Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

Learning Mathematics with Traditional Game "Jirak": Impact on Mathematics Disposition and Students' Achievement

Nizaruddin[1)], **Muhtarom**[2)], **Sugiyanti**[3)]

[1), 2), 3)] Mathematics Education Department Universitas PGRI Semarang, Indonesia

[1)] nizaruddin@upgris.ac.id, [2)] muhtarom@upgris.ac.id, [3)] sugiyanti@upgris.ac.id

Abstract. The study aimed to identify whether there are differences in achievement and dispositions of students who get the game "jirak" during learning and conventional learning. The population of this study was overall Junior High students grade VII in Semarang. Sampling was done by stratified cluster random sampling. The sample in this study were 200 students, with the details of 100 students from experiment class who get the game "jirak" during learning, 100 students from control class who get conventional learning. Based on the hypothesis test we concluded that: 1) there were differences in achievement and dispositions of students in experiment and control class (Lambda = 0.439 and p value (sig.) <5%). 2) the relationship between learning model with the results of student's achievement had a significance level (sig.) <5%, then H_0 was rejected. The average of student achievement with the game "jirak" was greater than the average of student achievement with conventional learning, it can be concluded that student achievement with the game "jirak" is better than student achievement with conventional learning. 3) The relationship between students' learning model with a disposition has a significance level (sig.) <5%, then H_0 was rejected. Because the average disposition of students with learning games is larger than the average student disposition to conventional learning, it can be concluded that the disposition of students who had learning with the game is better than the disposition of students who had conventional learning.

Keywords: Games, "Jirak", Disposition, Achievement

1. Introduction

Learning mathematics aims to develop the ability and disposition through the understanding of the mathematical concepts, explaining the relation between concepts and applying concepts or mathematical algorithm flexibly, accurately and appropriately in problem solving, as well as having respect for the benefit of mathematics in life, such as being curious, attentive, and interested in studying mathematics, as well as a tenacious attitude and confidence in solving problems. However, it turns out the weakness of mathematics teaching that had occurred up to now has created a negative perception in many children, for example mathematics is a frightening lesson. The low student achievement is due to a lack of confidence, less persistent in finding solutions to mathematical problems and lack of curiosity of students in learning mathematics [13]. Students become less interested in mathematics because they perceive that math is hard to understand.

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

Learning mathematics should be directed towards a more pleasant atmosphere for children, for example through the game to build an understanding of concepts, to develop thinking skills, and to train speed of arithmetic [8]. Furthermore, Indianto, et all [9] showed that the method of learning through game can encourage a sense of fun to math. Math games, when used in planning the instructional objectives with clear, precise, and in accordance with the time, can be an effective method to improve mathematics achievement.

Math game that is discussed in this paper is jirak. The game is done in pairs of two groups (@ 4-5 students) for 20 minutes. Each group selected one member to decide, to determine which group will choose a position, as a player or as bookie first. Bookie groups get 2 envelopes, each containing questions and answers, while groups of players play a game by turns, one by one by throwing a rubber band into a circle that has been prepared. The circle has several parts that have been numbered in accordance with the question that will be answered. Points are earned (in the form of a "star") when groups of players can answer the question in accordance with the "star" written on the circle. Furthermore, each group gets a chance to throw a rubber band as much as 4x. Then they reversed roles, a group of players into bookie and vice versa. The task of the group Bookie among others are: 1) to observe whether a group of players can shoot the target board appropriately with the requirements (throwing a rubber band distanced 2.5 meters from the jirak boards), 2) to provide problem in accordance to the numbers that are targeted by the group of players on "Jirak" board and 3) to limit the time given to answer the question, because each problem has a different difficulty level and the time given to complete it is also different. Questions from each section of the "jirak" board have different level of difficulty, so that the points of each part are different. Board with the numbers 1 star = 10, 2 = 20 star, 3 star = 30, and 4 = 40 star. If this group of players answers incorrectly two times in a row, the group finished the turn and was replaced by Bookie groups.

