International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 9, Issue 1, 2019

Using Valsiner theory to improve pre-service teachers' advanced mathematical thinking skills

S Tirto[a], Y Heryani[b], Supratman[c], [a,b,c]Universitas Siliwangi, Jl. Siliwangi No. 24 Tasikmalaya, West Java, Indonesia, Email: [a]sritirtomadawistama@unsil.ac.id, [b]yeniheryani@unsil.ac.id, [c]supratman@unsil.ac.id

There are so many teaching methods that have been applied to create something active and fun for students, one of which is through the process of constructing Valsiner zones. This research aims to analyse the improvement of advanced mathematical thinking skills of mathematics education students at Siliwangi University of Tasikmalaya, through learning based on the Valsiner theory. The method used in this research is quasi-experimental, with a research population that is pre-service teachers of mathematics education at the University of Siliwangi Tasikmalaya and the sample are students who follow the course of probability theory in semester V, consisting of one experiment class with 42 people and one control class with 40 people in the Mathematics Education Study Program. Random sampling was done by class. Data collection techniques included advanced mathematical thinking skills consisting of representation, abstraction, representational and abstraction relationships, creativity and mathematical proof tests. The data analysis technique used a two-averaging difference test of the two groups. The data obtained are categorised based on Mathematical Preliminary Ability (MPA) at above, middle and below. Conclusions, learning based on Valsiner theory can improve advanced mathematical thinking skills of pre-service teachers.

Keywords: *Valsiner Theory, Learning, Mathematics*

Introduction

Research conducted revealed that students have difficulties in learning probability theory, including difficulties in: determining the sample space and event space; working on the problem of complementary events; in solving multiple event problems; and, in working on questions in the form of a question's story (Dayat and Limbong, 2012). The material of probability theory is one of the methods in mathematics lessons that has not been mastered by students. One reason is the lack of application or context (Zulkardi, 2011). The assumption that mathematics is considered difficult is also expressed stating that many students experience difficulties in mathematics ranging from high school to college level. Correspondingly Devlin (2012) stated in his scientific speeches at the college level, that the ability of a pre-service teacher was still weak (Devlin, 2012; Harel and Sowder, 2005). Research on advanced mathematical thinking has been widely documented through research on students including: in his article entitled advanced mathematical thinking at various ages, it is natural development, and he also argues that advanced mathematical thinking can be seen as the potential to start in elementary school (Somakim, 2007). The development of advanced mathematical thinking through realistic mathematics learning is studied in Jooganah and Williams, 2010. The research prioritises the ability to construct and can find definitions and mathematical concepts. Jooganah (2010) discusses the transition to advanced mathematical thinking through sociocultural perspectives and student cognition (Suryana, 2012). In conclusion, there are differences in the system of activities of schools and universities in mathematics learning activities. Suryana (2012) discusses advanced mathematical thinking skills in mathematics statistics courses (Herlina, 2015). According to him, mathematics in universities shifts towards the formal framework of axiomatic systems and mathematical evidence and concepts contained in the subject, are too abstract. Herlina (2015) comprehensively reviewed the contribution of the application of the M-APOS approach to the achievement and enhancement of advanced mathematical thinking skills and mathematical creative thinking (Sangpom et al., 2016). The conclusion is that the application of the M-APOS approach is able to improve the ability of students in advanced mathematical thinking. Sangpom (2016) in his research discusses that through advanced mathematical thinking, students are able to successfully solve mathematical problems from simple to more complex levels, and are able to create effective ways to solve new problems (Santrock, 2011).

Thinking is one of the main abilities that human beings have. Pre-service teachers should develop this thinking in line with the concept of further thinking. According to Santrock (2011), thinking is manipulating or managing and transforming information to memory (Razzouk and Shute, 2012). According to Razzouk (2012) thinking is generally defined as an analytical and creative process that involves a person to experiment, create prototype models, create feedback and redesign (Alvonco, 2013). Alvonco (2013) also suggests that thinking is the process of the brain processing and translating incoming information through the senses of the happiness of the conscious or subconscious brain that generates meaning and a number of concepts (Tall, 1991). Pre-service teachers for mathematics education need to master advanced mathematical thinking skills in the learning process in college and this becomes a cutting-edge issue raised in learning. Through the ability of advanced mathematical thinking, the student is expected to be a strong and confident person. Somakim (2007) states that mathematical skills are concerned with mathematical characteristics that can be classified into low-level thinking and higher-order thinking (Jooganah and Williams, 2010). Tall (2002) suggests that the transition from basic-level mathematical thinking to an advanced level of change, exists between describing toward defining, from convincing to proving logically by definition (Blanton et al., 2005). There are three levels in the process of verification of advanced mathematical thinking, among others: the first is convincing yourself that you are self-assured, the second is convincing a friend means that he is able to convince others with coherent organised argumentation, and the third is convincing an enemy that is able to convince others with coherently organised arguments. Some experts describe the notion of advanced mathematical thinking. According to Tall (2002), the advanced mathematical thinking process consists of: 1. the process of representation, 2. the process of abstraction, 3. the relationship between representation and abstraction. Then Tall asserts that in addition to the above process, mathematical creative thinking is also classified as advanced mathematical thinking (Blanton et al., 2005). Similarly, according to Harel (2005), defining advanced thinking is a process of mathematical thinking such as process representation, abstraction, representational relationships and abstraction, creativity and mathematical proof (Somakim, 2007). Advanced mathematical thinking can be defined as the transition from the basic and high-level thinking processes to the advanced level with a variety of abilities including representation, abstraction, relationship representation and abstraction, creativity and mathematical proof, accompanied by strong characteristics in convincing yourself and others.

