Multimedia: an alternative to improve self-regulated learning and mathematical problem-solving skills

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Abstract. A question is said to be a problem if it can’t be solved by routinely procedures and if it is not too challenging enough for the learners. Problem-solving skills are useful in finding answers and solutions to phenomena. One way to solve problems is through critical thinking. Students must learn how to think beyond their knowledge and it will serve as training in order to provide a solution in solving problems based on an appropriate and rational basis. Some problem-solving strategies can be used in solving mathematical problems such as self-regulated learning. Self-regulated learning can make students be more creative, responsible and have their own initiative in solving a problem without direct teacher assistance. With the progress of time, education seems to shift into a more advanced era. Education can be done anywhere and anytime to develop students’ potential. One of them is by using multimedia that will showcase the appearance of material by using sound, image, video, and animation to encourage students’ critical thinking skills for mathematical problem-solving. This article will discuss multimedia as an alternative to increase self-regulated learning in mathematical problem-solving.

1. Introduction

In mathematics, creativity can help students to solve problems. Creativity is defined as a process of solving problems [1]. This is in line with self-regulated learning that can make students grow their creativity so they can solve problems more easily. Problem-solving is also important in mathematics because students can gain learning experience in learning and problem-solving using knowledge and skills that they already have to use in solving problems with new situations [2]. Therefore we need critical thinking skills or cognitive abilities of students so that students can solve mathematical problems more easily.

Zimmerman [3] defines self-regulated learning is an action based on thoughts and feelings that produce independently the achievement of personal goals through plans that are cyclically adapted. Students who use self-regulated learning, tend to be more active in their own learning processes in terms of motivation, behavior, and metacognition [4]. They will also arrange the way of learning by understanding which learning strategies are most appropriate for them so that they can succeed in achieving their learning goals [5].

Zimmerman [6] has conducted research on the nature, origin, and development of how students organize their own self-regulated learning process. In his research revealed how the process of self-regulated learning leads to success that can be schooled but in reality, there are still many kinds of problems, one of which is that some teachers still need to guide students fully in learning before students can understand how self-regulated learning is [6]. Moreover, in mathematics learning, even though the
students’ books have written steps in solving mathematical problems, students still find it difficult to understand what is written without the teacher’s guidance.

Multimedia has an important role in the process of learning and cognitive psychology [7]. Multimedia learning involves computer-based learning that contains words, images, illustrations, animations, narratives, graphics, and spoken words [8]. Computer Technology Research (CTR), states that a person is only able to remember 20% of what is seen, 30% of which is heard, and the rest is 50% of what is seen and heard. Whereas one can remember 80% of what is seen, heard and done at once [9]. Thus multimedia is very effective to use in learning because multimedia can present information that can be heard, seen, and done.

Based on research conducted by Zhu, et. al. [10], the use of multimedia as a teaching material can improve student learning competencies, especially in the cognitive domain, instructional thinking, and creative thinking. Another study that discusses multimedia is the research conducted by Zheng et. al. [11], the results of the research obtained indicate that multimedia can improve self-efficacy and problem solving and reduce the burden of students’ cognitive thinking. In addition, among the many skills needed to develop a multimedia, it must contain elements that can improve problem-solving skills and high analytical thinking creativity [12]. From these two studies, it can be concluded that multimedia can be a solution to improve self-regulated learning and problem-solving skills. This article will discuss how multimedia can be an alternative to self-regulated learning and mathematical problem-solving skills.

2. Problem

Problems arise when someone has a goal but does not know how to achieve that goal [13]. In learning, problems are often referred to as problems, but not all problems are a problem. This is because the problem usually lies in between knowledge, attitudes, and skills [14]. Students who can answer a problem using a routine procedure for them so that the problem is not a problem for them. For others, the question requires an organization of knowledge that they do not have routinely and is challenging to solve so that the problem is a problem for them. It can be concluded that what is meant by a problem is a problem that cannot be solved by routine and challenging procedures to be resolved.