Traditional game can encourage positive character in children and stimulate various aspects of child development [14]. Game-based learning can improve self-esteem, flexibility, persistency, tenaciousity, curiosity, and a way of thinking in mathematics, commonly called mathematical disposition. Mathematical disposition is the desire, awareness and a strong dedication on students to study mathematics and implement a variety of math activities ([10], [11]). Furthermore, NCTM [6] argues that the mathematical disposition shows confidence, expectations and metacognition, serious attention in learning math, persistence in facing and solving problems, high curiosity and the ability to share their thoughts with others.

Students require mathematical disposition to persevere in facing problems, taking responsibility for their learning and developing good work habits in mathematics. This means that the disposition of students cannot be separated from the mathematical knowledge (e.g. [1], [5], [12]). Students who have a weak ability tend to be negative towards mathematics; otherwise the students who have good mathematical skills tend to have a positive attitude towards mathematics. But the opposite can also occur, students with negative attitudes towards mathematics will tend to have weak math skills, while students with a positive attitude towards mathematics will tend more and more to have a good ability as well [1].

Noting the importance of students' mathematical abilities and mathematical disposition of junior high school students, learning advantages of game “jirak”, as well as some of the findings of the above study, encourage researchers to conduct studies to apply the learning of traditional game “jirak” in mathematics, especially for students class VII in Semarang. Selection of junior high school students is based on the stage of cognitive development of students who are still at the stage of concrete operational towards the abstract operations thus they have already started thinking about concrete experiences and think about it in more abstract, idealistic, and logical way.

Based on the description above, the major and minor hypothesis tested in this study were:

1. There is a difference in learning achievement and disposition of students who had learning with the game and conventional learning.
2. Achievement of students who get learning with the game is better than achievement of student who get conventional learning.

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

3. Mathematical disposition of students who had learning with the game is better than the mathematics disposition of students who had conventional learning.

2. Research Methods

This research was a quasi-experimental study, conducted in Class VII of junior high school in Semarang. Sampling was done by stratified cluster random sampling. The sample in this study were 200 pupils from three different schools namely SMP N 9 Semarang, SMP N 15 Semarang and SMP PGRI 01 Semarang; with details of 100 students had learning with the game jirak, 100 students had conventional learning. At the end of the study, both groups were measured using the same measuring instrument i.e learning achievement tests and students' mathematical disposition questionnaires. The procedures performed in this study are:

2.1. Determine research population

2.2. Determine the sample by stratified cluster random sampling, the sample was divided into two groups, then do a balance test on both samples to determine whether they were in a state of balance.

2.3. Give learning with the game "jirak" to the experimental group and give conventional learning usually carried out by teachers in the school to the control group

2.4. Give mathematics learning achievement test on the material: numbers.

2.5. Collect data regarding the students' mathematical disposition with a questionnaire.

2.6. Perform data analysis to determine the significance of differences in learning achievement and disposition of student who gets learning with the game "jirak" and conventional learning.

Table 1 Data Collection Procedures

Aspects	Indicators of Success	Data Sources	Instrument	Timing
Jirak Game-based learning devices	Learning devices and teaching material appropriate to use	Expert validation	Validation sheets for syllabi, lesson plans, worksheets, media, teaching materials and assessment.	In the beginning of developing the devices, before the data collection
Learning process	Teacher's ability in manage learning process	Teacher's activities	Observation sheets and video recording	Data collection process
	Increasing students activity	Students' activities in learning process	Learning activities observation sheet and video recording	Data collection process
Jirak Game-based Learning	- Student achievement in class which is learning with the game is better than student achievement in conventional learning - Math disposition of students who had learning with the game is better than the mathematics disposition of students who get conventional learning	Student's scores and results of mathematical disposition questionnaires	Learning achievement tests and mathematical disposition questionnaires instruments	Evaluation of learning process and disposition data collection through a questionnaire after learning process

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

3. Result and Discussion

After all the activities of learning mathematics are done, it is conducted the observations on learning activities in the control class and experimental class (learning with traditional games "jirak"), then students in experimental class and control class in each school were given mathematics achievement test, and mathematical disposition questionnaires, the results were presented in table 2. Table 2 showed about student achievement, it was known that the average score of the experimental class was better when compared to students in control class. Similarly, in mathematical disposition, it is showed the same thing, the average score of students in experimental class was better than the average score of control class. Nevertheless, it's necessary to do hypotheses test to prove it.

