triangulation of Data*. In this process, the data that was presented was adjusted from another source, for example, the data that was from observational results was suited with the data from the results of the documentation.

Fouthly, *the Withdrawal of the Conclusion*. After the data was adjusted, then, it became conclusions about how the communication ability of college students of the subject of research.

RESULTS AND DISCUSSION

Identification of the communication skills of the students in this research was known by the results of the work of the students and the presentation in the class. The findings in every cycle are following here:

Cycle I. The learning material on the first cycle is painting the slice field on the cube. The finding on cycle I as follows:

Firstly, the drawing procedure in determining the slice field was not heeded yet. For example, the students did not give number sort on any line painted. This affected on the process of rechecking the images, in which the students were confuse when they were asked to re-explain in painting the iris fields that had been drawn.

Look at figure 1, it was a student which was drawing and there was no number sort yet on any line that was drawn. If the drawing procedure was correlated with the mathematical communication skill, it meant that the students could not be able to convey their idea correctly in written.

Secondly, most of the student's ability in understanding the concept of intersect line was still low. For example, the students considered that two lines crossing could intersect in a single point, whereas two lines crossing could not intersect at a point. This error happened, because the ability of the students in representing 3 dimensions shape in figure 2 dimensions was still low. It meant that the students could not be able to convey their idea correctly visually.

From figure 1, it could be seen that the student tried to determine the point Z which was an intersection between line RR' with the line EF, even though the two lines would not

ISSN 1979-7877 and www.mindamas-journals.com/index.php/educare

intersect, since both of the lines crossed each other.

Thirdly, the students didn't not understand the concept of the slice field yet. This can be seen in figure 2.

From the figure 2, it could be seen that the students marked out the slice field to the geometry. This mistake showed that the students could not be able to convey their idea correctly visually.

Fourthly, the concept of students about how the formation of the line was still low. It could be seen when the students made a line, they used only one point. Whereas by passing through the single point could be made not only one line. This mistake happened, because there was a lack of the students' concept understanding of the line and the students' skill in conveying the mathematical idea visually was low as well.

Fifthly, there were still many students who had difficulties to develop the concept of the intersection of two lines in one plot, especially if the known points were not on the edge of a space. The example of images space was like in figure 3, when the point R was on the field ADHE, but it was not on the edge the space ABCD and EFGH. Related to the mathematical communication skill, this phenomenon showed that the students also were not be able to present their mathematical idea into the visual picture.

In the first cycle, there were two errors related to the students' mathematical communication skill in drawing the sliced field on the cube, such as:

Firstly, the students were not be able to convey their idea in written. It could be seen when the students did not mention the steps in drawing the sliced field on the cube. When the students were asked to re explain it, they would be confused. Finally, the students realised their lack that had been done. When the students had finally realised about it, hopefully they would not do the error anymore.

Secondly, the students were not be able to represent their mathematical idea in visual image. Visual representation helped the students to solve the problem by connecting the information, which had been found on the

