Improvement of Mathematical Communication Skills and Learning Independence Students Who Get Quantum Teaching Models and Discovery Learning Models

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Abstract

Mathematical communication is one of the abilities that students need to have to understand mathematics meaningfully. However, the reality is that there are still many students who have low mathematical communication skills. Therefore, it is necessary to apply specific learning models to increase these abilities. This study aimed to analyze the quality of the improvement in mathematical communication skills of students who received the Quantum Teaching model. This research is a quasi-experimental research with data collection techniques using quantitative analysis obtained from the pretest and post-test results. The study population was all seventh-grade students at one junior high school in Garut with a sample of two classes. The instrument used in this study was a test in the form of questions to measure mathematical communication skills. The results showed the quality of the increase in students' mathematical communication skills who got the moderate interpretation Quantum Teaching model.

Keywords:

Mathematical Communication Ability, Quantum Teaching Models

1. Introduction

Mathematics has a role as a language of symbols that allows for accurate and precise communication. The rapid development of information and communication technology today is also influenced by mathematics as a science. Vital mastery of mathematics from an early age is needed by students to master and create future technology. Therefore, mathematics subjects need to be taught at every level of education to equip students to keep up with the times.

However, in its implementation, there are still many problems in learning mathematics. This is as said by Johar, R., et.al (2018) that is the fact that Indonesian students lack mathematical communication skills. From the interviews with several mathematics teachers, it was found that most students already had a large enough interest in learning mathematics. However, the students' ability in mathematics communication is still low. It can be seen from 1. When faced with a story problem, students are not used to writing what is known and what is asked of the question before solving it, so that students often misinterpret the meaning of the question; 2. Students still do not understand a mathematical concept. It appears that most students still have difficulty using the idea of comparison in problem-solving; 3. The lack of students' accuracy in mentioning mathematical symbols or notations can be seen in most students still unable to distinguish between equals and unequal characters. 4. There is a sense of reluctance and students' hesitation to occasionally express or communicate mathematical ideas through pictures, tables, and graphs, so this causes students to have often difficulty reading problems (Elastika et al., 2019).

This is also in line with the results of research conducted by Kusuma (in Purwanti & Ahmad, 2016, p. 21) that the level of mathematical communication skills of junior high school students is still low. These studies indicate that the number of students who have high communication skills is relatively small.

Therefore, students need to be accustomed to communicating their ideas orally and in writing to others according to their interpretation so that other people can assess and provide responses to their performances. Through such activities, students will get a more meaningful understanding of what they are doing. This means that teachers need to encourage students' ability to communicate in each lesson (Elastika et al., 2019).

Based on these problems, a learning model is needed that can be used to improve students' mathematical communication skills. Triana, M.,et.al (2019) said that teachers require to cultivate students' mathematical communication skills through learning providing students opportunities to present their ideas. So that researchers conduct research using the Quantum Teaching model. According to Vos Groenendal (in Prawestri, 2013, p. 7), Quantum Teaching is proven to increase motivation, creativity, communication, building relationships, and developing life skills. Quantum Teaching can be successful because the design is known as "TANDUR" in the Indonesian language, namely Tumbuh (grow), Alami (experience), Namai (name), Demonstrasi (demonstrate), Ulangi (repeat), and Rayakan (celebrate) is used in the delivery of material and its main principle which reads "Bring Their World to Our World, and Deliver Our World to Theirs.". (Deporter in Prawestri, 2013, p. 8).

Based on the background described, the formulation of the problem in this study is how the quality of improving the mathematical communication skills of students who get the Quantum Teaching model?

2. Literature Review

2.1 Mathematical Communication Ability

According to The Intended Learning Outcomes (ILOs) (in Armiati, 2009, p. 271), "Mathematical communication is an important skill in mathematics, namely the ability to coherently express mathematical ideas to friends, teachers, and others through spoken and written language" By using the correct mathematical language to speak and write about what they do, they will be able to clarify their ideas and learn how to make convincing arguments and present mathematical ideas.

Communication skills should include sharing thoughts, asking questions, explaining questions, and validating ideas. Communication must be well integrated into the classroom environment. Students should be encouraged to state and write down conjectures, problems, and solutions. Sumarmo (in Kurniawan, Yusmin & Hamdani, 2017, p. 2) which states that indicators that can reveal mathematical communication skills include: 1. Linking real objects, pictures, and diagrams into mathematical ideas. 2. Explain ideas, situations and mathematical relations orally or in writing with real objects, pictures, graphics and algebra. 3. State everyday events in language or mathematical symbols. 4. Listen, discuss, and write about mathematics. 5. Read written math presentations and formulate relevant questions 6. Make conjectures, prepare arguments, formulate definitions and generalizations.

