# WIETE

*by* Nizaruddin Nizaruddin

**Submission date:** 18-May-2018 02:07PM (UTC+0700)
**Submission ID:** 965481755
**File name:** 02-Nizaruddin.pdf (184.26K)
**Word count:** 3510
**Character count:** 19169

*World Transactions on Engineering and Technology Education*
*Vol.15, No.2, 2017*



# Improving students' problem-solving ability in mathematics through game-based learning activities

**Nizaruddin, Muhtarom & Sugiyanti**

Universitas PGRI Semarang
Semarang, Central Java, Indonesia

ABSTRACT: The rationale behind this action research was to improve the ability of class VII students to solve problems involving material *numbers*. This study was conducted in two cycles, both of which consisted of planning, action, observation and reflection. The first cycle showed that 31.25% of students gained mastery in learning or scored 75 and 68.75% did not or scored < 75. The average score of the class was 63.44% and problem-solving abilities of students in the first cycle was 68.8%. In the second cycle, 100% of students gained mastery in learning or scored 75. The class average score was 95.71% and problem-solving abilities of students in the second cycle was 96%. Use of game-based learning can improve the ability of students to solve problems of material *numbers*.

## INTRODUCTION

Some of the rules found in the 2013 curriculum included the following: subjects must contribute to the formation of attitudes, skills and knowledge, and the depth of subject materials should be of international standard, must enable students achieve higher results than those obtained in PISA 2009 and TIMSS 2011. The competency framework of the 21st Century [1], implies learning should be able to make educators cooperate in their teaching and should enable learners study what is relevant to the society. Therefore, learning should be able to produce learners that are innovative and creative. Nuh states that the ability to be innovative, creative and intelligent can be obtained by observing, questioning, associating and experimenting [1].

One of the core competencies of class VII mathematics is understanding knowledge (factual, conceptual and procedural) by being curious about science, technology, art, cultural phenomena, and events relating to the physical world. These competencies demonstrate the abstract nature of mathematics, which makes it a difficult subject, and dreaded by students. Also, interviews done by a mathematics teacher revealed that the abstract nature of mathematics makes it a difficult subject and one that is feared by students of VII F in Junior High School, in Semarang. This is evident from the many students who did not obtain the minimum completeness score (reaches 25%). Yuksel et al said the fear of mathematics is a complex combination of affective and cognitive dimensions [2]. Personality, self-concept, self-esteem, learning styles, high demands from parents, negative attitudes to mathematics, avoiding mathematics, teachers' attitudes, ineffective learning styles, negative learning experience and less awards are factors that make students fear mathematics.

Kamii suggested that games can be used as an approach for studying mathematics [3]. Furthermore, success in teaching mathematics depends on the active involvement of students, and in connection to that, a game that promotes active involvement can help to create a positive environment [4]. Ernest explained that in mathematics, games can 1) provide reinforcement and practice skills; 2) motivate; 3) help in the acquisition and development of mathematical concept; and 4) through game students can develop a strategy to solve problems [5]. One game that can improve learning outcomes in mathematics is *Snakes and Ladders* with a smart circuit [6]. Based on the explanation above, the objective of this action research was to improve the ability of class VII students to solve problems involving material *numbers* in the 2016/2017 academic year.

## METHOD

This study was conducted in two cycles. The result of the research emphasises the problem-solving abilities of students. The order of the classroom action research began with planning the action (planning), implementing the action (action),

observing and evaluating the process, and the results of the action and reflection, until the improvement expected was achieved (success criteria). The research was conducted in two cycles. Each cycle in this study consists of four stages:

1. Planning:

   a. Preparing teaching materials on algebra by applying game-based learning.
   b. Preparing lesson plans, exercises, answer keys and other necessary materials.
   c. Developing observation sheets for students and teachers.

2. Actions;

Table 1: Process of game-based learning activities.

| No | Teacher activities | Students activities | Time |
|---|---|---|---|
| 1 | - Provide apperception and motivation<br>- Write down the goals and success criteria on the board<br>- Explain the learning objectives and success criteria to students | Understand learning objectives and success criteria given by teachers | 5 minutes |
| 2 | Conduct learning according to the lesson plan:<br>- Teachers prepare all the necessary equipment<br>- Students form groups (4 students per group)<br>- Each group is given a problem to solve during the game activities<br>- Presenting the results after solving the problem<br>- Other groups are welcome to give feedback<br>- Teachers and students conclude the discussion | Engage learning experiences according to the lesson plan | 60 minutes |
| 3 | Give problems | Solve the problems | 10 minutes |
| 4 | End learning and give motivation | | 5 minutes |

3. Observation;

During the teaching and learning activities, the eyewitnesses examined and recorded the results on the observation sheet used as the guidance for reflection in each cycle and combined it with the results of the evaluation.

