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Articulate Storyline 3 multimedia based on gamification to improve critical thinking skills and self-regulated learning

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ABSTRACT

This study measured the effectiveness of Gamification-based Articulate Storyline 3 multimedia on students' critical thinking skills and self-regulated learning. The research method used is a quasi-experimental method. The research subjects were 64 students and eight science teachers who have used the Gamification-based Articulate Storyline 3 multimedia on the nature of acidic, alkaline, and neutral solutions. Data collection techniques in this study were tests that aim to determine students' critical thinking skills and a questionnaire to measure students' learning independence. The data analysis technique was based on calculating the average score of the test items with high-order thinking skills and student learning independence. The study results obtained an average score of 81.50 for critical thinking skills on the material concept of the nature of the acid, base, and neutral solutions with an N-Gain of 72% in the high category. It was also known that the average percentage of student learning independence was 86.76% which falls into the good category. Therefore, Gamification-based Articulate Storyline 3 multimedia can improve students' critical thinking skills and independent learning on the nature of the acid, base, and neutral solutions.

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1. INTRODUCTION

Historical changes in human life have occurred with the outbreak of the COVID-19 pandemic, which has affected social interaction in the home and work, including in the school environment [1], [2]. This has had a significant impact on social, economic, health and education aspects, especially those related to the teaching and learning process [3]–[5]. Currently, teachers must be able to develop students' socio-emotional competencies, stress management techniques, create a pleasant learning atmosphere, done problem-solving skills through mastery of various online learning methods [6]–[11]. The use of technology in developing teaching materials such as multimedia and other digital platforms can help realize effective and efficient online learning. Science learning related to concrete and abstract concepts can take advantage of the technology of developing these teaching materials to produce 21st-century golden generation students who can think scientifically and critically to be ready to face global challenges.

Science learning in the 2013 Curriculum must develop scientific thinking to produce competent students with a culture of critical thinking with nuances of technology, environment, and society. Students are expected to learn concepts about the universe using 21st-century skills, namely Communication; Collaboration; Critical thinking and problem solving; Creative and innovative (4Cs). An increase in critical thinking skills will positively correlate with students' creative thinking skills and communication skills [6].

However, there is still a gap between the need for teaching materials according to 4Cs skills and existing teaching materials was obtained based on the analysis of the results obtained through online questionnaires to 40 science teachers as respondents. All respondents (100%) use WhatsApp as an online learning medium even though they realize that using this media is very difficult to implement 4Cs-oriented learning.

The use of multimedia can encourage mastery of 21st-century skills [12]. Online learning that uses multimedia can make it easier for students to access information via the internet and gain various learning experiences by providing interesting learning software. For example, authoring tools such as Articulate Storyline 3 can provide a variety of exercise menus according to the time and skills of students and help students get visualizations of abstract objects such as the properties of acid-base and neutral solutions. This software is suitable for use as a learning medium that can compete with adobe flash media [13]. Articulate Storyline 3 also has various advantages, such as ease of use, and the resulting output can be published in multiple formats, including HTML5, to produce attractive tutorial presentations.

The publication of the results of Articulate Storyline 3 is in the form of web-based media. It can also be run on various devices such as software on tablets, laptops, and applications on smartphones [14], [15]. The criteria as a guide in assessing the use of instructional media technology include quality of content and objectives (related to elements of accuracy and suitability to student conditions), instructional quality (increased motivation, the nature of instructional flexibility associated with other learning programs), instructional social quality, test quality and assessment evaluation that can have a positive impact on respondents, and technical quality (aspects of readability, ease of use, and quality of design) [16].

The use of technology such as Articulate Storyline 3 multimedia is easy to use because it is easy to share with students via the Google Drive link or an application that can be downloaded independently with the teacher acting as a facilitator. Self-regulated learning can be identified through an increased ability to solve problems and assignments independently by monitoring by the teacher as a facilitator [17], [18]. The characteristics of self-regulated learning can be seen when individuals can design their learning according to the needs or goals of the individual concerned, have a strategy and carry out their learning plans, also monitor their learning progress, evaluate their learning outcomes and then compare them to specific standards [19], [20]. Independent learning can be trained through a planned learning process on science material given through a fun game approach so that students are motivated to be involved continuously without realizing it.

