Journal for the Education of Gifted Young Scientists, 8(1), 571-589, March 2020
e-ISSN: 2149- 360X
http://jegys.org

Research Article

Gender Description on Problem-Solving Skills in Chemistry Learning Using Interactive Multimedia

Gunawan GUNAWAN[1], Ratna A. MASHAMI[2] and Lovy HERAYANTI[3]

Received: 30 December 2019 **Revised:** 26 February 2020 **Accepted:** 5 March 2020

Abstract

This study aimed to examine the effect of interactive multimedia on problem-solving skills based on gender. The sample was chemistry education students in IKIP Mataram that consisted of 10 males and females' students each. This study was pre-experimental research with a pretest-posttest one group design. Data collection was obtained by tests and interviews. The test of the problem-solving, in the form of the essay, was divided into three types, namely conceptual, algorithm, and conceptual-algorithm problems. Problem-solving was measured following the stages of Polya's problem-solving, namely understanding the problem, devising a plan, carrying out the plan, and looking back. The interview was conducted to gain more insight into their problem solving skill. Data were analyzed statistically using independent sample t-test and normalized gain scores (N-gain). The results of the analysis of the initial data obtained a significant value of 0.809, which indicated there was no difference between the problem-solving skills of male and female students. Meanwhile, the final data analysis obtained a significant value of 0.034 which means there was a difference between the problem-solving skills of the students. This furthermore showed that the use of interactive multimedia in chemistry learning increased the problem-solving skills of male better than the female. Moreover, male students' problem-solving skills were higher than the females in all types of problems and at all stages of problem-solving. Due to interactive multimedia, the conceptual understanding and learning motivation of students is enhanced.

Keywords:

gender, interactive multimedia, problem-solving skills

To cite this article:

Gunawan, G., Mashami, R.A., & Herayanti, L. (2020). Gender Description on Problem-Solving Skills in Chemistry Learning Using Interactive Multimedia. *Journal for the Education of Gifted Young Scientists, 8*(1), 561-589. DOI: http://dx.doi.org/10.17478/jegys.627095

[1] Dr., Senior Lecturer, Department of Physics Education, Faculty of Teacher Training and Education, Universitas Mataram, Indonesia. It is gunawan@unram.ac.id. ORCID no: 0000-0001-8546-0150

[2] M.Pd., Senior Lecturer, Department of Chemistry Education, Faculty of Mathematics and Science Education, IKIP Mataram, Indonesia. It is ratnamashami@ikipmataram.ac.id. ORCID no: 0000-0001-7710-077X

[3] Dr., Senior Lecturer, Department of Physics Education, Faculty of Mathematics and Science Education, IKIP Mataram, Indonesia. It is lovyherayanti@ikipmataram.ac.id. ORCID no: 0000-0002-0565-2732

Introduction

Problem-solving is an essential part of daily life used in understanding events as they occur and also employed in deciding what kind of response should be made. Problem-solving is also employed in a variety of fields, such as business, politics, education, health, social, and others, and its ability is inherent to all humans. It is nothing new that humans now live amid sophisticated technological developments. This has prompted the need to possess the necessary skills, such as problem-solving skills, to adapt effectively to developing knowledge and technological innovations (Voogt & Roblin, 2012). Problem-solving is one of the high orders thinking skill that is currently a very important aspect of education in the world (Funke & Greiff, 2017). These skills are quite versatile as long as human life and in any field. Education is seen as being able to practice these skills; therefore, the curriculum gets adjusted.

A series of the report showed problem solving ability of 15 years old students in Indonesia (OECD, 2013; OECD, 2017). According to the results of the assessment through the PISA program, Indonesia has a score that is far below average. Indonesia ranked 64th out of 65 countries in 2012 and then increased in 2015 to 64th out of 72 countries. Innovative domain in 2015 was collaborative problem solving, while in 2012 it was individual problem solving. Thus, problem solving needs to get special attention in learning.

Learning focus help students understand the concept of materials and also master skills in solving problems (Dole, Bloom, & Kowalske, 2016). The material learned is expected to solve problems in learning and some other contexts. Students cannot be said to have learned anything useful unless they have the ability to use information and skills to solve problems (Slavin, 2009). However, chemistry education students at IKIP Mataram do not exhibit good problem-solving skills. For instance, everyday chemical problems become difficult in relating it to the concept learned. Another example is buffer solution material, which has an abstractive concept with real examples. The process of stabilizing the pH of human blood given intake of acidic into the blood, furthermore, is also difficult to learn. Interviews conducted on several students showed that many merely memorized the formula to calculate pH neglecting the need to understand why the concentration of the component was calculated.

