

Effectiveness of Gomoku in Improving Problem Solving Skills of Grade 9 Students Using Mole Concept to Express Mass of a Substance

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ABSTRACT

Problem solving using mole concept to express mass of a substance is one of the least learned skills of Grade 9 (G9) students of Katipunan National High School (KNHS) as reflected in the Mean Percentile Score (MPS) and test item analysis for the past two school years (2017-2018 & 2018-2019). Finding ways to improve this skill was one of the primary goals of the science teachers of KNHS. This study presented the effectiveness of “Gomoku”, a game based learning strategy in improving problem solving skills of G9 students in mole concept. Pre-experimental design was used in the study, of which pretest was given after discussion of the topic and posttest after the “Gomoku” intervention. Scores were treated using paired sample t test and adjectival ratings; Outstanding (90-100), Very Satisfactory (85-89), Satisfactory (80-84), Fairly Satisfactory (75-79), and Did Not Meet expectation (Below 75). Respondents of the study were 29 out of 51 randomly selected G9 Yakal students. Results revealed that posttest ($m=5.414$, $s=1.21$) was interpreted as satisfactory and greater than the pre-test ($m=3$, $s=1.46$), $t(28) = -7.215$, $p \leq .05$, which was interpreted as “did not meet expectation”. This implied that students perform better when exposed to “Gomoku” strategy; hence, “Gomoku” was recommended as alternative solution in improving students’ problem solving skills using mole concept to express mass of a substance.

KEYWORDS: Game-based- learning, “Gomoku”, mole concept, problem solving

INTRODUCTION

Learning the mole concept was one of the foundations to master basic principles of chemistry. Unfortunately, this was also one of the topics that Grade 9 (G9) students of Katipunan National High School (KNHS) had found difficulties with. Students find it hard to use the mole concept to express mass of substances, hence it was considered as one of the least learned competencies for the past two school years, (S.Y. 2017-2018, 2018-2019). The poor performance of the students particularly in this topic contributed the low Mean Percentile Score (MPS) of the G9 Students who obtained (60.62 %) and (71.38%). This indicated that students were far from the 75% standard passing level.

The unsatisfactory MPS results encouraged the researcher to adapt an intervention strategy that

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allowed the students to practice solving mole concept problems while having fun. The used of Game integration or Game-based Learning (GBL) in the learning process satisfies the learn and fun approach in the classroom. GBL is the adoption of gaming principles and use them to real-life situations to engage users (Trybus, 2015).

GBL offers collaborative, interactive and engaging environment for students to learn. Competitive games in the classroom encourage students to be participative in the learning process (Milczynski, 2011). It also offers a unique structure that complement traditional way of teaching with an integration of the innovative thinking and provide diverse teaching methodologies (Boyle, 2011). The utilization of Games in the classroom is aligned with

the goals of the K-12 teaching strategy, which promoted the 21st Century Learning Skills pedagogies in teaching. In fact the Department of Education (DepEd) supports sci-dama and damath competitions in Science because these games promote critical thinking and problem solving skills.

Gomoku Narabe (Japan) or known as “Gomoku” is one of the games that offers the same positive benefits to teaching and learning process. “Gomoku” is a strategy game that most people find it most challenging (Moursund, 2006). The goal of the game is to get exactly five markers in a horizontal, vertical, or diagonal file. The game provides opportunities for students to create patterns, develop prediction and problem solving skills. The mole concept also involves problem solving and critical thinking and it would be more fun for the students if they practice mastering the learning competency while having fun playing the game.

Due to this premise, this research paper is conducted to explore possible advantages of “Gomoku” as an effective tool in improving the problem-solving skills of Grade 9 Yakal students of Katipunan National High School in improving problem solving skills using mole concept to express mass of a substance.

Review of Related Literature

The mole concept was one of the difficult topics to be effectively taught to students. The comprehensive review of Furio, Azcona and Guisasolo (2002) on the learning and teaching of the concepts amount of substance and mole, revealed that students have great difficulty in handling mole concept and amount of substance and the lack of understanding of the amount of substance and mole is strongly connected to teachers. Alternative conceptions of the mole concept also lead to students understand the concept wrongly. Faizal et. al, (2010) in their review of twenty-two articles of the students’ alternate conceptions on mole concept revealed that students’ pre-concepts, school -made misconception and students’ scientific language causes alternative conceptions in mole concept which resulted to the inability of students to relate new idea to previous knowledge, confusion and misunderstanding. Hence, teachers handling the topic must ensure that students really understand the concept and find effective strategies to teach the lesson effectively. Furthermore, Khang and Sai, (2008) in their study on the difficulties in learning the mole concept among secondary schools students in Singapore disclosed that in teaching mole concept, teachers should make use of every opportunity to train students to think in mole or number of particles rather than rigidly following patterns to solve problems.