Following current conditions, namely through online learning modes, learning will be presented differently according to student needs, using multimedia without reducing its purpose [21], [22]. Based on the survey results, the teacher wanted multimedia that accommodated the needs of practicum simulations virtually by providing variations such as quizzes, guessing pictures, guessing words, and crossword puzzles. The science material in grade VII can represent both content and context through the game creation. Interactive multimedia is needed to present science learning materials that require visualization of the object of study, for example, the material properties of acid, base, and neutral solutions. This material involves visualization to identify differences in the properties of solutions and apply them to everyday life by using critical thinking skills. The approach of the game to learning (gamification) can be used according to the learning objectives. This situation should be a challenge for teachers to create innovative learning media by incorporating game elements that students like, such as gamification.

Gamification is a concept that uses game elements in non-game situations. The goal is to motivate someone to do something in a fun way. Techniques commonly used in gamification are differences in game levels, scores, the player character, and competition. These techniques can develop students' thinking skills taught by teachers who do not have mastery of computer language programming, such as coding. Research on gamification has been carried out, such as the effectiveness of gamification in increasing student creativity [23], increasing learning motivation [24], [25], deepening concept mastery [26], [27], behavior change and collaboration between students [28]–[30], and students' critical thinking skills [31], [32]. Gamification research related to student learning independence is by researchers associated with the concept of self-regulated learning [33]–[35] and self-efficacy [36], [37]. While the Gamification research, which focuses on thinking skills and student independence, is still very little, as was done [38], [39]. For this reason, it is crucial to research to determine the effectiveness of Gamification-based multimedia in improving students' critical thinking skills and independence during the implementation of online learning.

The purpose of this study was to measure the level of students' critical thinking skills and self-regulated learning after using the Articulate Storyline 3 based on Gamification on the properties of acid, base, and neutral solutions. The criterion for critical thinking skills in this study was that students could complete 10 multiple-choice questions that met high order thinking skill (HOTS). Meanwhile, students' self-regulated learning can be seen from the students' skills to self-monitor and self-evaluate learning through multimedia teaching materials. The Articulate Storyline 3 multimedia based on Gamification as an innovation in developing online teaching materials can be accessed via laptop/computer or downloaded as an application on an Android smartphone device.

2. RESEARCH METHOD

This research was conducted on junior high school students accustomed to playing games via laptop and android devices. This study used a quasi-experimental research method or quasi-experimental [40]. An experimental group gets treatment and a control group that cannot be fully controlled from outside variables. The research design used the non-equivalent control group design with the pretest-posttest control group design technique [41], which consisted of two classes (the experimental and control classes). The population in the target in the study was 306 students of grade VII, while the sample of this study was 68 students from two different classes. The sampling technique is based on the purposive sampling method.

The researcher chose two groups randomly, and then they were given a pretest question. This aimed to determine the difference between the experimental group and the control group in the initial conditions. The pretest results will be declared good if there is no significant difference between the experimental and control groups. The test used is in the form of 10 HOTS-oriented multiple-choice tests, which have cognitive levels of application (C3) and analysis (C4). Before being tested on students, these questions had been tested for validity and reliability.

The research stage was continued with giving treatment to the experimental group through Articulate Storyline 3 multimedia, while conventional learning using WhatsApp was applied as usual to the control group. Posttests to the experimental group and the control group are given at the final stage to prove the influence of the learning media used on 'students' critical thinking skills and learning independence. The research design is described in Table 1.

Table 1. Research design

Group	Pretest	Treatment	Post-test
Experimental	O1	X	O2
Control	O3	C	O4

In the experimental group, the tests were carried out before treatment (O1) and after treatment (O2) with X as a gamification-based multimedia treatment. The control group also gave tests before conventional learning (O3) and after conventional learning (O4). In the control group, conventional learning took place without special treatment (C).

Quantitative data were obtained through the provision of multiple-choice critical thinking skills tests and questionnaires to measure student responses to the use of multimedia and student learning independence. This study used an instrument of critical thinking skills, consisting of 10 questions covering six indicators of critical thinking skills, referring to certain model [41] known as Focus, Reason, Inference, Situation, Clarity, and Overview (FRISCO). The data is then processed by giving a scale value of 0 for wrong answers and 1 for correct answers. The grid of multiple-choice questions for critical thinking skills can be seen in Table 2.