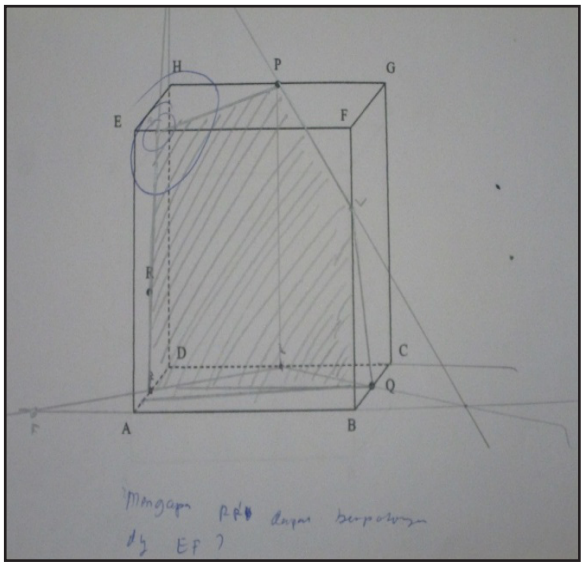

Figure 1:
Crossed Line

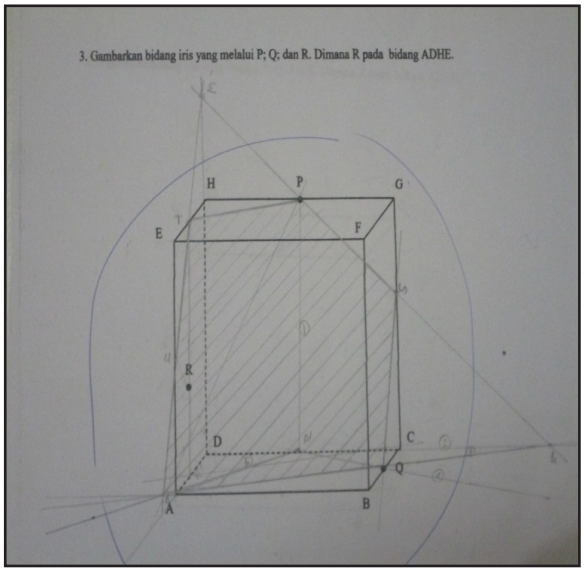

Figure 2:
Errors in Marking the Slice Field

mathematical problem which was needed to solve the problem (Woodward *et al.*, 2012; and Barmby *et al.*, 2013). In the other word, when the students were not be able to represent their problem in the visual form, they would have difficulty in solving the problem.

Cycle 2. Learning materials on the second cycle are painting the slice field at phiramid. The findings of the on cycle II as follows:

Firstly, the student still did not give the code sequence of line pictures that

ISSN 1979-7877 *and* ***www.mindamas-journals.com/index.php/educare***

was formed. This can be seen in figure 4. Although the errors still happened to the students, the amount of them was less than the first cycle. It meant that the students had tried to communicate their ideas in written.

Secondly, another procedure that was forgotten by the student in drawing the slice field was that they did not pay attention to the pencil scratches thickness on the drawing. This result that it was not able to distinguish which the line that was still an experiment and the one that had been an outcome. In addition, from the beginning since they had drown thick strokes as the error occured, then, the trace was not clean and could not be deleted clearly, and it made the figure looked dirty. This can be seen in figure 4.

Thirdly, the students do not yet understand the concept of the axis affinity. This can be seen in figure 5.

From the figure 5, it looked that axis affinity that students aimed at was the line RQ. This case went against the concept of the affinity of the axis. Because they had missconcept of this affinity axis, it had an effect on the results of the figure that would be got. Axis affinity mostly determined the formation of other lines that in one field.

Fourthly, the students do not yet understand the concept of a point. Note dan see in figure 6.

From the figure 6, it looked that the way that the students determined the point O was done randomly. Students should look for the lines that intersect each other and, then, it was continued by the new point. In these images, the students determined any point O on the line l and then they connected the point O with the point Q, so that it formed a line OQ.

Fifthly, for the more difficulty question, the students couldn't determine how to start to draw the figure. The Students wrongly connected all points. This can be seen in figure 7.

The finding number 3, 4, and 5 showed that the students did not understand yet the concept related to the material which was learnt. The understanding is the essential part so that the students can overcome their own problem (NCTM, 2000; and Newton, 2015). Based on the finding, it could be concluded