Teaching effectively the mole concept is not only limited to telling the right concept the students. Creating a friendly and pleasant classroom experience could also help improve students’ performance. Hernik and Jaworska (2018) in their study on the effects of enjoyment in learning showed that joyful lectures do not only bring happier students but also they remember more information of the topics even if the topics are purely business problems. Moreover, Kangas (2009) stated that fact-fiction and playful learning environment in teaching and studying help foster activity, creativity, imagination and group work along with academic achievement among learners. Game-based Learning strategy has both of these positive insights.

Games triggers discussion and learning concepts among students following a game play (Boyle, 2011). The results of the study of Des Amier Jr. et al (2016) on the use of game elements to increase students engagement in Course Assignment affirmed that students responded positively to games and were motivated to play them. The results were obtained from the quantitative collection from pre, mid and post surveys. GBL has also proven to be effective in improving the ability of students to solve material number as revealed in the study of Nizaruddin, Muhtaron & Sugiyanti (2018) on improving students, problem solving ability in mathematics through GBL activities which was conducted in two cycles.

Strategic games like “chess”, “damath” and “Connect 4 Game” contribute positively in improving learners’ performance. Hill and Kemp (2018) recognized the potential of “Connect 4” to be used in the future problem solving researches as a reliable elicitation tool of insight and search experiences for both negative and positive solving. The study also revealed that “Connect 4” may seem to offer more true to life solving exercises than other paradigms where a series of problems are solved (Hill and Kemp, 2018)

Both “Connect-four” and “Gomoku” are two-player games. However, “gomoku requires 5 pieces in a row which can be horizontal, vertical or diagonal, as opposed to “connect – four” which only require four in a line. “Gomoku” is a Japanese traditional logic board game and is also known in English Speaking countries as Five in a Row (www.gomokuworld.com). “Gomoku” can also be compared to more challenging “Tic-tac-toe” game, and is usually used in programming and game playing challenge in an Artificial Intelligence course (Moursund, 2006). This would imply that “Gomoku” is an easy game to play yet, offers more challenging task, which may help students in improving their problem solving skills.

On the other hand, GBL must be designed with learning principles in mind to increase students' motivation, engagement and learning (Pho and Dinscore, 2015) otherwise the game integration will not serve its purpose. GBL does not all the time give positive outcomes, like the study of Bragg (2018) in testing the effectiveness of mathematical games as a pedagogical tool for children's learning; test results indicated lesser gains in learning in game playing situations versus non-game activities, and that teacher-led discussion during and following the game playing did not improve children's learning. In addition, Bragg (2018) stated that educators should carefully consider the application and appropriateness of games before employing them as a vehicle for introducing mathematical concepts.

Although a negative result was achieved in the study of Bragg (2018), a positive enlightenment was highlighted in his study. That is the design of GBL must be aligned to the objective of the lesson as well as its appropriateness to the users. Hence, the use of "Gomoku" game as part of the GBL strategy in teaching will be focusing on two things; improving the problem solving skills in mole concept of grade 9 students and maximizing learning through playing simple and enjoyable board game.

The reviewed literature in this chapter offers sufficient evidence of the role of GBL in improving students' problem solving skills. It is also important to note that no studies had been made on the use of "Gomoku" in the classroom. In this regard, it is interesting to explore the effects of integrating "Gomoku" in improving students' performance in problem skills involving mole concept specifically in expressing mass of a substance

Statement of the Problem

The purpose of this action research is to determine the effectiveness of "Gomoku" game as intervention material in improving the level of problem-solving skills of Grade 9 Yakal students of KNHS in using mole concept to express mass of a substance. Specifically, it sought to answer the following questions:

1. What are the levels of problem-solving skills of grade 9 students in using mole concept to express mass of a substance in terms of mean scores/MPS
 - 1.1. prior to introduction of "Gomoku" game?
 - 1.2. after exposure of the "Gomoku" game?
2. Is there a significant difference in the level of problem solving skills of grade 9 Yakal involving mole concept;
 - 2.1. prior to introduction of "Gomoku" game?
 - 2.2. after exposure of the "Gomoku" game?

Hypothesis

The use of "Gomoku" has a significant effect in improving the level of problem-solving skills of Grade 9 students using mole concept to express mass of a substance.

Scope and Limitation

The study focused on the effectiveness of using "gomoku" in improving the level of problem-solving skills of Grade 9 Yakal Students in using mole concept to express mass of a substance.

The researchers used a teacher-made eight-item problem solving test. The results of the test score in the pretest and posttest were used to determine the effectiveness of using "Gomoku" in improving the level of problem-solving skills of Grade 9 Students using mole concept to express mass of a substance. In addition, there were only 29 randomly selected respondents in the study who were chosen regardless of their gender and academic achievement with no control group.