Table 2. Critical thinking skill indicators

Critical thinking indicators	Sub-indicator questions
Focus	Presented pictures, students can determine the concepts used to solve the problem
Reason	Given various examples of cases, students can provide reasons for the answers put forward
Inference	Presented a problem; students can make conclusions from the information available
Situation	Given a case or table, students can answer following the context of the problem and can answer application questions.
Clarity	Given a table, students can provide further clarity on both the definition and the relationship of concepts.
Overview	Presented a case or table, students can check what has been found, considered, and concluded.

Data were collected twice at the pretest and posttest. The data that has gone through the N-gain calculation process is then interpreted into several categories, then analyzed as a complete unit for each indicator. The N-Gain results were analyzed by categorizing the data [42]. The categories obtained show a general description of the improvement in critical thinking skills [43] after the treatment of Articulate Storyline 3 multimedia based on Gamification.

Data collection of student learning independence response was obtained by providing a questionnaire of 15 items, which were adapted from previous study [19] accompanied by five points of assessment of the use of Articulate Storyline 3 multimedia. Likert scale was applied with four alternative answers: a score of 4 states strongly disagree, a score of 3 states disagree, a score of 2 states agree, and a score of 1 states strongly agree. Indicators of student learning independence are related to students' skills to complete assignments on

time. Before being used for research, critical thinking skills and independent learning instruments have been tested for validity and reliability. The instrument validity and reliability test results have shown that all items are declared valid with a reliability coefficient of 0.833. This indicates that the value Cronbach's Alpha > 0.60 is considered reliable or consistent, so this research instrument is valid [44].

Furthermore, the normality test stage was carried out on the results pretest and posttest to determine whether the data distribution was normal or not with the Kolmogorov Smirnov test on SPSS version 26.0. The decision that the data is considered normally distributed at a value of $\alpha = 0.05$ will be taken if it matches the provisions of the Asymp. Sig (2-tailed) > 0.05 . If the value is normally distributed, it will be followed by an independent sample t-test to prove whether there is a significant difference between the pretest and posttest results through SPSS version 26. Then a decision can be made based on the results of the Sig value. (2-tailed) $p < 0.05$, which stated that there was a significant difference between the two. Conversely, if the Sig. (2-tailed) $p > 0.05$, so there is no significant difference in the data. If the data has been declared normally distributed, then the N-Gain test can then be performed. The effectiveness of Articulate Storyline 3 multimedia can be seen through the increase in the pretest and posttest scores (N-Gain value). Articulate Storyline 3 multimedia based on Gamification will be declared effective if the N Gain value ≥ 0.3 is obtained, which is included in the medium or high category [42]. Furthermore, the learning independence data is also categorized through descriptive analysis by calculating the mean [45].

3. RESULTS AND DISCUSSION

The development of Gamification-based Articulate Storyline 3 multimedia on the nature of the acid, base, and neutral solutions have gone through a validation process by experts and teachers with the results obtained. The highest score was in the software engineering aspect (93.75%), followed by the audio and visual communication aspect (91.67%) and the material presentation aspect (90%). This multimedia is given to the validator as an application that can be downloaded via Android or laptop. Figure 1 shows the appearance of the introduction to the media on the Android device of the student's research target. In contrast, the learning evaluation process in the form of the Word Wall educational game is shown in Figure 2. In general, validators from experts and teachers have deemed this multimedia feasible as alternative learning media during the COVID-19 pandemic.

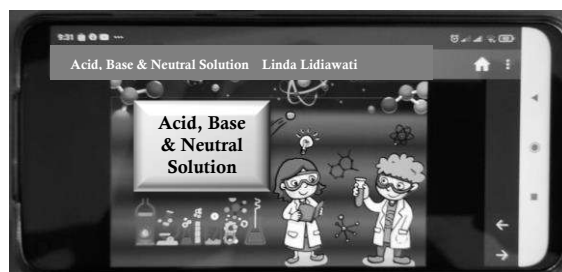


Figure 1. Opening multimedia based on gamification



Figure 2. Word wall educational game integrated with Articulate Storyline 3 multimedia

The consideration of using the Word Wall game in multimedia is because the visual characteristics of the game are following the age of the user, namely junior high school students. Several previous studies have also proven that this game can be used for online learning related to introducing new terms or vocabulary in the language field [46], encouraging student learning independence [47]. Table 3 contains multimedia specifications for Gamification-based Articulate Storyline 3 compared to printed teaching media.