4. Reflection;

Results were obtained from observations, and the result of the evaluation in the first cycle was used as guidance to discover whether it would be appropriate for the target or necessary to improve the organisation of learning in the second cycle to obtain better results.

Data from this study were obtained from students and teachers as follows: 1) qualitative data included the results of the analysis of the profile of problem-solving ability of students, and students' activity in learning were presented descriptively; and 2) quantitative data included students' learning outcomes as reflected in the current students' assessment sheets on problem-solving in each cycle of learning and evaluation tests. Data of students' problem-solving ability profile were obtained from the descriptive analysis of the students' work, and data for the reflection and changes that occur in the classroom were taken from the observation and evaluation of results. Data of students' learning outcomes were taken from the analysis of test evaluation.

Performance indicators are: 1) improvement in the problem-solving ability of students as seen from the analysis of the problem-solving ability of students in 1st to 2nd cycle, and so on. There are also indicators of success in problem-solving ability students derived from the analysis of problem-solving ability profile using the criterion score of at least 75% of the maximum score; 2) improvement of students' learning outcomes seen from the test results of students through the application of games by using a minimum criterion score of 70% and 85% of the total number of students; and 3) activities of students in the learning process of mathematics increased by at least 75% of the maximum score.

## RESULTS AND DISCUSSION

The first cycle activities included lesson plans, students' worksheets, mathematics games and competency tests. The first cycle was conducted over two weeks. In this cycle, the following matters were discussed: the concept of integers divisible by integers, factors of integers, prime numbers, prime factors and prime factorisation of integers, multiple integer, greatest common factor (GCM) and least common multiple (LCM). The first cycle activities are described as follows:

1. Planning

   a. Setting up game-based learning materials for the first cycle activities;

b. Preparing lesson plans, students' worksheets, mathematics games and competency tests;
c. Forming groups to consider the ability of members within the group, with each group consisting of four students;
d. Preparing observation sheets, both for students and for the implementation of learning undertaken by teachers. Observation to be conducted by the observer.

2. Action Implementation:

In the first cycle, mathematics lessons were conducted for hours (Monday, Wednesday and Friday). Details of the learning activities adjusted to the lesson plans were made. Game activities were carried out to determine the extent of students' understanding of the materials taught by their teachers.

3. Observation:

The activity of students in the first cycle was as follows: The students listened to the teacher, asked questions, answered questions and argued about the learning process; 65. 87% were categorised as active students. Moreover, five students had a very good level of activity, nine students had a good level of activity and three students had a quite good level of activity. The performance of teachers in the first cycle was as follows: the performance of the teacher in the game-based learning process was 82.5%, which is considered as very good. However, it still needs to be improved, because teachers pay less attention to students who experience difficulties in learning. These improvements meant that learning can be implemented optimally.

4. Reflection:

After observing the action learning in the classroom, the following occurred: a) the researchers and teachers exchanged opinions, so that the second cycle could be better in the process and outcomes of learning and understanding of students compared to the first cycle; b) the teachers were required to pay attention to students who have difficulty in learning, motivate students and encourage students to learn with games; c) games were designed not only to check students' understanding, but also be used to encourage them to learn mathematical concepts; and d) control of teachers on the application of games in learning enhances learning by creating a study group to further develop the students' problem-solving abilities.

From the analysis of learning outcomes, 68.75% of students had not yet thoroughly studied the problems, while 31.25% of students were able to solve problems. The average grade achieved was 63.44%. Furthermore, these results are in line with the average problem-solving ability of students, which was 68.8%. The average students' problem-solving ability are presented in Figure 1.

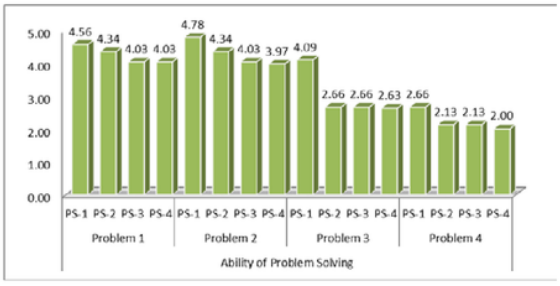


Figure 1: Average score of student problem-solving ability - first cycle.

