UJMER 9 (1) 2020 86 - 92

Unnes Journal of Mathematics Education Research

http://journal.unnes.ac.id/sju/index.php/ujmer

Mathematical Communication Ability Based On Cognitive Style in PBL With Tutor Feedback Assisted by Triangle Calculator

Lukky Fadillah✉, Kartono, Supriyadi

Universitas Negeri Semarang, Indonesia

Info Artikel

Article History
Received 16 December 2019
Accepted 10 February 2020
Published 15 June 2020

Keywords:
Komunikasi Matematis
Gaya Kognitif
PBL
Tutor Feedback
Triangle Calculator

Abstrak

This research's purposes are to (1) verify the effectiveness of Problem Based Learning (PBL) with tutor feedback assisted by triangle calculator towards the mathematical communication ability of 10th grade students, and (2) describe it based on cognitive style. This research used mixed method with concurrent embedded type as a methodology. The population of this research are 10th grade students of the Senior High School 1st Kadugede Kuningan (2018/2019). The result shows that (1) PBL with tutor feedback assisted by triangle calculator is effective toward the mathematical communication ability, and (2) the depiction of the mathematical communication ability based on Field Dependent (FD) cognitive style is able to complete four indicators, but unable to illustrate the image well and compete it correctly, on the other side based on Field Intermediate (FDI) cognitive style it is able to complete four indicators but not in a correct way, whilst based on Field Independent (FI) cognitive style it is able to complete for indicators correctly.

✉ Address correspondence:
Kampus Pascasarjana UNNES Jl Kelud Utara III, Semarang, Indonesia
E-mail: fadillahlukky1993@gmai.com

p-ISSN 2252-6455
e-ISSN 2502-4507

INTRODUCTION

Mathematical terms have many meanings depend on how people perceive and make use of it in their daily life. In that case, it depicts the characteristic of math as people's activity (Hendriana & Soemarno, 2014). Students encounter many obstacles trying to understand mathematics which cause them lack in communication skill. Upon discovering the mathematical communication state of the students, teachers must investigate the student's mathematics comprehension level, and using the student's misconception as information and reference is the correct learning method (Paruntu, et al., 2018).

According to the observation of the Senior High School 1st Kadugede students at the 10th grade in Kuningan, there are several reasons as to why the students lack in communication skill, especially in subject such as trigonometry, where most of the students don't understand the preconception of triangle and Pythagoras theorem, they found it difficult when the right triangle is modified. This problem is caused by the incomplete explanation and illustration of the trigonometry concept, descending motivation and interest of the subject seeing too many formulations instead of conceptions make the students reluctant to memorize them, and not to forget they are also facing complications in blending the concept of the subject into their daily life.

Another thing that needs to be concerned is the traditional way of teaching used in classes, in other words teacher-centered learning (Napitupulu, et al., 2016). This method can be found in almost every mathematic class, and this learning mainly focuses on basic skill without a proper mathematic implementation in student's daily basis.

In terms of understanding mathematic, mathematical communication is important, so it is necessary to find a learning simulation that provide opportunities and encourage the students to practice and increase their communication ability. According to Utami (2015) and Alhadad, et al (2015) the mathematical communication ability of the students can be improved by using a learning method that involve students to be active and focus on theoretical based learning, with the intention to improve their conception of mathematic alongside with their communication ability so they won't find any difficulties to implement mathematic in daily basis.

One of the innovative learning simulations that can improve mathematical communication ability is PBL. PBL mainly focuses on posing the teachers as a knowledge conveyer and facilitator towards the students. According to Aini, et al. (2015) teacher's duties and roles are no longer as information provider but as motivator, that encourage the students to construct their knowledge from many activities including communication.

As for the tutor feedback used in the simulation intent to provide directions and advices so the learning process can run smoothly. Teacher (tutor) is expected to be responsive in focusing the student's interest. According to Zinn (2006) the feedback provision that is smart, adaptive and effective require the tutor to exploit their knowledge and analyze student's activities through solution liability and misconception.