Table 3. Comparison of gamification-based Articulate Storyline 3 multimedia specifications and printed teaching media

Aspect	Articulate Storyline 3 multimedia	Print teaching materials
Appearance	Attractive and interactive	Less attractive and not interactive
Cost efficiency	Can be published online or offline in the form of CD, word processing, web, or LMS	Book
Flexibility	Easy to use to study anywhere and anytime	It tends to be heavy and impractical when brought
Feedback	Can provide learning motivation to students in the form of direct feedback	Feedback is only in writing. No interaction occurs
Learning orientation	Encourages student independence to complete their assignments without help from others	Students need a teacher as a facilitator to explain the contents of the book
Time duration	Can be adjusted to student learning speed	There is no time duration
Ease of use	Easy to use on smartphones or laptops for online learning	Difficult when learning online
Audio visual	Very interesting and suitable for students with visual and auditory learning needs	Less attractive and less suitable for students with visual and auditory
Learning	Constructivist. Students build knowledge through games, videos, and simulations	Students only get factual information
Learning evaluation	It can be done independently through a game approach, and the results are immediately known	Done independently, but students cannot know the results directly
Learning motivation	Encourage learning motivation by giving points or rewards	Cannot encourage learning motivation directly

Based on the research results on 22 male students and 46 female students in the experimental and control classes, there were differences in the pretest and posttest results in the two groups of respondents. Table 4 shows that in the experimental class, the minimum score at the pretest was 20, and the posttest was 60. While the maximum score at the pretest was 60 and at the posttest was 100. The mean score at the posttest was 84.41, much higher than the pretest of 41.47, with an N-Gain value of 0.76 (high category). Different things were shown in the control class where the minimum and maximum scores at the pretest were almost the same as the values in the experimental class, namely 20 and 70. However, the posttest results only produced a minimum score of 40 and a maximum of 100, accompanied by an N-Gain value of 0.50 (medium category).

Table 4. N-Gain descriptive statistic value

	Experimental class			Control class		
	Pretest	Posttest	N-Gain	Pretest	Posttest	N-Gain
Minimum	20	60	-	20	40	-
Maximum	70	100	-	70	100	-
Mean	41.47	84.41	0.76	42.35	70.29	0.50

The difference in N-Gain values in the experimental and control classes must then go through the Kolmogorov-Smirnov normality test. In the experimental group and the control group, the normality test value reached Sig. 0.200 > 0.05, which means that the research data is normally distributed. An independent t-test was carried out to determine to what extent this Gamification-based multimedia treatment has significant effectiveness, as shown in Table 5.

Table 5. The results of the independent t-test on n-gain

	f	sig	t	df	sig. (2-tailed)
Equal variances assumed	0.630	0.430	-2.837	66	0.006
Equal variances assumed			-2.837	64.629	0.006

In Table 5, it is known that the significance value (Sig) on the Levene test for equality of variances is $0.430 > 0.05$. It can be concluded that the variance of the N-Gain data (%) for the experimental class and control class is the same or homogeneous. The Sig value (2-tailed) of $0.006 < 0.05$ means that there is a significant difference in effectiveness between treatments using gamification-based multimedia towards conventional classes (control).

Furthermore, based on the analysis results of HOTS-oriented multiple-choice questions during posttest in the control and experimental groups, there are different achievements in average on each of the FRISCO critical thinking indicators [48] as shown in Figure 3. The figure reveals that the achievement of critical thinking skills in the experimental group shows a more significant average in all aspects of the indicators. They included the highest indicators is the Reason (85.29%), Situation (83.82%), Inference (82.35%), Focus (76.47%), Overview (75.00%) and the lowest in the Clarity indicator (73.53%). Whereas for the control group, the highest indicators were achieved by Reason (79.41%), Situation (76.47%), Clarity (65%), Inference (64.71%), Overview (63.24%) and Focus (61.76%) is the lowest critical thinking indicator.