Problem-solving can also be seen as a cognitive process directed at achieving a goal while the solution method is yet unknown. Therefore, a problem exists once someone has a goal but does not know how to achieve it. The major facets of knowledge required for problem-solving are facts, concepts, procedures, strategies, and beliefs (Mayer, 2013). To solve problems in chemistry learning, students are to understand the facts and concepts of chemistry itself. Chemistry is divided into three characteristics which are phenomena that can be seen, sensed, and felt (macroscopic), explanations of macroscopic phenomena in terms of molecular (submicroscopic), and quantitative and qualitative statements of phenomena using symbols (symbolic) (Gilbert & Treagust, 2009). Especially for submicroscopic representations, it requires the aid of computer applications to make molecular visualization as a learning medium. Learning involving these three representations was proven to have a positive impact on the student's understanding (Mashami, Andayani, & Gunawan, 2014; Guzel & Adadan, 2013). Computer-based multimedia has been shown to be able to provide better opportunities for students to develop a variety of capability tools such as conceptual understanding (Husein et al., 2019; Hermansyah et al., 2019) and critical thinking skills (Mashami & Gunawan, 2018). These abilities greatly influence students' problem solving abilities development.

Information and Communication Technologies (ICT) have facilitated communication and permitted new forms of work and learning, overcoming the traditional constraints of time and space (Romero, 2015). The use of technology in visualizing abstract concepts has been widely investigated and the results have greatly assisted students to understand the concept, creativity, and critical thinking (Husein et al., 2019; Gunawan et al., 2019a; Widiyatmoko, 2018; Tang & Abraham, 2016). Learning is no longer between teachers and students since the application of technology now makes the mutual relationship more meaningful. However, the learning process employed in the IKIP Mataram chemistry education department is yet to employ technological developments fully.

Most technological devices or equipment such as computers and LCDs are only used for media presentations in class. While the rest of learning remains face-to-face traditional teaching, assignments, and a few practicum times. The practicum is often done after the material has been studied in class. It consists of the macroscopic, submicroscopic and symbolic aspects of the material that are not in synchronization. In other words, theory and practice did not support each other. The study result, therefore, showed a deep understanding of theory is important and that experimental activities should be seen as a potential aid to the construction of scientific meaning (Colagrande, Martorano, & Arroio, 2017).

Also, the submicroscopic aspect is not delivered because molecular animation is not available on all concepts. However, viewing it from the impact of learning during the evaluation, students were unable to solve questions in the form of analysis as more memorization was done instead of understanding. This causes confusion whenever a problem different from the usual one is given, especially when it is very urgent to find a solution. As a facilitator, lecturers must think of innovative ways of making the learning process better.

Macroscopic, submicroscopic, and symbolic representations can be studied as a whole using interactive multimedia. This contains complete media elements which include audio, animation, video, text, and graphics that allow users to interact interactively through available features. The findings in the study show that interactive multimedia has many advantages. Some studies showed that multimedia interactive improves understanding and motivation in chemistry learning (Osman & Lee, 2013; Pekdağ, 2010).

Problem-solving and other thinking skills have also been debated for decades. However, recent technological developments have made the learning environment different. Student interaction with technology has influenced the way they think. In chemistry learning, sub-microscopic media animation had more influence on female students' critical thinking skills than male students (Mashami & Gunawan, 2018). In physics learning, virtual lab-made female students have higher creativity than male, although not significantly different (Gunawan, Suranti, Nisrina, Herayanti, & Rahmatiah, 2018) and the application of a virtual laboratory in electrical concept has a positive effect on student problem-solving ability (Gunawan, Harjono, Sahidu, & Herayanti, 2017). Therefore, problem-solving is still interesting to discuss, especially when associated with computer-based media and gender.

The issue of gender equality in education has long been a global spotlight. Nowadays most women have given the same opportunity to get an education with men. However, how female students achieve the goals in the learning process sometimes goes unnoticed. Especially with the issue of differences in the treatment of learning in male and female students in several regions of Indonesia (Izzati, Bachri, Sahid, & Indriani, 2019) will provide an in-depth understanding of differences in student development based on different genders caused by the application of multimedia. This finding will be useful for the lecturer concerning understanding the thinking ability of each gender so that they can facilitate the problem solving skills of both male and female students to develop optimally.