The PBL involves students through investigation that enable them to interpret and explain the real world phenomena and building the concept around it. Therefore, aside from being given assistance by a tutor, students can also confirm the answer of a certain problem especially trigonometry by using android based application called triangle calculator. Parrot and Leong (2018) said that the utilization of visual technology in problem solving can improve the student's comprehensive.

The assignment preparation in PBL requires understanding of the student's cognitive progression level. Because of the unfamiliar questions and assignment can decrease their involvement level in terms of cognitive progression. According to Fauziyah

& Kartono (2017) prior to PBL, the problem selection in collaborative learning must be associated with student's knowledge.

Processing information is diverse in every students and it affect the ability to understand a subject especially mathematical communication. Nurdianasari, et al. (2015) stated that every student is a key factor that determines the success of a learning process. The difference of each individual in terms of arranging and processing information is called cognitive style.

The purpose of this research is to verify the effectiveness of PBL with tutor feedback assisted by triangle calculator towards the mathematical communication ability of 10th grade students, and describe it based on cognitive style.

METHODS

This research used mixed method type with concurrent embedded where primary method is quantitative and secondary method is qualitative. The population of the research is 10^{th} grade students of Senior High School 1^{st} Kadugede Kuningan (school year of 2018/2019).

Sample acquiring technic used in this research is simple random sampling technic, which is selected randomly. By using this technic we obtain two classes population as samples that are Science Class 1 as experimental class and Science Class 2 as control class, both are in 10th grade and consist of 34 students in each class. As for the subject acquiring technic used in experimental class is purposive method with sixteen (16) students are tested by cognitive style FI, nine (9) students are tested by cognitive style FDI and nine (9) students are tested by cognitive style FD.

Quantitative data collection technic is done by testing mathematical communication ability and qualitative data collection technic is done by doing Group Embedded Figure Test (GEFT), interview and documentation. And then the quantitative data is analyzed by its normality, homogeneity, completeness, proportion, diversity and proportion balance, meanwhile the qualitative data is analyzed by following Miles & Hubermen concept which steps are data reduction, data presentation, conclusion and verification.

RESULT AND DISCUSSION

According to the preconception test of quantitative analysis, the mathematical communication ability of experimental and control class have normal and homogeny distribution among the students. And as for the effectiveness is tested using completeness and diversity test. The completeness test on mathematical communication ability with PBL simulation assisted by triangle calculator resulted in average completeness of t_{value} = 4,0180 > t_{table} = 1,69236 so H_0 is rejected. This result means the average skill of mathematical communication of the students exceeds minimum completeness criteria of 70%. While proportionality test gave out z_{value} = 1,7823 > z_{table} = 1,64 so the H_0 is rejected, it means the average skill of mathematical communication of the students exceeds minimum completeness criteria of 75%.

For the diversity test between experimental class and control class, it gave out an average diversity of t_{value} = 2,5206 > t_{table} 1,67 so H_0 is rejected, which means the average mathematical communication ability of experimental class is better than control class. Meanwhile, the proportionality test gave out z_{value} = 3,6290 > z_{table} = 1,64 so the H_0 is rejected, it means the average mathematical communication ability of experimental class is better than control class.

The key role to achieve completeness in mathematical communication ability of the students cannot be separated from what kind of learning simulation that is used. The learning simulation used must be based on theoretical learning, which can help improving mathematical communication ability of the students and eventually help the students in solving math problems in daily basis (Alhaddad, 2015).

This research used PBL with tutor feedback assisted by triangle calculator. The utilization of PBL gave positive impact towards the students (Geni, *et al*., 2017) and effective in mathematics teaching (Noriza, *et al*., 2015). The main focus in PBL is solving problems by involving the students to be active through small collaborative group that can improve their knowledge and skills, such as self-study, problem solving and communication ability (Haruehansawasin & Kiattikomol, 2018; Napitupulu, *et al*., 2016).

PBL is started by focusing on authentic problems that motivate the students to involve themselves in solving the problems. This is analogous to the Ausebel theory that stated the problems that are implemented in learning process; they are designed to direct the students to learn in a meaningful way (Jailani, *et al*., 2017).