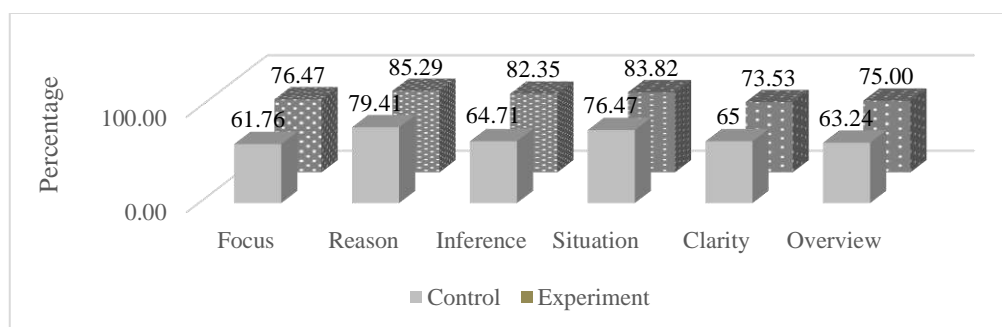


Figure 3. Comparison of the achievement of critical thinking indicators between the control and experimental groups

The most significant improvement in students' critical thinking skills was achieved in the Reason indicator, which relates to case examples in the context of everyday problems. Situation indicators rank the second largest, where students can answer questions about the material application, both in pictures and tables. Students in the experimental group became better able to solve problems because, in the Gamification-based Articulate Storyline 3, multimedia simulation of virtual experiments through a constructivism approach was provided. Students are asked to choose the right tools and materials through educational games before finally experimenting with artificial and natural indicators virtually. Questions given through educational games according to HOTS criteria can stimulate students' critical thinking skills. The findings are reinforced by the results of research using virtual simulations and educational games, which are proven to be able to improve students' critical thinking skills, especially in the ability to apply concepts in everyday life [49]–[51]. Students' skills in applying contextual concept applications honed through Articulate Storyline 3 multimedia determine students' quality of life in the future.

Based on the results of the analysis of the responses of 10 teachers and 68 students regarding the use of Gamification-based multimedia, it is known that this media can increase self-regulated learning (86.76%) or be in a good category. In addition, multimedia is considered to make an essential contribution as an alternative to online learning solutions that are deemed boring as presented in Figure 4. The highest percentage of student responses to the use of Gamification-based Articulate Storyline 3 multimedia is the increased enthusiasm for learning (87.50%) through the use of instructional media with attractive designs (87.01%), containing contextual material (86.76%) and easy to understand (84.19%) to improve student learning independence (86.76%). In addition, learning that uses the gamification approach enhance critical thinking skills (85.66%) and mastery of the material concepts of the properties of acid, base, and neutral solutions (85.29%). As for the media aspect, students think that multimedia is a learning medium with the proper selection of videos, experimental simulations, and educational games (84.19%), equipped with fun music (83.46%). The student response in the experimental group to Articulate Storyline 3 multimedia was very good overall.

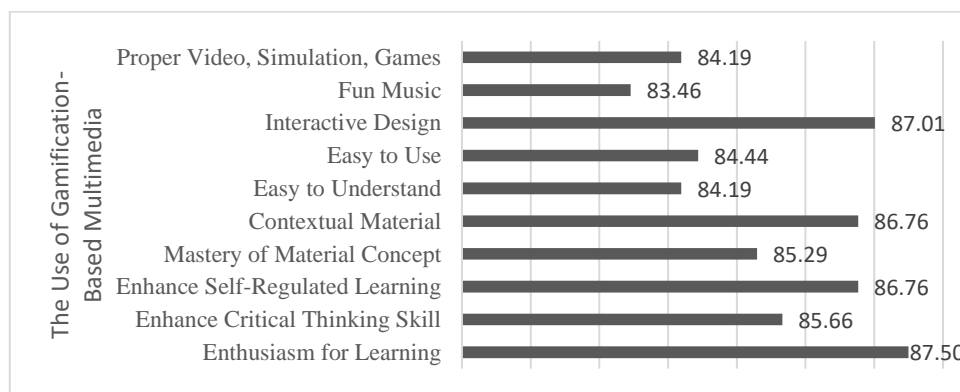


Figure 4. Students' response to the use of gamification-based multimedia

Student responses to the audio and visual aspects of the multimedia state that the design is very attractive (87.6%), providing a pleasant, positive effect to encourage students to be actively involved independently. This is following previous research, which states that visualization of interesting animation and games in multimedia can improve 'students' mastery of concepts independently [52], learning motivation [27], [53] and 'students' self-regulated learning [54], [55]. The addition of video content, simulations, and games has been proven to provide opportunities for students to conduct science experiments independently, even though they are not in the classroom [49], [56]–[58]. Fun online learning by including game elements can stimulate students to learn independently, which reduces special instructions from the teacher during learning.