2.1. Problem-Solving

Problem-solving is used in looking for one or multiple solutions to a problem. Problem-solving is a higher level of cognitive activity [15] so that it requires complex thinking processes including critical thinking. By having critical thinking skills, a person can also have conducive cognitive and disposition skills so that they can be used to make decisions and problem-solving in different situations [16]. Therefore, critical thinking is needed to provide a solution to the problem by using the right and rational basis.

2.2. Problem-Solving Skill

The ability to solve problems is related to one's skills in critical thinking [17]. The importance of problem-solving skills according to research conducted by Polya is that it can improve student achievement [18-19]. With the ability to solve problems, one can reason, prove, communicate, connect, and represent mathematical abilities. Therefore, having the ability to solve problems is very necessary.

2.3. Problem-Solving Skill Factors

Several previous studies have shown several factors for problem-solving abilities, namely intelligence, learning material, teaching strategies, learning methods, and the socio-economic background of parents [20]. Of these factors, learning method factors and teaching strategies are considered as the key factors that most influence students' problem-solving abilities. This is because the existence of learning methods and appropriate teaching strategies can improve student learning experiences so that students' intelligence can also increase.
2.4. Mathematical Problem-Solving
Problem-solving is not only a method in mathematics but a major part of learning mathematics where students deepen their understanding of mathematical concepts by analyzing and synthesizing their knowledge. To be able to solve problems mathematically, of course, students must be able to think mathematically as well. Some problem solving strategies that can be used in solving mathematical problems are thinking backwards, finding patterns, adopting different points of view, solving simpler, analogous problems (specifications without losing generality), considering extreme cases, making drawings (visual representation), intelligent guessing and testing, calculating all possibilities, managing data, and logical reasoning [21].

3. Self-Regulated Learning
Self-regulated learning is the process by which students have metacognitive, motivational, and proactive behavior towards the learning process [22]. With self-regulated learning, students tend to be able to choose their own ways of learning to be able to achieve certain learning goals [23]. Therefore students have greater responsibility for what has been learned and how students learn. Self-regulated learning can be more effective when students use at least some supporting media. The teacher's function in self-regulated learning can provide material related to the material so that students can explore it more when studying on their own. Students are expected to be able to gain new experiences in exploring the material discussed at school without being dependent on the teacher. The teacher can confirm the results of the student when school learning takes place.

The self-regulated learning is not necessarily only can be done outside of the school. When in the school, the teacher can direct students to try self-regulated learning by presenting learning media such as internet use, multimedia, student worksheets, and other learning media that can be done at school. That way it can be said that self-regulated learning has no limits for students in learning.

3.1. Self-Regulated Learning Factors
Self-regulated learning factors can be the cause of low mathematics learning achievement. Factors that influence the self-regulated learning include knowledge, motivation, and self-discipline [24]. While the factors that influence students to become self-regulated learning are internal factors (genetic or offspring of parents) and external factors (peers, parenting parents, education systems in schools and living systems in society) [25]. Therefore, although students do not have internal factors, the ability in self-regulated learning can be honed through external factors such as by making friends with friends who are diligent in self-regulated learning, parents encourage to do self-regulated learning, schools provide facilities that support self-regulated learning, and the community environment active in enforcing community learning hours.

3.2. Mathematics and Self-Regulated Learning
Mathematics is generally considered a difficult lesson so students show different acceptance of mathematics and show different levels of motivation [26]. Students who find it difficult to accept mathematics learning tend to have no interest in learning material until they have no interest in paying attention to their own teacher. From a mental perspective, students who have low self-confidence tend to behave quietly during lessons and do not have the courage to ask questions during the lesson. To overcome these thoughts and problems, students usually look for other learning outside of school such as self-regulated learning. Self-regulated learning can be in the form of the internet, multimedia, videos, and other learning media that students can learn informally.