Lots of teaching methods have been applied to create something active and fun for students in their learning. One suitable method is the construct process through learning the Valsiner zone. This learning focuses on students or in other words is student-centred learning. Through a series of instructions, students are instructed through Valsinal learning, from the Valsiner theory, which is divided into several zones that are developed from Vygotsky theory. Vygotsky Theory has the Zone of Proximal Development (ZPD) which is then equipped and developed by Valsiner from the Zone of Proximal Development (ZPD) to the Zone of Free Movement (ZFM) and the Zone of Promotion Action (ZPA). Valsiner (1997) describes that a student's development can occur through interaction between them, the Zone of Free Movement (ZFM) represents freedom of thought and action, and the Zone of Promotion Action (ZPA) is a series of activities by adults to promote their skills, while the Zone of Proximal Development (ZPD) is a space that characterises one's potential capacity to develop through the help of others who know better. Vygotsky suggests that ZPD is a potential ability to give room for one's development through the help of others who are more adept. The theory of Valsiner is divided into several zones which is the development of the Vygotsky theory.

Experimental Method

This research aims to analyse the improvement of advanced mathematical thinking skills of mathematics education students at Siliwangi University of Tasikmalaya, through learning based on Valsiner theory. The method used in this research is quasi-experiment, with the study population that is a pre-service teacher of mathematics education at University of Siliwangi Tasikmalaya and the sample is students who follows the course of the probability theory in semester V, consisting of one experiment class with 42 students and one control class of 40 students in the Mathematics Education Study Program. Random sampling was done by class. Data collection techniques included advanced mathematical thinking skills consisting of representation, abstraction, representational and abstraction relationships, creativity and mathematical proof tests. The data analysis technique used a two-averaging difference test of the two groups. The data obtained were categorised based on the Mathematical Preliminary Ability (MPA) above, middle and bottom. In the experimental class the students are grouped into 7 groups with each group consisting of 5 to 6 people with heterogeneous ability. Each group is placed by MPA students as above, middle and bottom, so that each group can contribute, so that the learning can be more interactive.

Results and Discussions

The data obtained through pretest and post-test is then calculated by N-Gain, then calculated average, standard deviation categorised by MPA top, middle, bottom and in total. The following is a recap of data on improving the Mathematical Thinking Ability (MTA) of the experimental group that is Learning Based on the Valsiner Theory (LBVT) and the control group using Conventional Learning (CL), can be seen in table 1 as follows:

Table 1: Descriptive data MTA.

Category MPA	Statistics	LBVT		Category N-Gain LBVT	CL		Category N-Gain CL	Total		Category N-Gain CL
		N-Gain	Lots of data		N-Gain	Lots of data		N-Gain	Lots of data	
Top	Average	0.80	12	High	0.59	10	Medium	0.70	22	High
	Standard Deviation	0.095			0.128			0.151		
Middle	Average	0.47	21	Medium	0.28	19	Low	0.38	40	Medium
	Standard Deviation	0.104			0.095			0.137		
Bottom	Average	0.24	9	Low	0.12	11	Low	0.17	20	Low
	Standard Deviation	0.034			0.019			0.070		
Total	Average	0.51	42	Medium	0.31	40	Low	0.42	82	Medium
	Standard Deviation	0.221			0.198			0.232		

Table 1 can be described as follows: the ability of MTA whose learning using LBVT with upper MPA category, middle and lower gets higher average than students who use CL. Viewed by category the normalised gain of LBVT for the upper MPA of 0.80 is in the high category, for the average CL of 0.59 is in the medium category. Furthermore, based on the average category of normalised gain of LBVT for middle MPA of 0.47 is in the medium category, for CL reratanya 0.28 is in the low category. The mean normalised gain of LBVT for the lower MPA of 0.24 is in the low category, for the average CL of 0.12 is in the low category.

Inferential data analysis enhancement of advanced mathematical thinking ability

The next test is the post-hoc test, the one-way Anova test. This test intends to see the difference of the standardised gain data of MTA students for each MPA category. The test criteria are as follows: if the variance of the data group is homogeneous or in other words, is not different, then the test done. This is the Bonferroni-test, and if the variance is different or not the same then the Games-Howell test is used.