Table 2 Research Data Description

	Group	Mean	Deviation Std.	N
Learning achievement	Control	62.87	12.910	100
	Experiment	88.88	10.845	100
	Total	75.88	17.647	200
Mathematical disposition	Control	98.76	21.649	100
	Experiment	115.37	18.405	100
	Total	107.07	21.702	200

Initiate hypothesis testing, multivariate normality and the equality test of variance covariance matrix need to be done. Multivariate analyzes were performed based on the assumption of similarity variance covariance matrix. To test the similarity matrix of covariance was used Box's tests. Tests were conducted using SPSS. The criteria used was the covariance matrix of homogeneous if the Box's M $<\chi 2$ (α, 0.5 (k-1) (p) (p + 1)) with $\alpha = 0.05$. From these test results it is obtained Box's M = 239.102 with Sig. = 0.000. This means that the covariance matrix of the combination treatment was not the same.

Table 3 Covariance Matrix Test

Box's Test of Equality of Covariance Matrices[a]

Box's M	239.102
F	78.828
df1	3
df2	7056720
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept+A

Based on the prerequisite test it can concluded that parametric statistical tests can't be done (because assumptions were not met) thus it is analyzed using non parametric statistical tests. Furthermore, the data was transformed from an interval scale to an ordinal scale (rank) that can be used in non-parametric statistical tests. Description of the data after the transformation was presented in Table 4.

Table 4 Data Transformation Result Description

	Descriptive Statistics			
	Group	Mean	Deviation Std.	N
Learning achievement	Control	58.22	40.372	100
	Experiment	142.78	38.634	100
	Total	100.50	57.879	200
Mathematical Disposition	Control	77.91	56.555	100
	Experiment	123.09	50.045	100
	Total	100.50	57.879	200

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

The research hypotheses:

H_o: There are no differences in learning achievement and disposition of students who get games and conventional learning

H_1: There are differences in learning achievement and disposition of students who get games and conventional learning

The hypothesis is tested using SPSS program and the evaluation results were in the following table.

Table 5 Multivariate Statistical Test Results

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.873	676.911[a]	2.000	197.000	.000
	Wilks' Lambda	.127	676.911[a]	2.000	197.000	.000
	Hotelling's Trace	6.872	676.911[a]	2.000	197.000	.000
	Roy's Largest Root	6.872	676.911[a]	2.000	197.000	.000
Group	Pillai's Trace	.545	117.833[a]	2.000	197.000	.000
	Wilks' Lambda	.455	117.833[a]	2.000	197.000	.000
	Hotelling's Trace	***1.196***	***117.833[a]***	***2.000***	***197.000***	***.000***
	Roy's Largest Root	1.196	117.833[a]	2.000	197.000	.000

a. Exact statistic

b. Design: Intercept + Group

$$T^2 = (n_1 + n_2 - 2)U^{(s)}$$
$$= (100 + 100 - 2)(1{,}196)$$
$$= 236{,}808$$

Non-parametric tests as follows:

$$v = (n_1 + n_2 - 1)\frac{U^{(s)}}{1 + U^{(s)}}$$
$$= (100 + 100 - 1)\frac{1{,}196}{1 + 1{,}196}$$
$$= 108{,}381$$
$$DK = \{v \mid v > \chi^2_{\alpha;p}\} = \{v \mid v > \chi^2_{0{,}05;2}\} = \{v \mid v > 5{,}991\}$$