4. Multimedia
In Computer-Based Learning and E-Learning, students get information in the form of narration, animation, text, and graphics. Students are involved in a cognitive and creative process that is known for the use of multimedia [27]. Cognitive processes in multimedia learning can describe information where students can choose verbal and visual related material; organize mental, verbal and visual
representations into coherent structures in working memory; and integrating mental, verbal and visual representations with each other with prior knowledge. The students can be more creative too from the way they use audio and visual from the multimedia. Aside from that, multimedia is also very practical to use because it can be used anywhere and anytime such as using a computer, laptop, and smartphone. Multimedia also has other advantages, which can make learning more communicative and interactive [9].

5. Research and Discussion
Table 1 shows the results of tracing articles related to self-regulated learning, problem-solving skills, and multimedia for the past 8 years.

| Author                                              | Year | Nation           | Subject                                                                 |
|-----------------------------------------------------|------|------------------|-------------------------------------------------------------------------|
| Kyparisia Papanikolaou and Maria Boubouka            | 2010 | US & Canada      | College students                                                         |
| Yen-Shou Lai, Hung-Hsu Tsai, and Pao-Ta Yu           | 2011 | Taiwan           | Teachers, sophomore and junior students in a technology college of a university |
| Areti Panaoura                                      | 2012 | Cyprus           | Elementary students                                                     |
| Marc Eckhardt, Detlef Urhahne, Olaf Conrad, and Ute Harms | 2013 | Germany          | Secondary school students                                               |
| J Michael Spector and ChanMin Kim                   | 2014 | Australia        | Students                                                                |
| Alessandro Antonietti, Barbara Colombo, and Chiara Di Nuzzo | 2015 | Italy            | Undergraduate university students                                        |
| Eunbae Lee and Michael J. Hannafin                  | 2016 | USA              | Students                                                                |
| Steven F Raaijmakers, Martine Baars, Lydia Schaap, Fred Paas, Jeroen van Merrie`nboer, and Tamara van Gog | 2017 | Netherlands      | Secondary school students                                               |
| Chiu-Lin Lai, Gwo-Jen Hwang, and Yi-Hsuan Tu        | 2018 | Taiwan           | Elementary students                                                     |

From a number of search articles related to self-regulated learning, problem-solving skills, and multimedia, the analysis was found that by using multimedia, it could be used as an alternative to improve self-regulated learning and mathematical problem-solving skills.

5.1. Self-regulated learning for Mathematical Problem-solving
Mathematics is generally an abstract subject that requires high conceptual skills. The process of abstracting will not be difficult when students can understand the appropriate concept. Skemp [35]
(1971) argues that mathematics learning can provide clear examples of the development of schemes and applications of mathematics to the problems of technology, natural knowledge, and economics is very important for the mental development of the surrounding environment.

One of the studies that have been conducted shows that self-regulated learning has the potential to improve students' problem-solving skills and the meaningfulness of class learning [36]. This certainly can be of concern to educators and observers, especially in the field of mathematics education who care about mathematical abilities. An overview of various relevant aspects so that it can also be a consideration and basis as an effort to improve students' mathematical abilities. If students are able to understand the concept, students can carry out the process of dedication into their thinking so they can think more critically to solve mathematical problems.

### 5.2. Multimedia Learning for Self-regulated learning

For higher learning, self-regulated learning can be done by using multimedia [37]. Multimedia programs are suitable for self-regulated learning by using aspects of multiplatform operating systems, independent use, type of content, type of media, testing system exercise, reuse, development, responsiveness, energy saving, independent concept learning, and layered encryption. Multimedia production can be reused and can be developed easily because it separates the interface and content through an external XML file so that if there is a development of knowledge, multimedia can be changed at any time.

Multimedia does not require system specifications to run it or do not need to install other programs to be able to run it and can also be used on mobile devices other than on computers. In addition, multimedia programs can be run by various operating systems such as Windows, Linux, Mac OS, and Android. Based on the results of research conducted, all students stated that they could use navigation and all content easily so that the devices used can run normally or be user-friendly.