The problem of the study

Based on the explanation above, the problem that will be answered in this study was how the effect of interactive multimedia on the problem solving skills of male and female students.

Method

Research Design

This study employed pre-experimental research since there was only one group as a subject. It was a quantitative and qualitative study and used pretest-posttest one group design. This design was chosen because the sample had studied buffer concepts initially. At the beginning of the study, students were given an initial test to investigate the problem-solving abilities possessed. During the learning process, students' ability to solve problems was explained from the qualitative data obtained. In the end, students were given a posttest and interview. This study only used one group; therefore, the sample gets the same treatment, such as pretest, interactive learning multimedia, and posttest. However, at the time of analysis, the data were divided into two groups, male and female, and were compared.

Participants

The population of this study was the first-year chemistry students in IKIP Mataram totaling 29 students (10 male and 19 female). Furthermore, the sample was chosen using a purposive sampling technique. The pretest was also conducted to select a sample of the females who had the same abilities as the males. Not all female students were sampled because they were adjusted to the number of males; therefore, the data compared were not too lame. The number of samples was 20 students consisting of 10 male and female students each.

Data Collection

Data collection was conducted by tests and interviews. Problem-solving furthermore was measured, followed by the stages of Polya's problem-solving, namely understanding the problem, devising a plan, carrying out the plan, and looking back. The research instrument used was a test of problem-solving in the form of an essay test. Previously the instrument had been tested to find out its validity and reliability. Ten items obtained six valid and reliable items. Six items in the test were divided into three types, namely conceptual, algorithm, and conceptual-algorithm problems. Examples of the three types of questions can be seen in Table 1. The acquisition of problem-solving scores for the test ranges from 0 to 100. The initial and the final test used different questions but have the same indicator. Interviews used simple guidelines to obtain qualitative data about what students think at each stage of problem-solving or what students think when writing answers. They were interviewed individually after the final test.

Table 1.

Examples of questions based on the type of problem

Type of Problem	Question
Conceptual	Water has a neutral pH (pH = 7). If an acidic solution is added to water, the pH of the water becomes less than 7 (acidic). If a base solution is added to water, the pH of the water becomes greater than 7 (basic). The properties of water are different from the properties of the buffer solution. If a little acid is added to the buffer solution, the pH of the buffer solution does not change (remains). How can the buffer solution maintain pH?
Algorithm	A total of 1 L of buffer solution containing CH_3COOH 0.1 M and CH_3COONa 0.1 M. If Ka $CH_3COOH = 1.8 \times 10^{-5}$, then determine the pH of the buffer solution if added 10 mL HCl 0.1 M.

Type of Problem	Question
Conceptual-Algorithm	Astri wanted to make a buffer solution using CH_3COOH 0.1 M and NaOH 0.1 M in the laboratory. The amount of CH_3COOH solution available is only 200 mL while the amount of NaOH solution is quite a lot. In your opinion, what volume of NaOH. Should Astri mix with the available CH_3COOH?

Data Analysis

Data were analyzed by using appropriate statistical tests, namely the normality, homogeneity, and independent t-test using SPSS version 23 software. All statistical tests were carried out at a 5% significance level. Enhancement of students' problem-solving was determined from normalized gain scores (N-gain) (Cheng et al., 2004).

$$N - gain = \frac{(S_{post} - S_{pre})}{(S_{max} - S_{pre})} \times 100\%$$

Note: N-gain > 70% (High); 30% ≤ N-gain ≤ 70% (Medium); and N-gain < 30% (Low).

N-gain data were also analyzed based on problem types and problem solving stages to strengthen the difference in the effects of interactive multimedia on male and female students.

Process

Students studied with interactive multimedia for four meetings. Students learned about the properties of buffers solution at the first meeting, how buffers solution works at the second meeting, buffers solutions pH at the third meeting, and buffers solution at the fourth meeting. Besides the meeting in class, the learning process also consisted of independent tasks and structured tasks. All of the concepts and the tasks were included in the interactive multimedia. As for the learning process when the meeting in class followed the learning path that was inside interactive multimedia. Interactive multimedia displays can be seen in Figure 1.