From the analysis results it is also obtained value of p = 0.000 (obtained from the excel calculation with the formula "= CHISQ.DIST.RT (108 381; 2)"). Because, the value of p <α, thus $v \in DK$. Besides value of $p < \alpha$, then the decision of the test was $H_{0\ is}$ rejected. So, there are differences in learning achievement and disposition of students with the game and conventional learning at α = 5%. To see the difference whether in the dependent variable of learning achievement or in scores of student mathematics disposition, then it is continued through the Mann-Whitney test for each dependent variable. If the null hypothesis is rejected at a multivariate test, then it is followed by univariate test on each dependent variable.

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

Table 6 Non-parametric equality test of two mean

	Learning achievement	Disposition score
Mann-Whitney U	772.000	2741.000
Wilcoxon W	5822.000	7791.000
Z	-10.331	-5.520
Asymp. Sig. (2-tailed)	.000	.000
Grouping Variable: Group		

For α = 5%, based on the Mann-Whitney test it was obtained: (1) the dependent variable of learning achievement is p = 0.000 p <α then H_0 is rejected. So, there are differences in learning achievement between the experimental class and control class; and (2) the dependent variable of students' mathematical disposition scores is p = 0.000 p <α then H_0 is rejected. So, there are differences in students' mathematical disposition scores between the experimental class and control class. To see which of the experimental class and control class that produces better learning achievement and students' mathematical disposition scores, it can be seen from the descriptive statistics, particularly on the average scores for each dependent variable. Based on the comparison of the mean (see Table 4) on each of the dependent variable, on the significance level of 5% it is concluded as follows. (1) The experimental class produces better students' learning achievement than the control class (mean of experimental class = 142.78> mean of control class = 58.22); besides (2) the experimental class also produces better students' mathematical disposition scores than the control class (mean of experimental class = 123.09> mean of control class= 77.91).

The results of descriptive statistical analysis are also supported by the results of the multivariate analysis. From calculations using the statistical Hoteling-Lawley it is obtained more detailed information, they are 1) there are differences in learning achievement and disposition of students who had learning with games and conventional learning. 2) learning achievements of students who are learning with games are better than learning achievement of students that are getting conventional learning and 3) the math disposition of students who had learning with the game is better than the mathematics disposition of students who received conventional learning. This happens because in the conventional learning, student activities were dominated by activities of hearing the teacher's explanation, making notes and working on the assignment from teachers, so that students feel bored and lack of motivation, self-confidence, curiosity, awareness and a strong dedication in learning mathematics. While in learning with the game jirak, there is a variety of student active activities, such as solving problems, asking questions, expressing opinions, helping to give an explanation on his friend, and the activity of thinking. The involvement of students in activities allows the student's mastery of the instructional materials become better, as well as his ability and attitude towards mathematics.

Learning through jirak game, student learning is not only a process which is done individually, but also a social form that runs together ([2], [15]). Vygotsky, a believer in social constructivist, emphasizes the primacy of social interaction as a prerequisite to the cognitive development of individuals through the internalization of ideas in a community [7]. As a social constructivist, realistic mathematics education also emphasizes the importance of social interaction in a learning process. Each concept or mathematical principles is presented in the form of concrete so that it can be well understood. This means that objects in the form of game activities will contribute if manipulated well in mathematics. Similar statement was expressed by Ernest [3] who found that the success of all the teaching of mathematics depends on the active involvement of students, in that sense a game is promoting the active involvement and helping to create a positive environment. Games that involve simple strategy can be used as an alternative way to improve problem solving abilities in students. This was in line with the opinion of Ernest [4], that (1) the game is able to provide reinforcement and practice skills, (2) the game can motivate, (3) games help the acquisition and development of mathematical concept, and (4) through the game students can develop strategies for problem solving.