To measure their performance, a teacher made eight-item quiz were utilized and used adjectival rating (DepEd Order 08, s. 2015) to describe their level of performance.

Definition of Terms

Gomoku Board - a modified gomoku board consist of 8 x 8 holes with numbers in it that will serve as given value.

Gomoku Game - a modified two-player game designed to allow students pair chemical formula of substances with given values on the board and solve for mass or number of mole.

Red and Blue Chips - Chips use in the gomoku, which contains chemical formula of substances. This is used to place in the gomoku game board.

Player - Students who are engaged in the gomoku game.

Winner - Students who has the greatest points in the gomoku game.

Loser - a student who has the least number of points in the game

Problem-solving Skill- refers to the level of problem solving skill in using mole concept to express mass of a substance which is measured in the scores obtain in their pre-test and post-test.

Pre-test- a test given to the respondents before the introduction of gomoku game.

Post-test - a test given to the respondent after gomoku game

Methodology

Research Design

This study utilized pre-experimental since there was only one-group for pre-test and post-test. Specifically, both results of the tests were used to find out the effectiveness of the use of Gomoku game as intervention material in improving the problem solving skills of G9-Yakal students of KNHS.

Sampling Technique

The target population of the study were the 51 G9 Yakal students of KNHS of which 29 of them were selected using simple random sampling regardless of their gender and academic achievement in the class.

Instrumentation:

This study used a modified Gomoku board, with 8 x 8 holes in it. The holes were labeled with given values. The Gomoku board was used during intervention using GBL strategy.

In order to measure students’ performance after the intervention, respondents were given a teacher-made eight-item test consisting of 4 items mole to mass problem and another 4 items mass to mole problem in varied degree of difficulties. Item analysis was used to validate the instrument.

Paired sample *t*-test was the statistical strategy used in this study since there was only one group in the study with two sample results (pretest and posttest). The level of problem solving skills is determined using the Mean Percentile Scores of the both tests and were transmuted in accordance to D.O. 8, s. 2015. The following were the adjectival and numerical ratings:

- Outstanding 90 – 100
- Very Satisfactory 85 – 89

Results and Discussion

The following are the results and the analysis done from the data collected.

- Satisfactory 80–84
- Fairly Satisfactory 75–79
- Did Not Meet Expectation Below 75

Procedure

During the conduct of the study, lesson in mole concept were given to the respondents. The subjects were given board work and individual exercises for them to practice. A day after the discussion the pretest was given to them. After the pretest, Gomoku was introduced to them as alternative strategy to the usual paper-pencil type of drills. The Gomoku game rules were discussed to them and they were given a full day to grasp and practice the game. The following day the students were playing against each other for 25 minutes. Post-test was given on the third day of the session and the scores were collected for data analysis and interpretation.

Data Collection Procedure

Permission to conduct the study was secured from the office of the principal. Identities of students participating in the study were not published nor mentioned in the paper. In addition, only the scores of the students were reflected in the tally sheet.

The students answered the pretest after the discussion of the lesson and posttest 2 days after the intervention. The sitting arrangement of the respondents were one seat apart from each other. Respondents were given 15 minutes to answer the questions in their test questionnaire. Test papers were collected by the teacher right after the students finished the exam and the raw scores are tallied and analyzed.