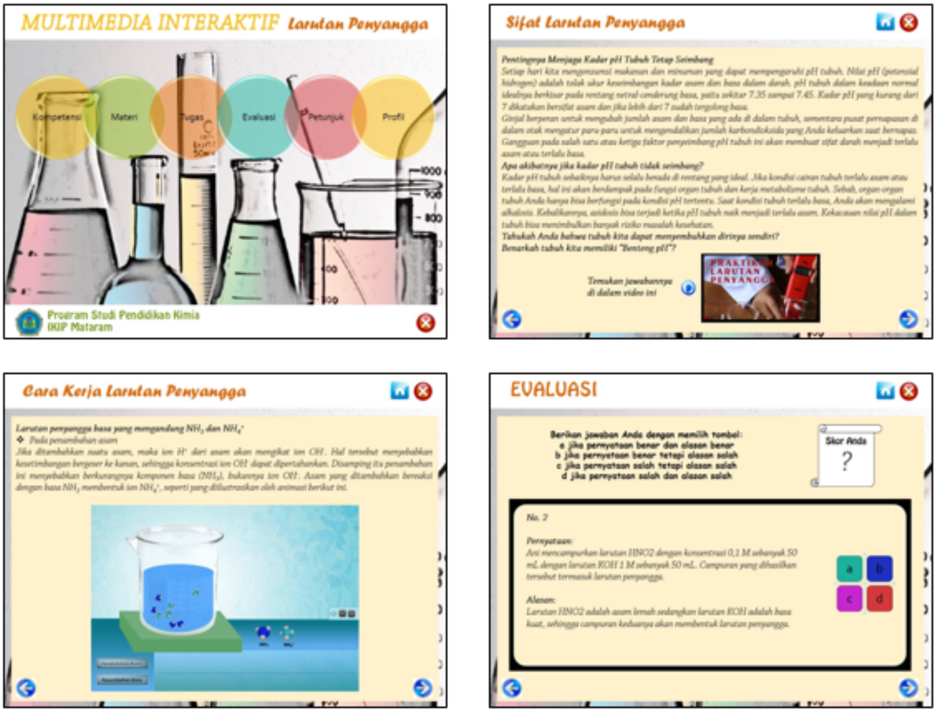

Figure 1.
Example of Interactive Multimedia Displays

Interactive multimedia has six main menus, namely competencies, materials, assignments, evaluations, instructions, and profiles. Interactive multimedia combines text, images, audio, video, and animation so that all three levels of representation can be displayed. The three levels of representation are macroscopic, submicroscopic and symbolic. The nature of the buffer solution which is a macroscopic representation was the pH of the solution students learned through the practicum video. Students observe the initial pH of the buffer solution, the pH of the buffer solution after adding acid, and the pH of the buffer solution after adding bases. Submicroscopic representation is a description of the behavior of a molecule in a solution that can show the components of the buffer solution and how the solution works when there is a slight addition of acid or base. Submicroscopic representations are explained using animation. Symbolic representations on the buffer solution concepts such as the measurement table of the buffer solution pH, the equilibrium reaction equation between the components of the buffer solution, the reaction equation on acid addition, the reaction equation on-base addition, and other elemental or molecular symbols.

Results

The Validity of the Test

The validity test was done empirically on the third and fourth-year students of 20 people. The trial results were analyzed using the product-moment correlation formula.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)\,(N\sum Y^2 - (\sum Y)^2)}}$$

Note: r_{xy} = The correlation coefficient between variable X and Y variable; N = Number of Students; $\sum X$ = Number of students scores on each items; $\sum Y$ = Total number of students scores; $\sum XY$ = Number of results of multiplication of students scores on each items with a total of students' scores.

The item test was considered valid if the r_{xy} was greater than 0.444 at a significant level of 0.05. Table 2 presents the results of the validity of the instrument. There was ten number of question but four were considered invalid.

