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Effectiveness of Gamified Instructional Media to Improve Critical and Creative Thinking Skills in Science Class

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ABSTRACT

Gamified Instructional Media has recently been widely used in the education sector to improve students' abilities. Using Gamified Instructional Media at the elementary school level becomes more interesting because it is in accordance with the way children learn K1-K6. The research aims to identify the gamified instructional using Genially to improve students' critical and creative thinking skills. A quasi-experimental method was applied using a nonequivalent control group research design. The research subject is 40 students of Public Primary School in Pekanbaru. The results show a significant effect of the gamified instructional learning using Genially toward students' critical and creative thinking skills. Besides, there is a significant difference in students' critical and creative thinking skills between the control and experimental group. This study implies that gamified instructional media with Genially can support teachers and teaching practices.

1. Introduction

Artificial intelligence contributes to education, particularly to the implementation of educational process, particularly in the teaching and learning scheme in the industrial revolution of the 21st century. It is necessary to conduct an online or blended learning program to respond the health situation we live in [1]. Despite the students appear to miss the face-to-face meetings interaction in a physical classroom setting, they can also adapt well to the sudden changes from offline to online settings [2]. This phenomenon further indicates that most of the current university students are ready to participate in an innovative educational procedure primarily based on blended learning activities. The strength of such educational setting is that the students are able to learn technical skills in their personal environment without any pressure as offered by the online platform, while simultaneously obtaining social resources in a classroom environment [3]. There were various 21st-century skills that students can improve through online platform, including critical and creative thinking skills [4, 5].

According to [6,7], critical thinking requires three components: (1) a disposition to thoughtfully analyze the issues and subjects experienced by someone, (2) knowledge concerning logical exploration and argumentation procedures, and (3) certain competence in using those approaches. Paul and Binker (1990) state that critical thinking skill is the ability and disposition to critically evaluate a belief, what assumptions are based on it and on what basis these assumptions can survive [8]. In [9, 10], the author stated that critical thinking skill is defined as the ability to make decisions by considering the facts available, the situation's context, and the concept raised. In [11], the authors then added that critical thinking is a form of a rational reflective thinking process that focuses on determining what to believe or what to do. Students are expected to have the ability to think critically if they are able to ask something and find information appropriately. Based on the analysis of the information and knowledge they have, students try to answer problems logically and creatively with conclusions that are acceptable to common sense [12].

Creative thinking skill is the ability of students to identify, solve or find solutions, and solve various problems by looking for alternative problem solving based on their own abilities and thoughts [13–15]. The ability to think creatively can be measured

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by several indicators including (1) fluency which means the capacity of sharing ideas, (2) flexibility which means the skill to suggest several problem solutions, (3) originality which is the capability to develop new ideas as a result of their own thought process, and (4) elaboration which is the capability to describe something in detail [16].

In practice, there are some factors causing students' low critical and creative thinking skills one of which is teacher-centered learning approach that the teacher function in the classroom is more like a lecturer presenting instructional materials and the students are expected to passively receive the knowledge being presented. Science teachers should applied student-centered learning approach in which students are allowed to hone and use their critical and creative thinking skills [17]-[20]. In the industrial revolution of the 21st century, direct learning model increasingly makes students not accustomed to think critically and creatively. Therefore, by using digital technology teachers can present science instructional materials which can allow the students to have a better critical thinking skill [21].

In the Industrial revolution of the 21st century, teachers usually use technology in presenting the instructional materials. The role of technology in education is very significant [16]. Almost all learning processes in elementary schools today involve technology such as using applications as instructional media. This is commonly known as blended learning, and the use of technology aims to support in achieving learning objectives and in creating a different learning experience for students.

Gamification is the use of game in a non-game environment to increase students' learning motivation [22]. Gamification increases students' participation in the learning process [23]. Children generally enjoy playing games and such phenomenon may be applied in learning context, prompting the development of a new teaching technique: gamification [24–27]. There are several applications that can be implemented to innovate interactive learning media one of which is Genially.

Genially is a learning media creation platform that has been widely used in education. vidergor [28] uses genially to design a digital escape room to increase elementary school students' collaboration and motivation. Genially has the advantage of being easy to use and accessible [29, 30]. The features in Genially are suitable for beginner developers, so teachers at schools can design learning media using Genially according to their needs [31]. Genially can also increase engagement in learning and allow students to may share their knowledge and improve their communication abilities [32].