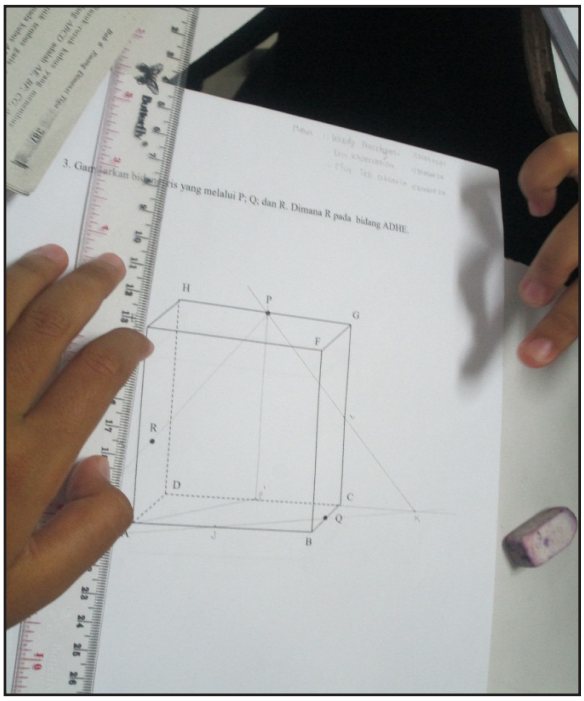

Figure 3:
The Point is Outside of the Edge

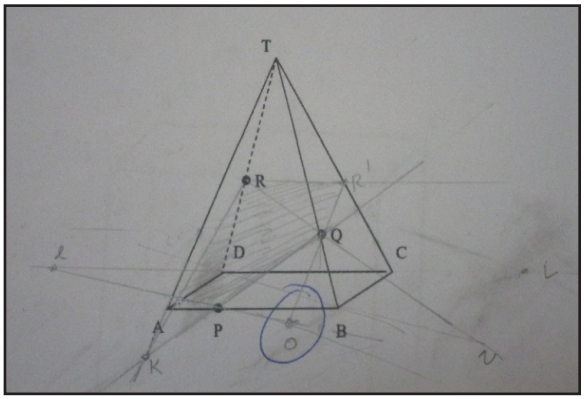

Figure 4:
Drawing Procedure Errors

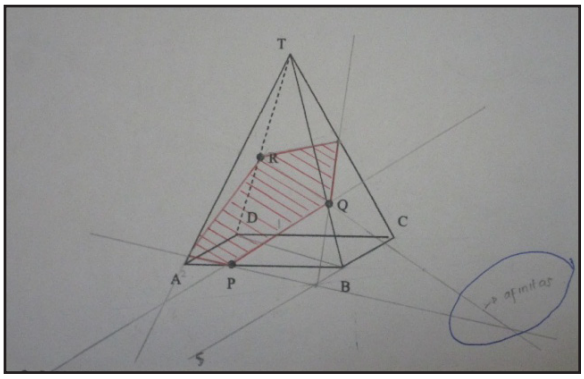

Figure 5:
Error Determining Axis Affinity

ISSN 1979-7877 and www.mindamas-journals.com/index.php/educare

that when the students could not understand the material which was learnt, then they could not communicate their mathematical ideas and finally they could not overcome their problem.

Cycle 3. The learning process on the third cycle was painting the slice field on the cube as well as calculating the extent. The findings of the on cycle 3, as follows:

Firstly, in this cycle, there was a new problem of the student that was that students experienced the obstacle toward the concept of comparison. The student could not draw if the data lines were known in the form of comparison. For example: student couldn't draw the line AB and point K on the line AB with AK : KB = 2, but he could draw AB : AK = 3 : 2. Even though the two problems were similar, but the students were confused. This problem occured, because the students could not apply the form of comparison in a figure.

Secondly, the student could not determine the name of the iris field that was formed. If a student was not able to determine the name of the two-dimension figures from of the iris that was formed, then the student had difficulty in determining the area (*cf* Paulu, 2001; Sava, 2007; and Kariadinata, 2010). It happened, because the students could not acknowledge the features on the figure, so that they would have a difficulty in counting the area.

On cycle 3, the issues facing college students still remain with regard to the inability of students to understand concepts which in the end, they weren't able to express mathematical ideas as they are in the form of writings or visual.