The second cycle concerns understanding the power of numbers, symbols of power, the power of integers, properties of power operations of integers and solving non-routine problems of integers. The description of the second cycle of activity is described as follows:

1. Planning:

The teachers and researchers collaboratively planed the based-game learning as follows: understanding of rank number, symbol of rank number, invention of the concept of rank integers, properties of rank integers, solving the problems of non-routine rank integers, and the lesson plan:

a. Setting up a game-based learning materials for the second cycle;
b. Preparing lesson plans, students' worksheets, mathematics games and competency tests;
c. Group in the first cycle was maintained with hopes of liveliness and increased student learning outcomes in line with expectations;
d. Preparing the necessary learning tool.

2. Actions Implementation:

In the second cycle, mathematics lessons were conducted for hours (Monday, Wednesday and Friday). The details of the learning activities were adjusted to match the lesson plans. Game activities were carried out to instil the concept of mathematics, and to determine the extent of students' understanding of the material that has been taught by the teacher.

3. Observation:

The activities of the active students in the second cycle were as follows: the students listened to the teacher, asked and answered questions and argued in the learning process; their performance was 85.42%, categorised as excellent. The performance of teachers in the second cycle was as follows: the teachers were very good in the mastery of the material and the implementation of learning by using game-based learning models. There was a significant increase in the role of teachers in guiding and fostering interaction between students. The teachers' performance in the learning process using game-based learning model was 92.5%, considered very good.

4. Reflection:

Implementation of learning was run properly, because the students paid attention to the teacher's explanation and active role in the teacher's guidance was perceived by students. Mastery of game-based learning model increased, so as to create learning groups to further develop students' problem-solving abilities.

The second cycle showed that active students could be categorised, because they reached a percentage of 85.42% and met success indicators that had been set. This increase was due to the ability of teachers to motivate and encourage interaction among students better than in the first cycle. In addition, students were getting used to the game-based learning model. From the analysis of learning outcomes of the second cycle, with a percentage of 100% students completing the study, the average grade achieved was 95.71. This completeness has fulfilled the specified criteria. To support this, statistical tests were performed as follows:

1. Completeness of test results.
2. Learning is said to be complete, if the average value of learning outcomes reached is at least 75%. Learning outcomes from the test results were obtained after a competency test was conducted using the game-based learning model.

Table 2: One-sample test analysis of students' mastery learning.

| | Test value = 75 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% confidence interval of the difference | |
| | T | df | Sig. (2-tailed) | Mean difference | Lower | Upper |
| Value | 21.189 | 31 | 0.000 | 20.719 | 18.72 | 22.71 |

As shown in Table 2, $t_{evaluation} = 21{,}189$ while $t_{table} = 1{,}645$; so $H_0$ was rejected. In other words, students' learning outcomes were complete. Furthermore, the proportion of test was used to determine the proportion of student learning outcomes data; that is whether learning outcomes of students were completed.

$H_0$: $\pi \geq 85\%$ (proportion of students who achieve mastery of at least 75 is 85%).
$H_1$: $\pi < 85\%$ (proportion of students who achieve mastery of 75 is less than 85%).

The hypothesis above is tested by using proportions.

$$Z = \frac{X - np_0}{\sqrt{np_0(1-p_0)}} = \frac{32 - 32.0{,}85}{\sqrt{((32)(0.85)(1-0.85))}} = 2.376$$

$Z_{evaluation} = 2.376$ with $Z_{table} = 1.65$ showed that $H_0$ is accepted; $Z_{evaluation} > Z_{table}$ means that students' learning outcome reached a minimium of 85% of the total number of students.

3. Comparative tests of learning outcomes.
4. Hypothesis test used is the average difference, the test of the right hand with the formula *t* test. The test is, then, used to determine the effectiveness of learning.

$H_0 : \mu_1 < \mu_2$ (Average test results of second competency test is not better than the results of first competency test).
$H_1 : \mu_1 \geq \mu_2$ (Average test results of second competency test is better than the results of first competency test).