From the indicators of mathematical communication skills above, the researcher only takes three indicators, namely: 1) Explaining ideas, situations, and mathematical relations orally or in writing with real objects, pictures, graphics, and algebra, 2) Stating daily events in language or mathematical symbols, and 3) Making conjectures, compiling arguments, formulating definitions and generalizations.

2.2 Quantum Teaching Model

Wena (in Oktarina, Ismail & Nery, 2017, p. 41) states that "the Quantum Teaching model is a new way to facilitate the learning process for all subjects." The main objective of the Quantum Teaching model, according to Sa'ud (in Oktarina, Ismail, & Nery, 2017, p. 41), is "To improve learning motivation, memory, and student participation in learning."

Harto (in Isnaini, Wigati & Halimatussya'diyah, 2016, p. 18) states that "The principle of Quantum Teaching is to bring their world to our world, and deliver our world to their world." This principle emphasizes that it is essential and foremost before our learning enters the world of students. According to DePorter (in Suryanti & Yunianta, 2018, p. 150) states, the Quantum Teaching model has six stages in learning known as TANDUR, namely: 1. Tumbuh (grow), which is to foster students' interest in learning activities. 2. Alami (natura)l, namely, bringing students broad experience by informing their knowledge. 3. Namai (name), which is to allow students to identify, sort, and define a concept with the knowledge they have. 4. Demonstrasi (demonstrated), namely, students are given the opportunity to convey their expertise in the learning process. 5. Ulangi (repeat). Students are allowed to ask questions about learning that has not been understood, then conclude. 6. Rayakan (celebrate), which is to give an award or motivation to students for the learning outcomes they get.

3. Methodology

This research was conducted in two classes, which were selected as samples. From these two classes, it was determined that the experimental group got the Quantum Teaching model, while the control group got the conventional learning model. Before learning begins, a pretest is held. This pretest is used to determine the initial ability before learning from the two groups of research subjects. After completing the learning following the research plan, then a posttest is held.

The design used in this study is the Non-Equivalent Control Group Design. As stated by Sugiyono (2016, p. 116), in this design, the experimental and control groups were not chosen randomly. The design description based on the research method used is as follows (Sugiyono, 2016, p. 116):

Pretest	Treatment	*Posttest*
O	X	O
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O		O

Notes:
O : *Pretest and Posttest*
X : Treatment with the Quantum Teaching model
------ : Quasi eksperiment.

In this study, the researcher took the study population, namely all students of class VII, at one of the junior high schools in Garut. The sample consisted of two groups, with 32 male students and 29 female students, totaling 61 people.

In collecting research data, researchers used essay test questions to measure students' mathematical communication skills. Accounting data analysis is to provide an overview of the data that has been obtained and collected. This is done to find conclusions and test hypotheses. The pretest and posttest data obtained from the control class and the experimental class were processed using statistical analysis techniques.

The mathematical communication data analysis consists of data from the pretest, posttest and continued with normalized gain in the control class and the experimental group. In this study, only the N-Gain data were analyzed because it refers to the formulation of the problem under investigation, namely improving mathematical communication skills.

4. Result and Discussion

This study's results include the pretest and post-test products, solving problems of mathematical communication skills that are divided into five questions from three indicators. The data is analyzed to answer questions in the formulation of the problem and answer the research hypothesis is given in Table 1.

Table 1. Mathematical Communication Ability Data

Quantum Teaching Group			
Category	***Pretest***	***Posttest***	***N-Gain***
Smallest Score	0	7	0.32
Greatest Score	4	15	0.74
Mean	1.26	11.90	0.57
Standard Deviastion	0.77	2.37	0.12
The Number of Students	31		
Control Group			
Category	***Pretest***	***Posttest***	***N-Gain***
Smallest Score	1	8	0.37
Greatest Score	8	17	0.84
Mean	2.10	13.10	0.62
Standard Deviastion	1.56	2.28	0.11
The Number of Students	30		

Ideal Score $= 20$

In Table 1, it is found that the average N-Gain in the two classes has moderate interpretation. Furthermore, the normality test, homogeneity test, and Mathematical Communication Skills test are given in Table 2.

Table 2. Normality test, homogeneity, and t-test Mathematical Communication Skills

Informations	***Quantum Teaching***	***Conventional Learning***
L_{maks}	0.1151	0.1338
L_{table}	0.1610	0.1634
Interpretation	Normally Distributed	Normally Distributed
Varians	0.12	0.11
F_{count}	1.0610	
F_{table}	1.8500	
Interpretation	Homogeneous	
t_{count}	-1.574	
t_{table}	2.0013	
Interpretation	H_o accepted	

In Table 2, it is found that students with the Quantum Teaching model have a value of $L_{max} = 0.1151$ $L_{table} = 0.1610$. Students with conventional models have a value of $L_{max} = 0.1338$ $L_{table} = 0.1634$. This study uses 5%. The criteria for normally distributed data is $L_{max} < L_{tabel}$, It can be concluded that the N-Gain results of the two groups of students are normally distributed. The variance of Quantum Teaching class 0.12 and Conventional class 0.11. So that it is obtained $F_{count} = 1.0610$ and $F_{table} = 1.8500$. This shows that $F_{count} < F_{table}$, so the two variances are homogeneous.