The utilization of PBL gave positive impact towards the students (Geni, *et al*., 2017) and effective in mathematics learning (Noriza, *et al*., 2015). The students become more active in constructing their knowledge so they can gain new knowledge through the problems that are prepared by the teacher. One of the key roles of PBL is the tutor role. Tutor's main role in PBL is creating an optimal condition in a learning process by mastering the subject that will be taught using PBL (Garcia, *et al*., 2017), also as knowledge conveyer and facilitator towards the students (Ismawati, *et al*., 2017). A tutor also must help the students to identify their needs, knowledge source and monitor their study. In addition to tutor's role is giving feedback. According to Hamer, *et al*., (2015) and Van Ginkel, *et al*., (2017) a tutor feedback outperform homework feedback and self-assessment.

Tutor feedback in this research is optimized by oral feedback and written feedback. Oral feedback is given when the PBL at the phase of guiding the group/individual, developing and presenting the outcome, while written feedback is given when PBL at the phase of analyzing and evaluating the problem solving progress by giving quizzes (quiz 1 and quiz 2). And the problems given at the quiz are identical with the ones solved in group. Just in case there are students that cannot solve the problems in quiz 1, then those students will be given quiz 2, in which both quiz 1 and quiz 2 have similar problems. Oral feedback and written feedback are given alternately, but all in all the feedback is emphasized on oral feedback.

This research used feedback that emphasized on the learning process rather than the outcome. According to Anggraini, *et al*. (2015) and Morris & Chikwa (2016) feedback is not an evaluation of a learning outcome or result but is used to find information on students, to what extent do they understand the subject discussed, and indirectly guiding the students to correct themselves according to their comprehensive. Therefore, a tutor feedback can outperform homework feedback and self-assessment (Hamer, *et al*., 2015; Van Ginkel, *et al*., 2017).

The other thing that needs to be concerned is the role of triangle calculator as confirmation of the answer justification of what the students have accomplished and as guidance outside the school if the students are given homework. According to Ghosh (2015), students prefer manual calculation to calculator, they used calculator only to confirm their answers. Triangle calculator is a technology in the form of mobile application that can help the students to solve mathematics problems like trigonometry especially trigonometric ratios, sine and cosine rules. The utilization of technology contributed in mathematical reflection, problem identification and decision making (Parrot & Leong, 2018), also, the utilization of mobile application in mathematics learning has improved the student's performance and comprehension (Etcuban & Pantinople, 2018).

As for the qualitative analysis results, the description of mathematical communication ability based on cognitive style can be concluded as similarity and diversity between FD, FDI and FI students with indicators as follows.

Expressing an image into ideas or mathematics design. This indicator showed that FD, FDI and FI students have similarity in terms of expressing an image into ideas or mathematics design. Ubuz & Aydınyer (2019) stated the opposite thing that FI individuals tend to have more positive remarks towards mathematics compare to the others. FD, FDI and FI students are also capable to solve the problem in the same steps, but there are some FD and FDI students who cannot interpret the illustration correctly. According to Noppe & Gallagher (Amstrong, *et al.*, 2011) FI individuals are better in terms of differentiating and integrating information compared to FD individuals.

Making mathematical conjecture using their personal language. This indicator showed that FD, FDI and FI students have similarity but different approach in the making of mathematical conjecture and there is only one FD student who cannot make the conjecture correctly. FD and FDI students showed disarray steps of solution while FI students showed structured steps of solution. Analogous to this result is Amstrong, *et al*. (2011), that stated the FD students prefer an irregular situation to a regular one, while FI students prefer a regular situation (structured). Furthermore, at the final completion, FD students are the only ones who can provide a conclusion accordingly and most of FDI students cannot give any conclusion. Chen, *et al*. (2019) stated that FI students put more focus on the details.

Illustrating idea, situation or mathematical relation into an image and mathematics design. This indicator showed that FDI and FI have similarity to be able to illustrate idea, situation or mathematical relation into an image. As for illustrating idea, situation or mathematical relation; FD, FDI and FI students are capable of simulating it correctly; it is just one FD student who cannot substitute image illustration into the mathematics design due to incorrect picture. This showed that FD students are not capable to illustrate idea, situation or mathematical relation into an image but capable to illustrate idea, situation or mathematics relation into mathematics design. According to Amstrong, *et al*. (2011), FD students will find difficulties in solving problems that require out of context information, because the information implanted in their minds is mathematics only consist of concept and formulas not an image, so FD students can only organized what were given and present it as it is. Opposite to FD students, FDI and FI students can solve the problems by finding components in the form of images that were made into mathematical design.