Table 2.
The Validity of Problem Solving Skills Instrument

Number of Question	Type of Problems	r_{xy}	Decision
1	Conceptual	0.392	Invalid
2	Conceptual	0.459	Valid
3	Algorithm	0.449	Valid
4	Conceptual	0.532	Valid
5	Conceptual-Algorithm	0.240	Invalid
6	Algorithm	0.454	Valid
7	Conceptual-Algorithm	0.541	Valid
8	Algorithm	0.366	Invalid
9	Conceptual-Algorithm	0.306	Invalid
10	Conceptual-Algorithm	0.458	Valid

Reliability of The Test

The reliability of the instrument was conducted using Cronbach's alpha formula.

$$r_{11} = \left(\frac{n}{(n-1)}\right)\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

Note: r_{11} = Instrument reliability scores; n = The number of items, $\sum \sigma_i^2$ = The sum of the variance of each item; σ_t^2 = Total variances.

The value of the reliability level of Cronbach's Alpha can be shown in Table 3 (Hair, William, Banin, & Anderson, 2010). Based on calculations obtained an r_{11} value of 0.802 which indicated that the problem solving skills instrument was very reliable.

Table 3.

The Cronbach's Alpha reliability level

Cronbach's Alpha Value	Level of Reliability
0.0-0.20	Poor
>0.20-0.40	Rather Reliable
>0.40-0.60	Reliable Enough
>0.60-0.80	Reliable
>0.80-1.00	Very Reliable

Problem Solving Skills Data

The influence of interactive multimedia on problem solving skills of male and female students can be viewed from various aspects, namely, compare the score of problem solving skills both on the initial test and the final test, compare the improvement score from the initial test to the final test, compare the improvement scores based on the type of problems, and compare improvement score based on problem solving stages.

The results of the preliminary test analysis showed that the sample had the same problem-solving skills. Data on male students have an average of 44.17, while female students at 43.13. The maximum score of problem-solving skills was 100. The results of the preliminary test showed that the data was homogeneous and normal. Then, the preliminary data on problem-solving skills were analyzed using the independent sample t-test. Table 4 shows that the value of sig. (2 tails) worth 0.880, the value is greater than 0.05. It can be understood that at the time of the pre-test, the problem solving abilities of male and female students did not differ significantly. The results of the statistical tests showed that there was no difference between male and female students' problem-solving skills.

Table 4.

T-Test for Equality of Pre-Tests' Means (Problem Solving Skills)

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Problem Solving	Equal variances assumed	0.153	18	0.880	1.04167	6.80307
	Equal variances not assumed	0.153	17.992	0.880	1.04167	6.80307

Table 5.

T-Test for Equality of Post-Tests' Means (Problem Solving Skills)

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Problem Solving	Equal variances assumed	2.293	18	0.034	12.29167	5.35983
	Equal variances not assumed	2.293	16.960	0.035	12.29167	5.35983

At the end of the study, final tests and interviews were given. Based on the analysis, male and female students obtained average scores of 85.83 and 73.54, respectively. The statistical test showed that the data was homogeneous and normal such that the hypothesis test used was an independent sample t-test (Table 5). The significant value obtained was 0.034 (less than 0.05) which means there was a difference between male and female students' problem-solving skills in post-test. Male students' problem-solving skills were higher than the females indicating the effect of the use of interactive multimedia.

The amount of the increase was analyzed using the normalized gain score (N-gain) to determine the extent to which students' skills improved after learning interactive multimedia. Male students experienced a high category increase with an average score of 79% and the females' improvement with 55% in the medium category. The difference in conditions between pre-test and post-test showed that there were factors that influence the development of problem-solving abilities of male and female students, in this case the application of interactive multimedia. Students' problem-solving abilities were quite significantly the same (homogeneous) at the time of the pre-test, after being treated (the application of interactive multimedia) there were differences in problem solving of male and female students that have been statistically proven.

Table 6.
Data on Students' Problem-solving Skills

Criteria		**Male**	**Female**
Amount		10	10
Pretest	Average	44.17	43.13
	Normality	0.200	0.200
	Homogeneity	0.983	
	Hypothesis test	0.880	
Posttest	Average	85.83	73.54
	Normality	0.064	0.200
	Homogeneity	0.102	
	Hypothesis test	0.034	
Average N-gain Score		79%	55%

The results of the next data analysis are the comparison of N-gain scores of male and female students based on the type of problems. Average N-gain scores of male students were higher than average N-gain scores of female students in all types of problems as shown in Table 7.