The results of the analysis of student responses in the experimental class show that the use of Articulate Storyline 3 multimedia has the characteristics of being easy to use (84.4%) so that the role of the teacher can be minimized. Providing links via laptops and Android applications allows students to learn independently, with their respective learning times and speeds [59]–[61]. One of the aspects of self-regulated learning, namely the implementation of independent learning evaluation through quizzes or games, can have positive implications for the emotional condition of students [62] and their mental health [63]. In addition to doing this online, doing the quizzes can also be accessed offline to save students' quotas. The use of gamification-based multimedia plays a major role in reducing student stress levels when they have to undergo online learning situations without the help of teachers.

The role of the teacher in learning using the gamification approach is to design a learning activity by incorporating game elements such as badges, scores, rewards, and feedback through multimedia technology. The experimental group students showed high enthusiasm for participating in learning (87.50%) through badges, scores, and rewards that encourage a competitive spirit; it is a crucial factor in gamification-based learning, as suggested by previous researchers [63], [64]. As for the feedback in multimedia gamification, some are positive to encourage and motivate the strengths of students [65], [66] and negative feedback, which is more aimed at improving student weaknesses [67]. Gamification-based learning using Articulate Storyline 3 multimedia shows student involvement at a fairly high level, accompanied by an increase in critical thinking and self-regulated learning as components of 21st-century skills. The characteristics of 21st-century learning should pay attention to students' emotional intelligence and mental health aspects and mastery of 4Cs skills, which can be achieved through the implementation of Gamification-based learning.

4. CONCLUSION

Gamification-based Articulate Storyline 3 multimedia is an effective way to improve and deepen knowledge virtually, through constructivist and fun learning. It does not rule out the learning objectives (the mastery of 21st-century skills, including students' critical thinking skills, learning by incorporating elements of games, videos, and practicum simulations that can be accessed via laptops or android smartphones, proven to improve students' self-regulated learning). Mastery of 21st-century skills can be achieved through learning that considers students' emotional and mental health needs, namely by incorporating game elements. This study suggested gamification-based learning using user-friendly multimedia of Articulate Storyline 3 to be a solution in facilitating students to learn both online and offline according to learning needs in the new normal era after the COVID-19 pandemic.