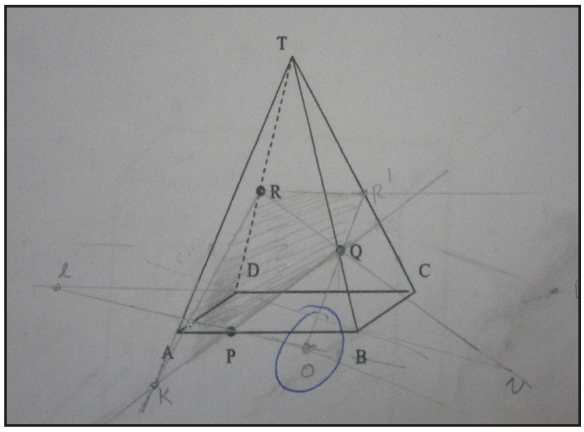

Figure 6:
Error Determining Point

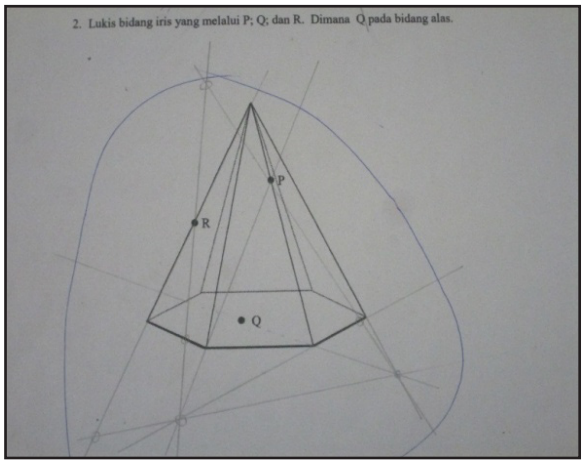

Figure 7:
The Geometry Difficulty Level which is More Difficulty

CONCLUSION

Based on the findings of the three cycles, it could be said that the miscommunications of mathematical student that were found, firstly, the procedure of drawing in the determination of the field of iris. Student mathematical communication errors in the drawing procedure were: determining which line with thick or thin pencil stroke; giving the numbers sort in any lines which were formed; and the hygiene of the paper. Those errors made the students had the difficulty in conveying the mathematical ideas in the written form and the visual form, so that the people could not understand what the students thought.

Secondly, the concept of figure in three dimensions. These errors were that the students were not being able to explain and imagine the shapes of three dimensions, which were presented in the form of images (in the form of two dimensions). Furthermore, for the vice versa, the students could not imagine the real shape of the figures of three dimensions which were given. It meant that the students had the difficulty to express their mathematical ideas in the visual form.

Thirdly, the concept of students in the field analysis. The mathematical communication error analysis of students in this field were:

ISSN 1979-7877 *and* ***www.mindamas-journals.com/index.php/educare***

(1) the misunderstanding of the concept of points, lines, and fields. Some concepts were not mastered, such as that there was one intersection that passed through the two lines which intersected each other, one line could be made by passing through two points, there was no intersection on the intersecting lines, and there were many points in one line, so that in order to decide the intersection point, it should be known that there was other line which intersected the line; and (2) drawing the line using the long comparison that was determined before.[1]

References

Attride-Stirling, J. (2001). "Thematic Networks: An Analytic Tool for Qualitative Research" in *Qualitative Research*, Vol.1, No.3, pp.385-405. Available online also at: http://goo.gl/VpQeQJ [accessed in Purwokerto, Indonesia: October 28, 2016].

Barmby, Patrick *et al*. (2013). *Developing the Use of Visual Representations in the Primary Classroom*. UK [United Kingdom]: Durham University. Available online also at: http://www.nuffieldfoundation.org/sites/default/files/files/Developing [accessed in Purwokerto, Indonesia: October 28, 2016].

Bold, Christine Elizabeth. (2001). "Making Sense of Mathematical Language in a Primary Classroom". *Unpublished Doctoral Dissertation*. Available online also at: https://oro.open.ac.uk/18838/1/pdf133.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].