Table 3: Learning outcomes comparative test results (paired samples test).

| | Paired differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Std. error mean | 95% confidence interval of the difference Lower | Upper | | | |
| Pair 1, Value1 - Value2 | 32.281 | 18.191 | 3.216 | 25.723 | 38.840 | 10.038 | 31 | 0.000 |

*T*-test was used to evaluate comparatively the students' learning outcomes from the first and second competency test. As clearly presented in Table 3, $t_{evaluation} = 10{,}038 > t_{table} = 1{,}645$, so that $H_0$ is rejected. This shows that the average results of the second competency test are better than the results of first competency test. The difference between the control class and experimental class is explained in Table 4.

Table 4: Difference of learning outcomes (paired samples statistics).

| | | Mean | N | SD | Std. error mean |
|---|---|---|---|---|---|
| Pair 1 | Value 1 | 95.72 | 32 | 5.531 | 0.978 |
| | Value 2 | 63.44 | 32 | 17.248 | 3.049 |

The average of learning outcomes from the second competency test is greater than that of the first competency test. These results are consistent with the problem-solving ability of students who achieved 96%; the average problem-solving ability of students is presented in Figure 2.

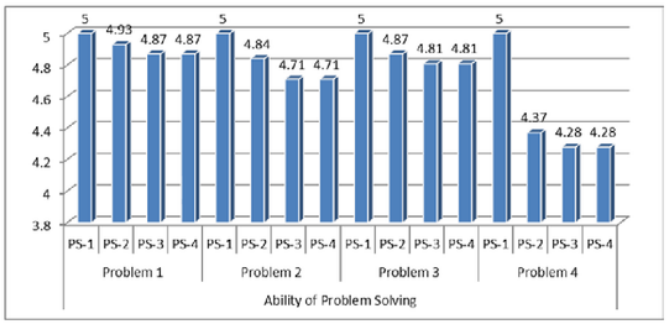


Figure 2: Average score of student problem-solving ability - second cycle.

In this study, the average value, learning mastery and problem-solving ability profile demonstrated the effectiveness of game-based learning. An average score of 95.71% was obtained. The percentage of classical completeness is 100% (minimum is 85%). The results in this study show that the average students' ability to understand mathematicss was 5.00%. The average students' ability in problem-solving plan was 4.76%; the average students' ability to implement plan was 4.67%. The average students' skills in problem-solving rechecking results was 4.67%. The analysis of this study showed that the average problem-solving ability is still at a very good level.

The learning tools developed in this research include syllabi, lesson plans, students' activity sheets, teachers' observation sheet, students' observation sheets, mathematics games and competency test. Furthermore, the learning device has been validated by experts in order to obtain the learning device based on criteria/validity. Slavin emphasises the socio-cultural nature of learning; how students learn through interaction with adults and peers [7]. Vygotsky's theory is in line with the main component contextually, i.e learning society, the interaction of students with each other, as well as between students with mentors (teachers). In addition to finding strategies (the inquiry), the assistance provided was limited to the question the teachers asked the students at the beginning until the students understand the purpose of the problem.

The emphasis was on learning in context. That is, learning should involve the mental processes of students, should be fun, encourage students, and give students the opportunity to construct their learning experience, so that learning becomes meaningful. In this case, the teacher acts as a facilitator in learning and creating an effective learning environment. This theory was used as a basis for the learning and teaching of mathematics in the study. The students and teachers responded that using game to study mathematics is very effective; students with high, medium and low mathematics ability interact and discuss properly, perform the task well, and get involved in competition between members of the group. The positive attitudes of the students after the game-based learning are supported by several factors, among others:

1. The learning atmosphere was not tense and students were able to play around and be creative.
2. The game used caught the students' attention, because it was attractive, and accompanied with questions that the students could understand.
3. Students felt that they were receiving a new learning experience and quite different from the previous learning experience.

Mathematics teachers, in the case of junior high school, have had a good response to mathematics instruction that uses game-based learning. One of the contributing factors in obtaining positive responses from mathematics teachers was the desire of teachers to enhance students' creativity in mathematics lessons through a variety of learning. Furthermore, the results showed that:

1. Implementation of game-based learning is done well.
2. Students respond well to game-based learning activities.
3. The teacher gave a good response to game-based learning activities.

Furthermore, in this game-based learning, an average score of 95.71% was obtained by the students; the percentage of classical completeness is 100% (minimum is 85%). Improvement in the students' problem-solving ability and learning outcomes was due to the fact that the students were able to understand and adjust to game-based learning applied by the teachers. Moreover, questions and answers during the learning process led to creative ideas (the thinking process was much richer) of students to complete the exercises. Game-based learning was able to increase their competitive spirit to get good grades at the end of the lesson and to get the best result in the competency test.