Arranging the mathematics design of daily phenomena into language or mathematics symbols. This indicator showed that FI students are capable to depict the illustration of daily phenomena problems, but most of them did not use the concept and formula perfectly, meanwhile FD students faced difficulties to illustrate the daily problems. According to Chen, *et al*. (2019) and Amstrong, *et al*. (2011), in terms of processing information, FI students analyze and orient it analytically, while FD students analyze and orient it globally. This statement was confirmed by Noppe & Gallagher (Amstrong, *et al.*, 2011) that FI students are more creative compared to FD students. As for FDI students, most of them are capable to illustrate the daily problems, but cannot compile the mathematics design. Arranging mathematics design of daily phenomena into language or mathematics symbols requiring the ability to integrate daily (social) and experience of the students into mathematics problems, both in the form of image or design. FDI and FD students are capable to integrate an image into an illustration, but that does not apply to FI students, they cannot integrate an image into illustration. Ubuz & Aydınyer (2019) said an opposite thing, that FI individuals don't have any interest in the subject learning related with social content.

CONCLUSION

According to the research's result and discussion, PBL with tutor feedback assisted by triangle calculator is effective towards mathematical communication ability of the students and based on the cognitive style description, FD cognitive style is able to complete four indicators, but unable illustrate any image and solve it correctly, while FDI cognitive style is unable to complete four indicators correctly, on the other hand, cognitive style FI is able to complete four indicators correctly.

REFERENCES

Aini, N. N., Sukestiyarno, S., & Waluya, B. 2015. "Analisis Komunikasi Matematis dan Tanggung Jawab pada Pembelajaran Formulate Share Listen Create Materi Segiempat". *Unnes Journal of Mathematics Education Research*, 4(2): 115-121.

Alhaddad, I., Kusumah, Y. S., Sabandar, J., & Dahlan, J. A. 2015. "Enhancing Students Communication Skills Through Treffinger Teaching Model". *Journal on Mathematics Education*, 6(1): 31-39.

Amstrong, S.J., E. Cools, & E.S. Smith. 2011. "Role of Cognitive Styles in Business and Management: Reviewing 40 Years of Research". *International Journal of Managemnt Reviews*, 14(3)" 238-262.

Anggraini, W., Hudiono, B.,& Hamdani. 2015. "Pemberian Umpan Balik (Feedback) Terhadap Hasil Belajar Dan Self-Efficacy Matematis Siswa Kelas VII SMP". *Jurnal Pendidikan dan Pembelajaran*, 4(9): 1-13.

Chen, Y. T., Liou, S., & Chen, L. F. 2019. "The Relationships among Gender, Cognitive Styles, Learning Strategies, and Learning Performance in the Flipped Classroom". *International Journal of Human–Computer Interaction,* 35(4-5): 395-403.

Etcuban, J. O., & Pantinople, L. D. 2018. "The Effects of Mobile Application in Teaching High School Mathematics". *International Electronic Journal of Mathematics Education*, 13(3): 249-259

Fauziyah, L., & Kartono, K. 2017. "Model Problem Based Learning dengan Pendekatan Open-Ended untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa". *Unnes Journal of Mathematics Education Research*, 6(1): 59-67.

Garcia, I., James, R. W., Bischof, P., & Baroffio, A. 2017. "Self-Observation And Peer Feedback As A Faculty Development Approach For Problem-Based Learning Tutors: A Program Evaluation". *Teaching and Learning In Medicine*, 29(3), 313-325.

Geni, P. R. L., Mastur, Z., & Hidayah, I. 2017. "Kemampuan Pemecahan Masalah Siswa pada Pembelajaran Problem Based Learning Bernuansa Etnomatematika Ditinjau dari Gaya Kognitif". *Unnes Journal of Mathematics Education Research*, 6(1): 11-17.