The data from the calculation results obtained the combined standard deviation value (csd) = 0.1161, the value of $t_{count} = -1.574$ with 5% and degrees of freedom (df) of 59, obtained $t_{table} = 2.0013$. The test criterion is if $-t_{table} < t_{count} < t_{table}$ then Ho is accepted, it means that Ho is accepted. So the conclusion is that there is no difference in the improvement of mathematical communication skills between students who get the Quantum Teaching model and the conventional learning.

The results of the previous data analysis, namely the increase in mathematical communication skills between students who received the Quantum Teaching model with conventional learning models did not show any significant differences, and when viewed from the average calculation of the increase in the two groups showed the same results, namely moderate interpretation.

In general, students who get the Quantum Teaching model tend to be confused when working on Student Worksheets because, in this model, students are expected to be able to bring their own experiences to fill in the steps on the Student Worksheets so that they find a concept. The Quantum Teaching model with the (TANDUR) syntax Grow, Natural, Name, Demonstrate, Repeat, and Celebrate. It turned out that after the application of this approach, some students did not like the repetitive syntax. But in general, quantum teaching learning model can improve students' mathematical communication skills. This is consistent with the results of research from Rumapea, G, etc (2017) that **there is an increase student learning outcomes in study algebraic operations by using quantum teaching learning model.**

This has implications for the 1st and 2nd indicators of mathematical communication skills, namely explaining ideas, situations, and mathematical relationships orally or writing with real objects, pictures, graphics, and algebra, and states everyday events in language or symbols. The increase in mathematical communication skills on indicators 1 and 2 exceeded half of the number of students showing moderate interpretation. So it can be said that some students have not been able to explain ideas, situations and mathematical relations orally or in writing with real objects, pictures, graphics, and algebra; and express everyday events in language or symbols even though they have got the Quantum Teaching model.

Another case for the 3rd indicator, students can make conjectures, compile arguments, formulate definitions, and generalizations. In the Quantum Teaching class, some students are able to define or draw conclusions from a problem. It can be seen from the interpretation of the improvement for this 3rd indicator is high. Similar to conventional learning classes, some students can define or conclude a problem.

The results of the achievement of these two classes do not show any difference, because seen from the posttest results of mathematical communication skills in the class that received the Quantum Teaching model, the highest score obtained was 15 with a value of 75, meaning that new students were able to answer 75% of the whole questions, as well as with In the class that received conventional learning, the highest score obtained was 17 with a value of 85, which means that new students were able to answer 85% of all the questions.

In line with the obstacles faced, other factors cause the improvement of students' mathematical communication skills who receive the Quantum Teaching model is still not optimal, namely learning is carried out after sports lessons. The fatigue factor can be one of the causes for the lack of concentration during learning. Also, in terms of time, it is cut by the time to change clothes after exercising. When learning, the Quantum Teaching class is not optimal in terms of time availability and utilization.

According to the researchers' observations, the things that have been described above are the factors that cause there is no difference in the increase in mathematical communication skills between students who receive the Quantum Teaching model and conventional learning. Also, students' attitudes towards applying the Quantum Teaching model still do not show high enthusiasm, especially related to self-regulated learning. This is in line with the results of Hidayah's research (2014, p. 11), which states that students tend to dislike mathematics, students' busyness in other activities makes them ignore mathematics, even if they only learn mathematics when they do tests. And this is in line with the results of Qohar and Sumarmo's research (2013, p. 71) there was association between mathematical communication and self-regulated learning.

5. Cloncluion

Based on the description of the results and discussion, it is concluded that the increase in mathematical communication skills of students who get the Quantum Teaching model is in the moderate category, and there is no difference in the increase in mathematical communication skills between students who get the Quantum Teaching model and conventional learning. The teacher should understand each step of the learning model that will be applied and pay attention to time to be appropriately used, and learning objectives can be achieved. Also, further research is needed to improve students' mathematical communication skills and learning independence.

References

Amalia, A. dkk. (2018). Hubungan antara Kemampuan Pemecahan Masalah Matematik dengan Self Efficacy dan Kemandirian Belajar Siswa SMP. *Jurnal Pembelajaran Matematika Inovatif*, 1*(5)*, 887-894. [*Online*]. Diakses dari https://journal.ikipsiliwangi.ac.id/index.php/jpmi/article/download/1531/283.