Table 7.
The Average N-gain Scores Based on the Type of Problems

Type of Problems	Average N-gain Score (%)	
	Male	Female
Conceptual	79	49
Algorithm	77	70
Conceptual-Algorithm	77	49

Problem-solving skills data were also compared and analyzed at each stage of Polya's problem-solving. The significant difference in students' improvement score was shown in Figure 2. Step 1 is understanding the problem, step 2 is devising a plan, step 3 is carrying out the plan, and step 4 is looking back. Average N-gain scores of male students were higher than average N-gain scores of female students in all problem solving stages.

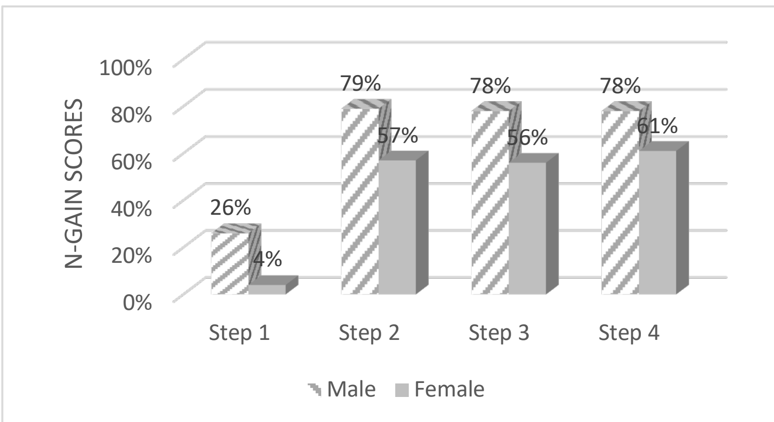

Figure 2.
Graph of the Average N-gain Score of Students at Each Problem-solving Stage

The data presented in this section showed that the problem solving skills of male students are higher than those of female students in all aspects. The use of interactive multimedia in chemistry learning has a greater influence on male students than on female students.

Discussion

Male and female students have the same initial problem solving skills. Using the concept of buffer solutions that they have been studied before this study, students write down problems, plan solutions, and implement a solution plan based on existing data in the questions. In general, the use of interactive multimedia was effective in improving students' problem-solving skills. Learners were more active and engaged, furthermore more effective learning was achieved through this well-embedded concept (Manurung & Mihardi, 2018). The development of high-level capabilities is strongly supported by the application of interactive multimedia because it has been proven to help in developing high order thinking skills (Dasilva et al, 2019) and of course, science process skills (Gunawan et al., 2019b). These abilities are very helpful in developing problem solving skills. Problem solving is a skill that requires a higher level of thinking ability and will be widely used in understanding the scientific process. The part of the competency employed to solve problems is the ability to gain and use the gained knowledge actively. It was needed to have such knowledge for the successful resolution and solving of the problem It is also possible to speak about the cognition basis (Dostál, 2015).

Interactive multimedia in learning buffer solutions influenced the conceptual understanding of male students' better than female students. The combination of video, text, animation, and graphics makes adrenaline-driven male students conquer a series of learning correctly so that the concept of buffer solution was well understood. Aside from interactive multimedia presented, three forms of representation were used to improve problem-solving skills, that are macroscopic, submicroscopic, and symbolic. Moreover, the result showed that students were able to solve problems using the various types of representation (Nizaruddin, Muhtarom,& Murtianto, 2017). For example, to solve the conceptual problem as written in Table 1, students have to understand how the solutions works and it's component. Submicroscopic representation in interactive multimedia explained those through animation. Students answer "for example buffer solution HNO_2/ NO_2^-, means that this solution contains HNO_2 molecules, H^+ ions, Na^+ and NO_2^- molecules. The addition of a small amount of strong acid will increase the concentration of H^+ in solution, but this excess is neutralized by NO_2^-, forming HNO_2 so that the equilibrium shifts toward HNO_2. This makes the amount of H^+ in the solution constant so that the pH value remains". The answer was a combination of submicroscopic and macroscopic representations that they have understood and then written down with some symbolic representations such as reaction equations or compound formulas.