The study conducted by [24] found that a game increased the knowledge of Serbian fifth graders in recognizing plants. In education, Gamification may help students improve their computational thinking skills and motivate them to develop their learning capacities on their own by assisting them in increasing their insight, processing the information, communication, and community awareness skills [33]. During the learning process, students get innovation and new insight. In other words, students get a new atmosphere in the learning process. Therefore, students easily understand the learning materials [34]. Science learning involves students directly in acquiring knowledge as a result of student curiosity. The effectiveness of gamification is different from each student. Gamification must be studied and implemented with care, by paying attention to several factors such as including individual learning styles and personality characteristics [35]. Summary of the findings reported Gamified learning experiences developed using the software package Genially were shown to enhance the students' critical thinking competence.

Through information technology, blended learning is able to enhance students' critical thinking skills [36]. In this case, the teachers conduct the learning process by employing learning media in the forms of technology [37]. In particular, gamification can improve the performance of academic skills [38]. Academic skills can be developed through oral discussion, critical thinking, vocabulary development, oral interpretation, creative acting, observation and recording, information research, graphs and graph interpretation, and summaries. In a classroom setting, a physical and intellectual setting provided has the ability to supports the development critical thinking through a spirit of discovery [39]. Critical and creative thinking skill are two skills that must be included in school curriculum in the 21st century.

Gamification such as digital escape room was implemented as a teaching approach, particularly in science classes for the fourth-graders students of primary school. This approach has been proven to affect students effectively, so that they become more motivated and able to solve problems they face [40]. In addition, both critical and creative thinking skills significantly affected the cognitive learning outcomes [41]. Compared from urban environments, higher levels of realism were believed to boost the restorative effects of viewing natural environments and promote creative thinking [42].

The learning objective of learning science in primary schools is to develop students' process skills in investigating nature, solving problems and making decisions, and applying the learning experiences gained in the previous learning process that has been done [43]. Science learning at the fifth-grade primary school level includes several materials that are human and animal organs, green plants, adaptation of living things and their environment, the building blocks of objects and their properties, changes in the properties of objects, forces, simple machines, light, earth, and the universe. The instructional materials of heat transfer are learnt in the sub unit of changes in the properties of objects. The instructional materials are basic materials at the primary school level so that the instructional materials must be presented as attractively as possible [44]. The presentation of the heat transfer materials should be done in an interesting way. For example, it can be done by using Genially.

Gamification is expected to make students able to remember science concepts and be able to apply learning in everyday life [38]. According to [45], Improvements in critical thinking abilities can be identified both from novel biological and non-biological daily issues, indicating that thinking skills can be implemented in various aspects. Furthermore, knowledge test, the experimental students outperformed the control group, implying that "knowledge of facts" and "learning to think" both as educational purposes should be able to interact with each other.

In science learning, teachers can design learning that can improve the critical and creative thinking abilities of the students by using gamified instructional media using Genially since it has many features that support interactive learning. Therefore, by using gamified instructional media with Genially to teach science, it is expected to improve students' critical and creative thinking skills.

In accordance with the background above, this study aimed to used Genially to create interactive science learning media in elementary schools. The researchers make an educational video game that helps students in learning science and in improving their critical thinking. The research question underpinning this study is: Can gamified instructional using Genially improv students' critical and creative thinking skills?

2. Methodology

This study investigated the effectiveness of gamified instructional media with Genially to improve fifth-grade primary school students' critical and creative thinking skills in science class. The researchers applied a quasi-experimental nonequivalent control group research design to conduct this study. The researchers taught the experimental class by using gamified instructional media with Genially while the control class had conventional learning. The sample comprised 40 students of Public Primary School in Pekanbaru, 20 students in the experimental class and 20 students in the control class. This study was conducted from March to April 2021. To collect the data, the researchers used an instrument consisted of 7 short-answered questions to assess the students' critical thinking and 4 short-answered questions to assess their creative thinking skills.

The researchers conducted a pretest and posttest before and after the treatment by using the instrument. The validity and reliability of the instrument had been tested before it was used. After assessing the students' critical thinking and creative thinking skills, the data collected was analyzed. The link to the gamified instructional media is; https://view.genially/605214085ec620fd0b41406/interactive-content-hasil-final.

The data obtained were analyzed by using SPSS, a computer program used for statistical analysis, to know the effectiveness of gamified instructional media with Genially to improve critical and creative thinking skills of the students in fifth grade of primary school in science class on the topic of heat. This research was conducted from March to April 2021 in the fifth grade of Public Primary School in Pekanbaru. Among these populations, samples were selected based on those who have obtained legality based on the certificate of doing research no: 422/SDN192PKU/2021/277.