Ghosh, J. B. 2015. "Learning Mathematics in Secondary School: The Case of Mathematical Modelling Enabled by Technology". *In Selected Regular Lectures from the 12th International Congress on Mathematical Education*, 203-222. Springer, Cham.

Hamer, J., Purchase, H., Luxton-Reilly, A., & Denny, P. 2015. "A Comparison of Peer and Tutor Feedback". *Assessment & Evaluation in Higher Education*, 40(1): 151-164.

Haruehansawasin, S., & Kiattikomol, P. 2018. "Scaffolding In Problem-Based Learning For Low-Achieving Learners". T*he Journal of Educational Research*, 111(3): 363-370.

Hendriana, H & Soemarmo, U. 2014. *Penilaian Pembelajaran Matematika*. Bandung: PT Refika Aditama.

Ion, G., Sánchez Martí, A., & Agud Morell, I. 2019. "Giving Or Receiving Feedback: Which Is More Beneficial To Students' Learning?". *Assessment & Evaluation in Higher Education*, 44(1): 124-138.

Ismawati, A., Mulyono, M., & Hindarto, N. 2017. "Kemampuan Pemecahan Masalah Matematika dalam Problem Based Learning dengan Strategi Scaffolding Ditinjau dari Adversity Quotient". *Unnes Journal of Mathematics Education Research*, 6(1), 48-58.

Jailani, J., Sugiman, S., & Apino, E. 2017. "Implementing The Problem-Based Learning In Order To Improve The Students' HOTS And Characters". *Jurnal Riset Pendidikan Matematika*, 4(2): 247-259.

Morris, C., & Chikwa, G. 2016. "Audio Versus Written Feedback: Exploring Learners' Preference and The Impact of Feedback Format on Students' Academic Performance". *Active Learning in Higher Education*, 17(2): 125-137.

Napitupulu, E. E., Suryadi, D., & Kusumah, Y. S. 2016. "Cultivating Upper Secondary Students Mathematical Reasoning-Ability and Attitude towards Mathematics Through Problem-Based Learning". *Journal on Mathematics Education*, 7(2): 117-128.

Noriza, M. D., Kartono, K., & Sugianto, S. 2015. "Kemampuan Pemecahan Masalah dan Disposisi Matematis Siswa Kelas X pada Pembelajaran Berbasis Masalah". *Unnes Journal of Mathematics Education Research*, 4(2): 66-75.

Nurdianasari, H., Rochmad, R., & Hartono, H. 2015. "Kemampuan Literasi Matematika Siswa Kelas Viii Berdasarkan Gaya Kognitif". *Unnes Journal of Mathematics Education Research*, 4(2): 76-83.

Parrot, M. A. S., & Leong, K. E. 2018. "Impact of Using Graphing Calculator in Problem Solving". *International Electronic Journal of Mathematics Education*, 13(3): 139-148.

Paruntu, P. E., Sukestiyarno, Y. L., & Prasetyo, A. P. B. 2018. "Analysis of Mathematical Communication Ability and Curiosity Through Project Based Learning Models With Scaffolding". *Unnes Journal of Mathematics Education Research*, 7(1): 26-34.

Ubuz, B., & Aydınyer, Y. 2019. "Project-Based Geometry Learning: Knowledge And Attitude Of Field-Dependent/Independent Cognitive Style Students". *The Journal of Educational Research*, 1-16.

Utami, C. 2015. Pembelajaran Model Generatif dengan Strategi Group Investigation untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa. *Unnes Journal of Mathematics Education Research*, 4(1): 26-33.

Van Ginkel, S., Gulikers, J., Biemans, H., & Mulder, M. 2017. "Fostering Oral Presentation Performance: Does The Quality Of Feedback Differ When Provided By The Teacher, Peers Or Peers Guided By Tutor?". *Assessment & Evaluation in Higher Education*, 42(6): 953-966.

Zinn, C. 2006. "Supporting Tutorial Feedback to Student Help Requests and Errors in Symbolic Differentiation". *In International Conference on Intelligent Tutoring Systems*. Springer, Berlin, Heidelberg: 349-359.