Budiarto, Mega T., Koespono & T.R. Nindyo. (1998). "Analisis Kesalahan Materi Geometri bagi Guru-guru SLTP dan SMA". *Unpublished Research Result*. Surabaya: Pusat Penelitian IKIP [Institut Keguruan dan Ilmu Pendidikan] Surabaya.

Chun, Youngsub. (2015). "How to Communicate with Others: The Effective Communication Skills". Available online at: https://www.linkedin.com/pulse/how-communicate [accessed in Purwokerto, Indonesia: September 12, 2016].

Creswell, J.W. (1998). *Qualitative Inquiry and Research Design: Choosing among Five Traditions*. Thousand Oaks, CA: Sage.

Dansereau, F. & S.E. Markham. (1987). "Superior-Subordinate Communication: Multiple Levels of Analysis" in F.M. Jablin *et al*. [eds]. *Handbook of Organizational Communication*. Newbury Park, CA: Sage, pp.343-388.

Elliott, Robert & Ladislav Timulak. (2005). "Descriptive and Interpretive Approaches to Qualitative Research". Available online at: http://nideffer.net/classes/GCT_RPI_S14/readings/interpretive.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].

Eryaman, Zeynep. (2009). "A Study on Sixth Grade Students' Spatial Reasoning Regarding 2D Representations of 3D Objects". *Unpublished Master Thesis*. Available online also at: https://etd.lib.metu.edu.tr/upload/3/12611378/index.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].

Evbuomwan, Dickson. (2013). "An Investigation into the Difficulties Faced by Form C Students in the Learning of Transformation Geometry in Lesotho Secondary Schools". *Unpublished Master Thesis*. South Africa: University of South Africa. Available online also at: http://uir.unisa.ac.za/bitstream/handle/10500/10589/dissertation_evbuowan [accessed in Purwokerto, Indonesia: October 28, 2016].

Flevares, Lucia M. & Jamie R. Schiff. (2014). "Learning Mathematics in Two Dimensions: A Review and Look Ahead at Teaching and Learning Early Childhood Mathematics with Children's Literature" in *Frontiers in Psychology*, Volume 5. Available online also at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4033191/ [accessed in Purwokerto, Indonesia: October 28, 2016].

Jacobs, G.M., G.S. Lee & J. Ball. (1996). *Learning Cooperative Learning via Cooperative Learning: A Sourcebook of Lesson Plans for Teacher Education on Cooperative Learning*. Singapore: SEAMEO Regional Language Center.

Kariadinata, R. (2010). "Kemampuan Visualisasi Geometri Spasial Siswa Madrasah Aliyah Negeri (MAN) Kelas X melalui Software Pembelajaran Mandiri" in *Jurnal EDUMAT*, Vol.1(2).

Kawulich, Barbara B. (2005). "Participant Observation as a Data Collection Method" in *FQSR: Forum Qualitative Social Research*, Vol.6(2). Available online also at: http://www.qualitative-research.net/index.php/fqs/article/view/466/996 [accessed in Purwokerto, Indonesia: September 12, 2016].

Kemendiknas RI [Kementerian Pendidikan Nasional Republik Indonesia] *et al*. (2012). *Panduan untuk Lesson Study Berbasis MGMP dan Lesson Study Berbasis Sekolah*. Jakarta: Penerbit IDC.

Kilpatrick, J., C. Hoyles & O. Skovsmose. (2005). *Meaning in Mathematics Education*. New York: Springer.

Lee, Ji-Eun & Mary Zeppelin. (2014). "Using Drawings to Bridge the Transition from Student to Future Teacher of Mathematics" in *IEJEE: International Electronic Journal of Elementary Education*, Vol.6(2), pp.333-346. Available online also at: https://files.eric.ed.gov/fulltext/EJ1053765.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].