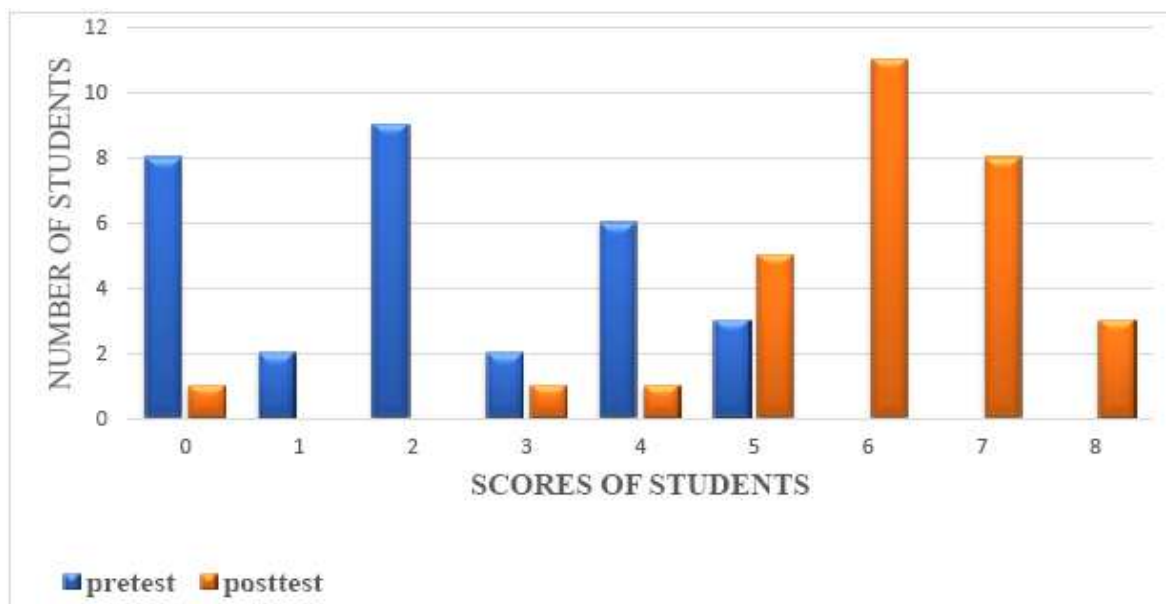


Figure 1. PRETEST AND POSTTEST SCORES OF STUDENTS

Figure 1 revealed that only 3 students got the passing mark during the pretest. On the other hand 24 (83%) students passed the posttest with 16 of them had score greater than the passing mark of 4.8. This means that students perform better during the posttest as compared to pretest. This implies that students got higher scores when “Gomoku” game was used as intervention.

The results showed how game based learning strategy motivated students to perform better. This result was similar to the study of Bahrami et.al (2002), that students exposed to GBL had higher scores than traditional ones. The increase of scores of students can also be attributed to the presence of playful learning environment during the game. This promoted active interaction among students and encouraged positivity to learning. This idea is in accordance with Kangas (2009) and Kim et.al (2008) who both supported and agreed of the positive effects of playful environment in learning.

The increased of scores of students also resulted to the increase of the MPS as shown in the Table 1 below.

Table 1. Mean scores of Pretest and Posttest

	Mean	SD	Interpretation
PRE-TEST	3	1.46	Did not meet expectations
POST-TEST	5.414	1.21	Satisfactory

Table 1 showed that mean scores of students increased by 2.414 points (66.67 %) after the intervention. This was enough to achieve a *Satisfactory* remark from *Did Not Meet Expectation*. This means that MPS scores increases when students were exposed to “Gomoku” strategy. The results suggested that one way of increasing MPS scores of students was to use “Gomoku” as an intervention material for improving students’ problem solving skills in mole concept.

The increased of MPS supported the role of “Gomoku” as game based learning activity that increased students’ performance in problem solving. However it should be noted that objective of the “Gomoku” in this study was intended only for improving students’ problem skills in mole concept, particularly in converting mole to mass and mass to mole. Thus, the same effect cannot be expected to other topics. Since designing GBL strategy must focus with learning principles in mind to increase student’s motivation, engagement and learning (Pho and Dinscore, 2015). In addition, the appropriateness of the game must be examined thoroughly in order to arrive with the positive outcome as what is highlighted by Bragg (2018).

Moreover, results of the paired sample t-test offer sufficient proof to conclude of the significant contribution of “Gomoku” as an intervention material in improving students’ problem solving skills in mole concept as shown in Table 2.

Table 2. Results of Paired Sample t-test

	Mean	Std. Deviation	T	df	Sig (2-tailed)
Pair 1 pretest –posttest	-2.41	1.76	-7.215	28	.000

Table 2 presented the test for significant difference of the mean score between pretest and posttest. It revealed that students exposed to “Gomoku” obtained significantly higher scores ($m=5.414, s=1.21$) than when they were not exposed to it ($m=3, s=1.46$). This means that there is strong evidence ($t=7.215, p=0.000$) that the use of “Gomoku” as intervention material improved the marks of the students on average of 2.41 at 0.05 significance level. The statistical result supported the hypothesis of the study that the use of “Gomoku” has a significant effect in improving the level of problem-solving skills of Grade 9 students in mole concept.

Findings

The following were the findings of this action research.

1. MPS in the pretest was equal to 27.08% with mean scores of 2.167 ($Sd=2.97$) significantly differed with MPS in the posttest which was 74.17% with mean scores of 5.93 ($Sd=2.54$).
2. The mean scores increased by 47.09% from 27.08% to 74.17 %
3. The used of “Gomoku” Game was effective in increasing the MPS.

Conclusions

Based on the findings, conclusions are as follows:

1. “Gomoku” game increased the MPS of the grade 9 students.
2. “Gomoku” significantly improved the problem-solving skills of students relating to mole concept from *Did Not Meet Expectations (below 75%)* to *Satisfactory (80%-84%)*.

Recommendations

Based on the above findings and conclusion, recommendations are suggested.

1. Teachers are encouraged to use game based learning in line with the learning competencies to motivate students.
2. “Gomoku” game should be used in grade 9 students as an intervention material in improving the problem solving skills of G9 students in mole concept.
3. More research on the pros and cons of “Gomoku” game in classroom instructions.
4. Create and design an online game similar to the one used in the study.

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