Proceeding ICMETA: Volume 1/2017, June 27th 2017 ISBN 978-602-397058-2

4. Conclusion and Suggestion

Based on the research objectives and the research result that has been described, it can be concluded that: 1) there are differences in learning achievement and dispositions of students who learning with the game and students who learning with conventional learning, p value (sig.) <5%). 2) The relationship between learning model and student learning achievement has a significance level (sig.) <5%, then H_o is rejected. Because the average of student learning achievement in class that learning with the game is greater than the average of student learning achievement with conventional learning, it can be concluded that student learning achievement of learning with the game is better than student learning achievement that getting conventional learning. 3) The relationship between students' learning model with a disposition has a significance level (sig.) <5%, then H_o is rejected. Because the average of students' disposition that learning with games is greater than average of student disposition in conventional learning, it can be concluded that the disposition of students who had learning through game is better than the disposition of students who received conventional learning. Suggestion can be given is the games should be developed further to accommodate range of material concerning in class VII and higher level class.

References

[1] Choridah D T 2013 Peran Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Komunikasi dan Berpikir Kreatif Serta Disposisi Matematis Siswa SMA *Jurnal Ilmiah Program Studi Matematika STKIP Siliwangi Bandung* **2(2)** 194-202.

[2] Cooke B D, Buchholz D 2005 Mathematical communication in the classroom: Teacher makes a difference *Early Childhood Education Journal* **32(6)** 365 – 369

[3] Ernest P 1986a Games: A Rationale for their Use in the Teaching of Mathematics *Mathematics in School* **15(1)** 2-5.

[4] Ernest P 1986b Games *Teaching Mathematics and its Applications* **5(3)** 97-102.

[5] Kilpatrick J, *et.all* 2001 *Adding It Up: Helping Children Learn Mathematics*, Washington, DC: National Academy - Press.

[6] NCTM (National Council of Teachers of Mathematics) 2000 Principles and Standards for School Mathematics, Reston, Virginia: NCTM. pp: 4.

[7] Nyikos M, Hashimoto R 1997 Constructivist Theory Applied to Collaborative Learning in Teacher Education: In Search of ZPD *The Modern Language Journal* **81(IV)** 506 – 517

[8] Patahuddin S M, Rokhim A F 2009 Website Permainan Matematika Online Untuk Belajar Matematika Secara Menyenangkan *Jurnal Pendidikan Matematika* **3(2)** 103-111.

[9] Sari R, Listyorini T 2011 Game Edukasi Logika Matematika *Sains dan Teknologi* **4(1).**

[10] Sumarmo U 2006 Berpikir Matematik Tingkat Tinggi: Apa, mengapa, dan bagaimana Dikembangkan pada Siswa Sekolah Menengah dan Mahasiswa Calon Guru, *Makalah disampaikan pada Seminar Pendidikan Matematika di Jurusan Matematika FMIPA Universitas Padjadjaran.*

[11] Sumarmo U 2010 *Berpikir dan Disposisi Matematik: Apa, Mengapa, Dan Bagaimana Dikembangkan Pada Peserta Didik*, Bandung: FPMIPA UPI, 1 – 27.

[12] Sumirat L A 2014 Efektifitas Strategi Pembelajaran Kooperatif Tipe Think-Talk-Write (TTW) Terhadap Kemampuan Komunikasi Dan Disposisi Matematis Siswa *Jurnal Pendidikan dan Keguruan* **1(2)** 21-29.

[13] Yuanari N 2011 *Penerapan Strategi Think-Talk-Write sebagai Upaya Meningkatkan Kemampuan Pemecahan Masalah dan Disposisi Matematis Siswa Kelas VII SMPN 5 Wates Kulonprogo* Thesis UNY, 21.

[14] Yudiwinata H P, Handoyo P 2014 Permainan Tradisional Dalam Budaya dan Perkembangan Anak *Paradigma* **2(3)**.

[15] Zack V, Graves B 2001 Making mathematical meaning through dialogues: "Once you think of it the Z Minus Three Seems Pretty Weird. *Educational studies in mathematics* **46** 229-271.