Morgan, C. (2002). *Writing Mathematically: The Discourse of Investigation*. Bristol: Taylor & Francis, Inc.

NCTM [National Council of Teachers of Mathematics]. (2000). *Principles and Standarts for School Mathematics.* Reston VA: The National Council of Teachers of Mathematics, Inc.

Newton, Ewart. (2015). "How Can Teachers Help Students Overcome Their Fear of Maths?". Available online at: https://www.britishcouncil.org/voices-magazine/how-can-teachers-help-students [accessed

[1]***Statement***: Herewith, we declare that this paper is our original work; it is not product of plagiarism and not reviewed or published by other scholarly journals elsewhere.

ISSN 1979-7877 and www.mindamas-journals.com/index.php/educare

in Purwokerto, Indonesia: October 28, 2016].
Paulu, Nancy. (2001). *Helping Your Students with Homework: A Guide for Teachers*. USA [United States of America]: Office of Educational Research and Improvement, U.S. Department of Education. Available online also at: https://www2.ed.gov/PDFDocs/hyc.pdf [accessed in Purwokerto, Indonesia: October 28, 2016].
Pope, C., S. Ziebland & N. Mays. (2000). "Analysing Qualitative Data" in *British Medical Journal,* 320, pp.114–116. Available online also at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1117368/pdf/114.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].
Pressman, H. Mark. (1997). "Hume on Geometry and Infinite Divisibility in the Treatise" in *Hume Studies*, Vol.XXIII, No.2 [November], pp.227-244. Available online also at: http://www.humesociety.org/hs/issues/v23n2/pressman/pressman-v23n2.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].
Reilly, Anthony J. (1998). "Three Approaches to Organizational Learning" in *The Pfeiffer Library*, Vol.16(2). Available online also at: http://home.snu.edu/~jsmith/library/body/v16.pdf [accessed in Purwokerto, Indonesia: September 12, 2016].
Sava, Deanna Iris. (2007). "Visual Perception Related to School". Available online at: https://mt08000619.schoolwires.net/cms/lib/MT08000619/Centricity/Domain [accessed in Purwokerto, Indonesia: October 28, 2016].
Shadiq, F. (2009). *Kemahiran Matematika*. Yogyakarta: Depdiknas RI [Departemen Pendidikan Nasional Republik Indonesia].
Soekamto, T. *et al*. (1993). *Prinsip Belajar dan Pembelajaran.* Jakarta: Depdikbud RI [Departemen Pendidikan dan Kebudayaan Republik Indonesia].
Susilo, H. *et al*. (2009). *Lesson Study Berbasis Sekolah Guru Konservatif Menuju Guru Inovatif*. Malang: Bayumedia.
Syaban. (2006). "Menumbuh-Kembangkan Daya Matematis Siswa" in *Journal Pendidikan dan Budaya*. Available online also at: http://educare.efkipunla.net/inde 2.php?option=com_content&d_pdf=1&id=62. [accessed in Purwokerto, Indonesia: September 12, 2016].
Syamsuri, I. & Ibrohim. (2009). *Lesson Study*. Malang: UM [Universitas Negeri Malang] Press.
TA [Tim Akademik]. (2016). *Panduan Akademik Universitas Muhammadiyah Purwokerto*. Purwokerto: Penerbit UMP [Universitas Muhammadiyah Purwokerto] Press.
Van de Walle, J.A. (2007). *Elementary and Middle School Mathematics: Teaching Developmentlly*. Boston: Pearson Education, Inc., 6th edition.
Woodward, J. *et al*. (2012). *Improving Mathematical Problem Solving in Grades 4 Through 8: A Practice Guide.* Washington, DC: NCEE [National Center for Education Evaluation] and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Available online also at: http://ies.ed.gov/ncee/wwc/publications_reviews.aspx#pubsearch [accessed in Purwokerto, Indonesia: October 28, 2016].

ISSN 1979-7877** and **www.mindamas-journals.com/index.php/educare