The test results showed that the standardised gain analysis of MTA students receiving LBVT and CL variance was homogeneous, therefore the next test was the Bonferroni test. Judging from the value of Sig. <α = 0.05, this has the meaning that there is a difference in average normalised gain of MTA in all three categories of MPA. The following table 2 is the result of the normalised gain analysis of MTA from all three categories of MPA:

Table 2: Post-hoc test results

Modeling	Statistic Test	MPA Level (I)	MPA Level (J)	Mean Difference (I – J)	*Sig.*	Decision
LBVT dan CL	*Bonferroni-Test*	Atas	Tengah	0.323*	0.000	there is a difference
			Bawah	0.531*	0.000	there is a difference
		Tengah	Atas	-0.323*	0.000	there is a difference
			Bawah	0.208*	0.000	there is a difference
		Bawah	Atas	-0.531*	0.000	there is a difference
			Tengah	-0.208*	0.000	there is a difference

Table 2 is the post-hoc Bonferroni-test of average difference in normalised gain of MTA based on the upper, middle and lower with a total of MPA categories for upper and middle upper MP, between upper and lower MPA, between middle and upper MPA, between middle and lower MPA, between MPA bottom with top, between bottom MPA with middle, indicating that Sig. $< \alpha = 0.05$ which means that there is a significant difference in the increase of student MTA between categories MPA.

Conclusion

Descriptively, it can be seen in table 1, it concluded that the average enhancement ability of advanced mathematical thinking with learning based on Valsiner theory is higher than students who obtain learning conventionally. The increasing categories of both groups are seen from the normalised gain values included in the medium category.

Inferential in table 2 decision H0 from Mann - Whitney U statistic test on MTA with LBVT and CL model is rejected, it means that there is difference of mean of increase of the MTA student which used learning based on Valsiner theory, which is significantly better than a student learning conventionally.

The result of posthoc test from the result of acquisition in table 2 shows that for MPA level with upper, middle and lower category, there is a greater influence in improving student MTA. In other words, LBVT modelling can be said to be successful in increasing MTA to students in all categories of MPA.

REFERENCE

Alvonco, J. (2013). *The Way of Thinking Creative and Rational Thinking for Success in Work, Business and Life* (Jakarta: Elex Media Komputindo Kompas Gramedia).

Blanton, Westbrook, S. and Carter, G. (2005). Using Valsiner's Zone Theory To Interpret Teaching Practices in Mathematics and Science Classrooms *JMTE* **8**(1) 5–33.

Dayat, and Limbong, R. (2012). *Student Difficulties in Studying Statistics Mathematics and Opportunities (Bandung: STKIP Siliwangi).*

Devlin, K. J. (2012). *Introduction to Mathematical Thinking* (UK: Keith Devlin)

Harel, G. and Sowder, L. (2005). Advanced Mathematical - Thinking at Any Age: Its Nature and Its Development *Mathematical Thinking and Learning* **7**(1) 27–50.

Herlina, E. (2015). Improved Advanced Mathematical Thinking and Disposition of students' mathematical creative thinking through the M-Apos Dissertation approach (Bandung: Universitas Pendidikan Indonesia).

Jooganah, K. and Williams, J. (2010). The Transition to Advanced Mathematical Thinking: Socio-cultural and Cognitive Perspectives eds M Joubert and P Andrews *Proceedings of the British Congress for Mathematics Education* (UK: University of Manchester).

Patahuddin and Sitti M 2010 Model authentic teacher professional development. scientific oration strengthening national character through the revitalization of gurud education with a model of professional development of the authentic state teacher of Surabaya Surabaya Journal of Research Innovation and Education Engineer **http://www.academia.edu.**

Razzouk, R. and Shute, V. (2012). What is Design Thinking and Why is It Important *Review of Educational Research* **82**(3) (US: Florida State University) 330–48.

Sangpom, W., Kongtip, Y. and Inprasitha, M. (2016). Advanced Mathematical Thinking and Students Mathematical Learning: Reflection from Students Problem Solving in Classroom Mathematics *Journal of Education and Learning* **5**(3).

Santrock, J. (2011). *Life Span Development* 13th edition (New York: McGraw Hill Companies, Inc.).

Somakim, (2007). Advanced Mathematics Development Through Realistic Mathematics Learning Papers presented at the National Seminar on Mathematics Education (Yogyakarta: UNY).

Suryana, A. (2012). Advanced Mathematical Thinking Ability (AMT) in Mathematics Statistics Course I Proceedings Papers presented at the National Seminar on Mathematics and Mathematics Education (Yogyakarta: Department of Mathematics Education FMIPA UNY).

Tall, D. (1991). The Psychology of Advanced Mathematical Thinking *Advanced Mathematical Thinking* ed D Tall (Dordrecht: Kluwer Academic Publishers) p 3–21.

Zulkardi, (2011). Model Improving the Quality of High School Education in Prabumulih City, Ogan Ilir Regency, and Ogan Komering Ilir Regency National Seminar on Research Results at Palembang Element (Palembang: Sriwijaya University).