3. Results and Discussion

The results and discussion sections are divided into several sections, analyze of critical thinking skills, analyze of creative thinking skills and the correlation between creative thinking skill and critical thinking skill to get more in-depth data. In the end the study results are discussed to analyze the effects of Gamified Instructional Media more deeply.

3.1. Analysis of Critical Thinking Skills

Pretest

After the researchers had conducted normality and homogeneity test, the researchers conducted an independent sample t-test. Table 1 below presents the results of the independent sample t-test.

Table 1: The output table of the independent sample t-test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Critical Thinking Skills	Equal variances assumed	8.758	.005	-.871	38	.389	-.300	.345	-.997	.397
	Equal variances not assumed			-.871	27.428	.391	-.300	.345	-1.006	.406

Table 2: The output table of the independent sample t-test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Critical Thinking Skills	Equal variances assumed	1.055	.311	4.887	38	.000	3.450	.706	2.021	4.879
	Equal variances not assumed			4.887	36.929	.000	3.450	.706	2.020	4.880

Levene's Test for Impartiality of Discrepancies had an implication rate of 0.005 0.05. Because the value indicated that the two variances were not the same, the interpretation of the above output table was based on the values in the equal variances not assumed column. In the equal variances assumed column, the Sig. (2-tailed) value was 0.391> 0.05. There was no substantial difference in critical thinking skills among students in the experimental and control groups, according to the results (pretest). In other words, before treatment, the critical thinking skills of students in the experimental and control classes were the same.

Posttest

After the researchers had conducted normality and homogeneity test, the researchers conducted an independent sample t-test. Table 2 below offers the outcomes of the independent sample t-test.

The consequence rate of Levene's Test for Equivalence of Discrepancies was 1.055 > 0.05. The value indicated that the two variances were identical, so the interpretation of the output table above is based on the values in the identical variances assumed column. The Sig. (2-tailed) value in the equal variances assumed column was 0.000 < 0.05. It indicated a significant difference in critical thinking skills between students in experimental and control classes (posttest). In other words, the critical thinking skills between students in experimental and control class before treatment was dissimilar.

This study proved that the gamified instructional media with Genially media can progress students' critical thinking skills. This benefit arises from agreeing on the separate mastery of procedural skills in the secluded and stress-free situation provided by the operational stage and admission to social properties in the classroom situation. Instruction and education consuming online platform have carried confident influences specifically in emerging the 21st-century assistances. Critical thinking skills are one of the 21st-century skills that must be included in the world of education. However, the main challenge is how to teach thinking or critical thinking and how to stimulate students to reflect on their own thinking ways. [46].

3.2. Analysis of Creative Thinking Skills

Posttest

After the researchers had conducted normality and homogeneity test, the researchers conducted independent sample t-test. Table 3 below presents the results of the independent sample t-test.

The significance value of Levene's Test for Equality of Variances was 0.005 0.05. The value indicated that the two variances were not the same, so the interpretation of the output table above was based on the values in the equal variances not assumed column. The Sig. (2-tailed) value in the equal variances assumed column was 0.391> 0.05. It revealed that there was no significant difference in critical thinking skills between students in the experimental and control groups (pretest). In other words, before treatment, the critical thinking abilities of students in the experimental and control classes were the same.

According to [47], games can be used as a supplement to traditional teaching methods to improve learners' learning experiences while also teaching other skills such as following rules, adaptation, problem solving, interaction, critical thinking skills, creativity, teamwork, and good sportsmanship. Furthermore in [48], contend that digital games can assist students in developing higher-order thinking skills and 21st-century skills, as well as making learning more enjoyable and engaging.

3.3. Analysis of the correlation between students' critical and creative thinking skills Experiment class

To know if there was a correlation between students' critical and creative thinking skills, the researchers conducted a (Pearson) bivariate correlation. Table 4 below is the output table of the (Pearson) bivariate correlation.