## CONCLUSIONS

It can be concluded that: 1) there is an increase in students' problem-solving abilities. The problem-solving ability of students in the first cycle was 68.8% and increased to 96% in the second cycle. The value of the average grade achieved was 63.44% in the first cycle and increased to 95.71% in the second cycle; 2) learning mathematics through the use of games can improve students' learning outcomes. This can be seen in the percentage of classical completeness of students who in the first cycle originally achieved 31.25% and 100% in the second cycle; 3) learning mathematics with games can increase the intensity of students' activity. This can be seen in the percentage of students' activity, which in the first cycle was 65.89% and 85.42% in the second cycle; and 4) game-based learning can improve the ability of teachers in mathematics. It can be seen in the percentage, which was 82.5% in the first cycle and 92.5% in the second cycle.

## ACKNOWLEDGMENTS

The authors would like to express their thanks to the Rector of Universitas PGRI Semarang for the opportunity provided to the authors to carry out this research, and the management of SMP Negeri 9 Semarang for allowing the authors to conduct this research.

## REFERENCES

1. Nuh, M., *Pengembangan dan Implementasi Kurikulum 2013*. Bandung: PT Remaja Rosdakarya, 7-10 (2013) (in Indonesian).
2. Yuksel-Sahin, F, Mathematics Anxiety among 4th and 5th grade Turkish elementary school students. *Inter. J. of Mathematics Educ*., 3, **3**, 179-192 (2008).
3. Turmudi, Permainan dan teka-teki dalam pembelajaran matematika. *Prosiding Seminar Matematika Tingkat Nasional: Peranan Matematika dalam Peningkatan Kualitas Sumber Daya Manusia untuk Menghadapi Era Industri dan Informasi*., Bandung, Indonesia, 38-43 (2002) (in Indonesian).
4. Ernest, P., Games: A rationale for their use in the teaching of mathematics. *Mathematics in School*, 15, **1**, 2-5 (1986).
5. Ernest, P., Games. *Teaching Mathematics and its Applications.* 5, **3**, 97-102 (1986).
6. Yasin, Y. and Umi, A., *Sirkuit Pintar Melejitkan Kemampuan Matematika dan Bahasa Inggris dengan Metode Ular Tangga*. Jakarta: Visimedia, 15-19 (2011) (in Indonesian).
7. Slavin, R.E., *A Practical Guide to Cooperative Learning*. Needham Heights, MA: Allyn and Bacon, 10-15 (1994).

# WIETE

ORIGINALITY REPORT

| 14% | 12% | 3% | 2% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | pps.uny.ac.id<br>Internet Source | 10% |
| 2 | profdoc.um.ac.ir<br>Internet Source | 1% |
| 3 | eprints.unm.ac.id<br>Internet Source | 1% |
| 4 | S Y S Widuri, L Almash, F Zuzano. "Application of Learning Engineering Techniques Thinking Aloud Pair Problem Solving in Learning Mathematics Students Class VII SMPN 15 Padang", IOP Conference Series: Materials Science and Engineering, 2018<br>Publication | <1% |
| 5 | Submitted to Universitas Negeri Surabaya The State University of Surabaya<br>Student Paper | <1% |
| 6 | scholarcommons.usf.edu<br>Internet Source | <1% |
| 7 | Submitted to Edith Cowan University | |

| | | |
|---|---|---|
| | Student Paper | <1% |
| 8 | Lilit Rusyati, Harry Firman. "Validation of science virtual test to assess 8th grade students' critical thinking on living things and environmental sustainability theme", AIP Publishing, 2017<br>Publication | <1% |
| 9 | prr.hec.gov.pk<br>Internet Source | <1% |
| 10 | jurnal.fkip.uns.ac.id<br>Internet Source | <1% |
| 11 | K S Kuncoro, I Junaedi, Dwijanto. "Analysis of problem solving on project based learning with resource based learning approach computer-aided program", Journal of Physics: Conference Series, 2018<br>Publication | <1% |
| 12 | Judith Donnelly, Michele Dischino, Fenna Hanes, Nicholas Massa. "Creating and Using Industry-Based Problem-Based Learning Challenges in Photonics: Lessons Learned", Education and Training in Optics and Photonics, 2009<br>Publication | <1% |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 5 words |
| Exclude bibliography | On | | |