When compared, interactive multimedia affected the problem solving skills of male students better than female students. During the four meetings, students were taught with interactive multimedia assisted learning, and the lecturer made the needed observations during the learning process. The role of technology in science teaching activities has been proven to be responded positively by both teachers and students (Alkan & Altundağ, 2015). The interest of male students when operating interactive multimedia was more enthusiastic. One of the studies showed that female students were more influenced by teachers they choose as their role models and show high levels of intrinsic motivation (Christophersen, Elstad, Solhaug, & Turmo, 2015). Previous research by Mashami & Gunawan (2018) also found that female students had a higher increase in critical thinking than male students. This supports that female students are more critical than male students because female students have higher motivation. This was inversely proportional to females that studied with interactive multimedia as they tend to be less confident. Before learning begins, the lecturer explained how to operate the interactive multimedia. And when in operation, the female students often ask how to use the interactive multimedia out of fear of wrongly operating the system. However, the males were quick to operate interactive multimedia without fear. Moreover, the results observed through interviews showed that male students completed a series of learning with interactive multimedia quicker than their female counterparts.

In addition to cognitive competence, motivation also serves as one of the determining factors in successfully solving a problem (Dostál, 2015; Mayer, 2014). Therefore, male students have higher problem-solving skills. Moreover, these results were in accordance with the PISA 2012 assessment of the individual problem-solving ability, where male students generally outperformed. However, it differs from the PISA 2015 assessment in which female students performed significantly better in collaborative problem-solving (OECD, 2017).

The problem solving skills of male and female students also differ in terms of the type of problem they solved. The average improvement skills of male students were higher than female students in all types of problems (Table 7). The improvement skills of male students were in the high category, the highest increase in conceptual problems by 79%. The improvement skills of female students were included in the medium category. In the algorithm problems, female students experienced an increase of 70% which almost reached a high category. While the score of improvement in conceptual problems or conceptual-algorithm problems only reached 49%. An interesting finding from this study was that female students are less able to solve problems that require an explanation of concepts. Based on these data also, female students seem to lack the mastery of concepts. Therefore, they could not solve problems that require analysis. This finding was in contrast to other studies which stated that understanding concepts do not affect student success in solving problems (Bodner & Herron, 2004). On problems that contain concepts, female students were not confident enough as their male counterparts. For instance, the concept of buffer solutions obtained by interactive multimedia was not as good as that of male students and this was indicated by the stages of problem-solving that were not done optimally. It was observed that students tend to check for conceptual accuracy when confident in the solution done (Gulacar, Bowman, & Feakes, 2013).

Differences in problem solving skills of male and female students were also seen at each stage of Polya's problem-solving (Figure 2). In the first step, the improvement skills of male and female students were equal in the low category. For the following step, the improvement skills of the male were in a high category while improving the skills of female students was in the medium category. The use of interactive multimedia in learning made male students devising a plan (step 2) very well. On the other hand, female students showed better-looking back ability (step 4) compared to other abilities. At the end of the study, a brief interview was also conducted to determine the student's reasoning during the problem-solving stages. These data were helpful in describing the skills of male and female students.

Step 1. Understanding the Problem

The first step to being taken by students in solving any problem is to understand the question itself. And this can be done by understanding the data asked and analyzing known data from the questions. Notations and symbols are then used to clarify the given problem. Male and female students experience an average improvement in, but with a significant number of differences of 22%. The ability improvement of males and females was at 26% and 4% respectively. Interviews of both genders gave the same result as gotten earlier. After learning with interactive multimedia, male students gained more insight into the existing data and those that are not present in the problem and this sharpens their ability to understand the question asked.

Step 2. Devising a Plan

In the second step, students find out the relationship between the known and unknown data and then formulate a solution that will be used to solve the problem. Their flow of thought was depicted with simple diagrams or formulas. Male students experience an ability improvement classified in the high category, while the females were classified in the medium category. The difference between the two was 22%. In the course of this step, the sample was asked what they were thinking and it was discovered that the males were trying to recollect whether the problem had been encountered before and whether the same approach can be employed to connect the known and unknown data. Similarly, the females had the same answer although some were undecided on what formula to use in accordance with the known data.

Step 3. Carrying out the Plan

Furthermore, students employed the plan of the solution and explained the lines of thought that have been compiled before, entering numbers into the calculation formula. Asked what was being thought, the sample said they were trying to connect one concept to another with the provision of material that had been learned. Also, male students think about the accuracy of the calculations while the females do not consider how accurate the solution was. The difference in the improvement in male and female abilities also reached 22% as in the previous two stages. Male students experienced an improvement in ability that was included in the high category, while the females were included in the medium category.

Step 4. Looking Back

The last step taken was to examine the solution obtained and at this stage, the male students check from the beginning to the end. The female students do the same thing but not confidently, thinking there was a mistake in the solution. This is under the results of research that states that males have stable internal attributes while the female has unstable internal attributes (effort or concentration) (Benölken, 2015).