By using multimedia, students can also think creatively. Creativity is the construction of various aspects and is complex, making it difficult to define and examine. Knowledge is an important element of creativity. Students' understanding of general knowledge can help generate creative ideas [38]. Multimedia that contains apperception, video, animation, images, and games can enhance students' creativity while students explore their self-regulated learning experiences.

### 5.3. Multimedia Learning for Mathematical Problem-solving

Multimedia has several advantages including users can operate multimedia learning according to their learning needs so that cognitive abilities will also develop. This affects a person to think critically because of a sense to solve a mathematical problem that wants to be resolved. In addition, multimedia can help students in abstract thinking so that abstract problems can also be solved with the help of multimedia learning.

Using multimedia learning can attract interest as stated by Munir [9], multimedia can develop sensory abilities and attract attention and interest. The problem is a problem that cannot be solved in a routine and challenging way to be resolved. That way, multimedia is the right learning media to solve a problem. The description of students with high intelligence is those who have the ability to understand and solve problems quickly, remember lessons effectively, high creativity and a growing imagination.

The ability to remember, think creatively and imaginatively can be developed through the student learning experience. To get a good learning experience, students must have the chance to execute what they have learned rather than keeping it to themselves. When experience shows a process, students will focus on different ways of learning, such as training. Exercise will make the learning experience more perfect and can be a habit that is difficult to eliminate [39]. Color, text, background, and variations in the presentation in multimedia can also increase creativity. The brain will easily remember and increase creativity if the colors used are bright colors. Thus using exercises and color selection in multimedia, students can imagine a problem so that students can abstract and can think more mathematically and can think more critically in solving mathematical problems they face.
5.4. Multimedia as an Alternative to Improve Self-Regulated Learning and Mathematics Problem-Solving Skills

From the results of the discussion, the use of multimedia as an alternative to improve self-regulated learning and mathematical problem-solving skills can be outlined in the scheme or figure as follows.

![Diagram](image)

**Figure 1.** Multimedia as an Alternative to Improve Self-Regulated Learning and Mathematics Problem-Solving Skills

From the scheme of Figure 1, when students encounter problems and the problem will be solved or resolved, an ability arises to solve mathematical problems. The mathematical problem-solving ability is divided into two, namely through formal learning such as learning in school and student learning abilities. Formal learning of students in school can be a means to solve mathematical problems directly, but there are also some students who still cannot solve mathematical problems entirely because of the interference of the surrounding environment. By using self-regulated learning, students can explore their learning experiences so as to improve their critical thinking skills so that students can solve mathematical problems directly. If students already have sufficient learning experiences, students can immediately solve problems. If students do not have sufficient learning experiences, then multimedia can help students to develop learning experiences and critical thinking skills. Eventually, students can solve mathematical problems through their own abilities independently.

6. Conclusions

Multimedia that is good to improve self-regulated learning and mathematical problem-solving skills should include videos, images, and animations that can make students imagine so that their creative thinking skills will develop. Color, text, background and interesting presentation variations can also increase the ability to remember. In addition, multimedia learning should not present an abstract material but in contrast, multimedia learning should display examples and cases that are not abstract as they relate to everyday life. It is intended that students who will abstract their own examples and cases so that students can think more mathematically again. That way, students can be motivated because of the emergence of challenges and inspiration in reasoning examples and cases given from the help of good multimedia learning.

References

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Acknowledgments
Praise be to Allah SWT for His blessings and mercy so that the writing of this article will be completed. In carrying out the activities of writing this article can’t be separated from the guidance and assistance of various parties both moral, material and spiritual. Therefore, the author would like to thank Mrs. Dr. Djamilah Bondan Widjajanti, M.Si as a lecturer who gave directions in writing this article; Parents who have given moral and material encouragement and support so that this article can be properly compiled; Friends of Yogyakarta State University who have provided input, assistance and support; And all parties who cannot be mentioned individually. Thank you for all the unlimited support.