Armiati. (2009). Komunikasi Matematis dan Kecerdasan Emosional: Universitas Katholik Parahyangan. [O*nline*]. Diakses dari: http://eprints.uny.ac.id/id/eprint/7030.

Elastika, R.W., Zulkarnain, Indriati, M., Sukono, Subiyanto, and Bon, A.T. (2019). Analysis of Student's abilities in Completing Mathematical Problems Dimension Three in Junior High School. *Proceedings of the International Conference on Industrial Engineering and Operations Management,* Bangkok, Thailand, March 5-7, 2019, 3036-3044.

Isnaini, M. Wigati, I. dan Halimatussya'diyah. (2016) Pengaruh Model Pembelajaran Quantum Teaching Dengan Langkah-Langkah Tandur Terhadap Keterampilan Proses Belajar Siswa Materi Sel Kelas XI Di SMA Muhammadiyah 1 Palembang. *Jurnal Bioilmi*, 2*(1)*, 16-29. [*Online*]. Diakses dari: http://jurnal.radenfatah.ac.id/index.php/bioilmi/article/download/1155/974/

Johar, R., Junita, E., Saminan. (2018). Students' Mathematical Communication Ability and SelfEfficacy using Team Quiz Learning Model. International Journal on Emerging Mathematics Education (IJEME). Vol. 2, No. 2, September 2018, pp. 203-214.

Kurniawan, D. Yusmin, E. dan Hamdani. (2017). Deskripsi Kemampuan Komunikasi Matematis Siswa dalam Menyelesaikan Soal Cerita Kontekstual. *Jurnal Pendidikan dan Pembelajaran*, 6*(2)*, 1-11. [*Online*]. Diakses dari: http://jurnal.untan.ac.id/index.php/jpdpb/article/view/18451.

Lestari, E. K. dan Yudhanegara, M. R. (2018). *Penelitian Pendidikan Matematika.* Bandung: Refika aditama.

Oktarina, S. Ismail, F. dan Nery, R. S. (2017). Pengaruh Model Quantum Teaching Terhadap Pemahaman Konsep Matematika Siswa Di Kelas X SMA Ethika Palembang. [*online*]. Tersedia: https://scholar.google.com [05 Februari 2019].

Prawestri, A.E. (2013). *Upaya Meningkatkan Kemampuan Komunikasi Matematika Siswa Dalam Pembelajaran Matematika Melalui Kolaborasi Model Quantum Teaching dan Model Pembelajaran Kooperatif Tipe Kancing Gemerincing Pada Siswa Kelas VIII B SMP Muhammadiyah 2 YogyakartaTahun Ajaran 2012/2013*. Skripsi pada Program Studi Pendidikan Matematika UAD Yogyakarta. [*Online*]. Diakses dari:

http://digilib.uad.ac.id/penelitian/Penelitain/detail/67320/upaya-meningkatkan-kemampuan-komunikasi-matematika-siswa-dalam-pembelajaran-matematika-melalui-kolaborasi-model-quantum-teaching-dan-model-pembelajaran-kooperatif-tipe-kancing-gemerincing.

Purwanti dan Ahmad, A. (2016). Peningkatan Komunikasi Matematis dan Kemandirian Belajar Siswa melalui Pendekatan Problem Posing berbantuan Mind Map. *Jurnal Didaktik Matematika*, 3*(2)*, 19-34. [*Online*]. Diakses dari: http://www.jurnal.unsyiah.ac.id/DM/article/view/5639.

Qohar, A and Sumarmo, U. 2013. Improving Mathematical Communication Ability and Self Regulation Learning Of Yunior High Students by Using Reciprocal Teaching. IndoMS Journal on Mathematics Education (JME). Vol. 4 No. 1 January 2013, pp. 59-74.

Rumapea, G., Syahputra, E., and Surya, E. 2017. Application of Quantum Teaching Learning Model to Improve Student Learning Outcomes. *International Journal of Novel Research in Education and Learning*. Vol. 4, Issue 2, pp: (118-130).

Sugiyono. (2016). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif dan R&D.* Bandung: Alfabeta.

Suryanti, W. dan Yunianta, T. N. H. (2018). Penerapan Model Pembelajaran Quantum Teaching Untuk Meningkatkan Hasil Belajar Matematika Materi Pecahan Pada Siswa Kelas VII SMP Negeri 3 Getasan. *Jurnal Mitra Pendidikan*, 2*(1)*, 148-159. [*Online*]. Diakses dari: https://e-jurnalmitrapendidikan.com/index.php/e-jmp/article/view/251.

Triana, M., Zubainur, C.M., Bahrun. (2019). Students' Mathematical Communication Ability through the Brain-Based Learning Approach using Autograph. *Journal of Research and Advances in Mathematics Education*. Vol. 4, No. 1, pp. 1-10, January 2019

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