All stages that students employed to solve problems were cognitive processes (Mayer, 2013). Male students experience better cognitive processes than female students so that male students' self-efficacy was also better. Chemistry self-efficacy also influenced the students' strategy use. Students who believed they were capable of chemistry tended to use a working-forward strategy and solve the problems successfully (Taasoobshizari & Glynn, 2009).

Limitation of the Study

The finding of this study has to be seen in light of some limitations. the first was the number of face-to-face meetings only four times. The concept of a buffer solution was one of the materials students learn in fundamental chemistry courses. If calculated as a percentage, the concept of buffer solution represents 10% of the entire material in one semester. The second limitation concerned the limited number of samples especially male students. The female students sampled must be adjusted to the number of male students so that the data being compared is more valid. The last limitation was the literature and study that discusses the differences in problem solving skills based on gender, especially if associated with interactive multimedia that is used as a learning medium, are very rare. As for the explanation of the findings in this study carried out by linking one theory with another theory so that a reasonable reason was found.

Conclusions and Recommendations

It can be concluded that the use of interactive multimedia in chemistry learning has a different influence on the problem-solving skills students. Male students' problem-solving skills were seen to be higher than for females. Male students experienced an increase in the high category with an average score of 79% and female improvement by 55% in the medium category. Based on the types of problems, the average improvement skills of male students were higher than female students. The highest improvement skills for male students by 79% in conceptual problems, while for female students by 70% in algorithm problems. Moreover, the average improvement skills of male students were higher than female students at all problem solving stages. The use of interactive multimedia in learning made male students devising a plan (step 2) very well. On the other hand, female students showed better-looking back ability (step 4) compared to other abilities.

Based on the results and discussion, interactive multimedia has a positive impact on students' problem solving skills. The author recommends interactive multimedia collaboration with other learning methods so that students' skills, especially female students, become even better. In addition, further research needs to be done to determine the effect of interactive multimedia on higher-order thinking skills, such as critical thinking, creative thinking, and decision making. And finally, the specificity of the ways of thinking or problem solving for both male and female students can be used as a basis for teachers or lecturers in making good learning plans.

Biodata of the Authors

Dr. Gunawan, M.Pd. was born at Sumbawa, on May 1st, 1981. The author is a Senior Lecturer in Physics Education, the Faculty of Teacher Training and Education, Universitas Mataram. He completed his doctoral program in a physics education study program at the Indonesian Education University in January 2011. Currently, he is the Director of the research center for physics and technology education, Universitas Mataram. His research focus in recent years has been in the development of virtual laboratories, interactive multimedia, and learning management systems. **Affiliation:** Dr., Senior Lecturer at Department of Physics Education, Faculty of Teacher Training and Education, Universitas Mataram, Indonesia. **E-mail:** gunawan@unram.ac.id **Phone:** +6281246673311 **SCOPUS ID**: 57205026913 **WoS Researcher ID**: R-8042-2019

Ratna A. Mashami, M.Pd. obtained her Bachelor of Chemistry Education from the University of Mataram in 2009. She received her Masters of Science Education from the University of Mataram in 2012. She is a lecturer at IKIP Mataram since 2013 until now. The focus of her research is in the fields of Gender, Learning Media, and Higher-Order Thinking Skills. **Affiliation:** M.Pd., Senior Lecturer at Department of Chemistry Education, Faculty of Mathematics and Science Education, IKIP Mataram, Indonesia. **E-mail:** ratnamashami@ikipmataram.ac.id
Phone: +6281805248797 **SCOPUS ID**: 57205025801**WoS Researcher ID :** -

Dr. Lovy Herayanti, M.Pd. is a Lecturer in Physics Education, the Faculty of Mathematics and Science Education, IKIP Mataram, Indonesia. She completed her doctoral program in a science education study program at Surabaya State University in February 2018. Currently, she is actively researching several issues related to information technology applications in science learning.

Affiliation: Dr., Senior Lecturer at Department of Physics Education, Faculty of Mathematics and Science Education, IKIP Mataram, Indonesia.

E-mail: lovyherayanti@ikipmataram.ac.id

Phone: +6281910607354 **SCOPUS ID**: 57196098000 **WoS Researcher ID :** -

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