Table 3: The output table of the independent sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Creative Thinking Skills	Equal variances assumed	4.672	.037	2.148	38	.038	1.550	.722	.089	3.011
	Equal variances not assumed			2.148	27.782	.041	1.550	.722	.071	3.029

Table 4: the output table of the (Pearson) bivariate correlation

		Critical thinking skills	Creative thinking skills
Critical thinking skills	Pearson Correlation	1	.588**
	Sig. (2-tailed)		.006
	N	20	20
Creative thinking skills	Pearson Correlation	.588**	1
	Sig. (2-tailed)	.006	
	N	20	20

**. Correlation is significant at the 0.05 level (2-tailed).

Table 5: The output table of the (Pearson) bivariate correlation

Correlations			
		Critical thinking skills	Creative thinking skills
Critical thinking skills	Pearson Correlation	1	.425
	Sig. (2-tailed)		.062
	N	20	20
Creative thinking skills	Pearson Correlation	.425	1
	Sig. (2-tailed)	.062	
	N	20	20

**. Correlation is significant at the 0.05 level (2-tailed).

Based on the output table, the correlation coefficient was 0.588, and the Sig. (2-tailed) value was 0.006 < 0.05. Therefore, there was a positive correlation between students' critical thinking skills and creative thinking skills, and the correlation was at a moderate level.

Control class

To know if there was a correlation between students' critical and creative thinking skills, the researchers conducted a (Pearson) bivariate correlation. Table 5 below is the output table of the (Pearson) bivariate correlation.

The correlation coefficient was 0.425, and the Sig. (2-tailed) value was 0.062 > 0.05, according to the output table. As a result, there was no positive correlation between students' critical and creative thinking skills, and the correlation was moderate.

This study demonstrated that students in the experimental class demonstrated a positive correlation between critical thinking skills and creative thinking skills, whereas students in the control group demonstrated no positive correlation between critical thinking skills and creative thinking skills.

This finding is supported by [41] claim that there is a significant correlation between critical thinking skills and creative thinking skills on cognitive learning outcomes. The restorative properties of nature are most visible for creativity when viewing stimuli indoors; however, being outdoors in general may be enough to stimulate creativity, regardless of whether it is surrounded by nature or a busy urban environment [42, 49]. The application of Digital Escape Room with Science Teaching in Primary School has Problem Solving Ability. Especially in science subjects [50].

Figure 1: Interesting animation

There is a significant effect because gamification of instructional media makes the learning fun and interesting (see figure 1) and helps students develop higher-order thinking skills [48]. Moreover, [44] and [51] state that presenting instructional materials by using interactive instructional media provides convenience to students. In addition, the animations displayed and interactive simulations that must be done by students through discussion sheets can train students' logical thinking in physics problems solving related to the concepts of temperature and heat. That evidence proves that there is a significant role of using gamified instructional media with Genially to teach science on the topic of heat transfer.

Based on the test results above, the results of this study have the same results with the study proposed by [44] showing on the topic of temperature and heat, interactive instructional media affects the students' conceptual understanding and critical thinking skills. Gamified instructional media can help students improve their computational thinking competence and motivate them to develop their learning capacities on their own by assisting them in expanding their insight, processing information they have, communication, and community awareness skills [33].

Figure 2: interesting games in the learning media

Learning media on heat transfer material with genius has an interesting game. In addition, another previous research project also claimed that games can also be implemented teach other skills including critical thinking, problem solving, sportsmanship, interaction and peers-collaboration [47]. Moreover, great potential is provided by games for training because they affect the learning process of users significantly [52]. Hikmah and Ngazizah (2020) state that creative thinking skills are part of higher order thinking

skills. Therefore, gamified instructional media with Genially can improve students' creative thinking skills which belongs to higher order thinking skills.

The existence of technology and various innovations helps overcome learning problems, especially at the primary school level [40]. That indicates that gamified instructional media helps students to identify and solve problems. Instructional media is one of the most important things that support learning. Gamified instructional media is physical means in delivering instructional materials from teachers to students in a more sophisticated and efficient way [53], [54]. Therefore, gamified instructional media is necessary to be considered carefully as it has long-term effects on education [55].

In conclusion, gamified instructional media using Genially in science class, particularly on heat transfer topic improve students' critical and creative thinking skills in terms of the ability to generate ideas, the ability to propose various solutions to problems, and the ability to create different ideas.

4. Conclusions and Suggestions

This study discusses in depth the effects of Gamified Instructional Media on critical thinking and creative thinking skills, then analyse of correlation between critical thinking and creative thinking skills. The results of the study prove that Gamified Instructional Media has an influence on the critical thinking and elementary school students' creative thinking skills. While the education is focusing on improving high order thinking skills, this study adds new literature on Gamified Instructional Media at the elementary school level which can convince teachers that using Gamified Instructional Media is to increase HOTS at the elementary school level effectively.

Based on the results, the researchers suggest that teachers have to improve their technology literacy so that they can involve technology in their teaching. With technology, teachers can develop many forms of instructional media. The researchers also suggest facilitating teachers to develop instructional media with technology to others stakeholders in education.

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