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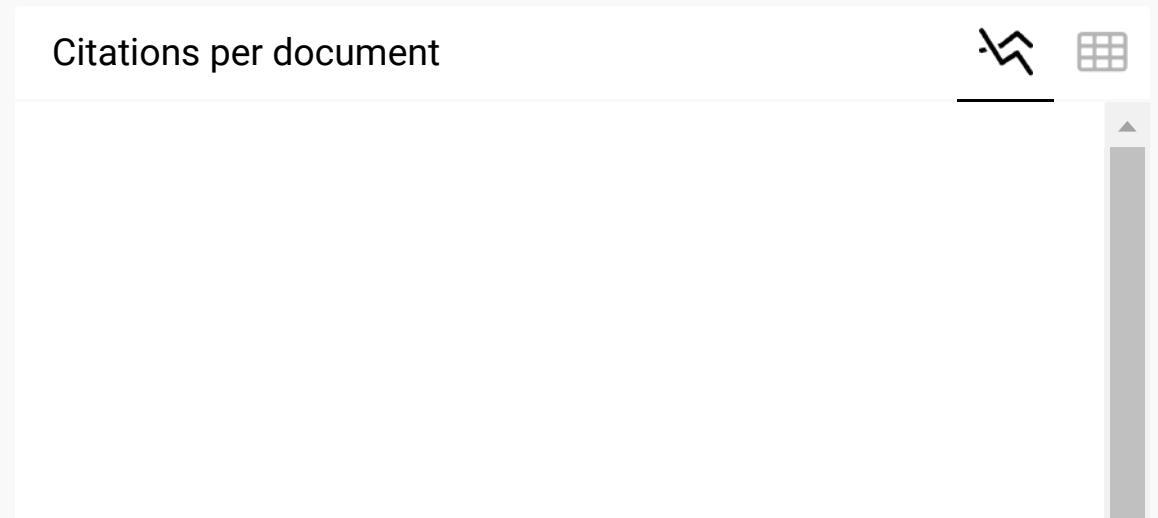
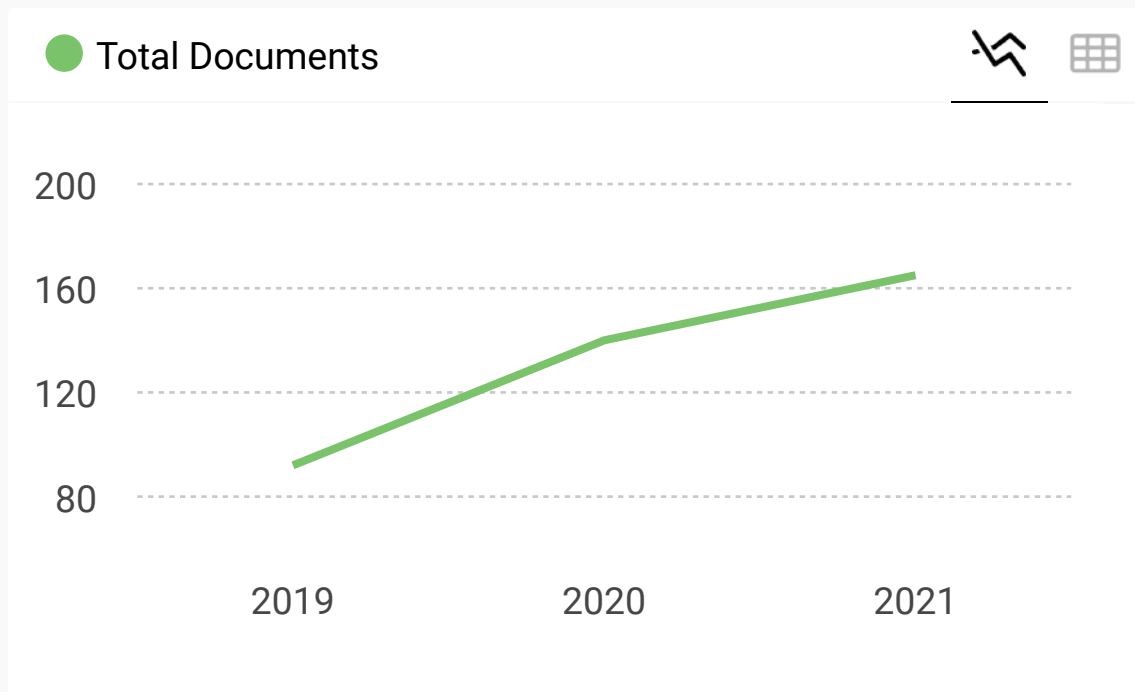
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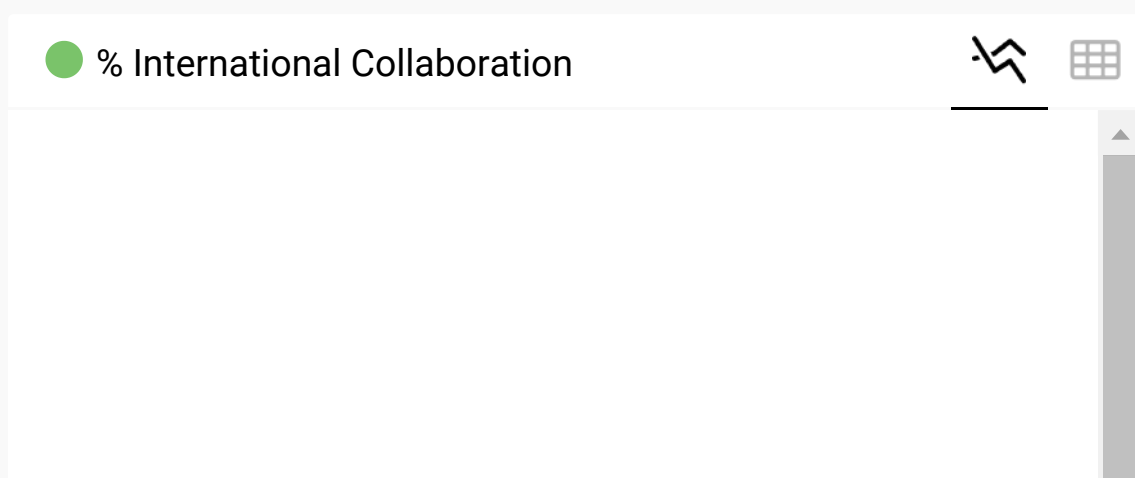
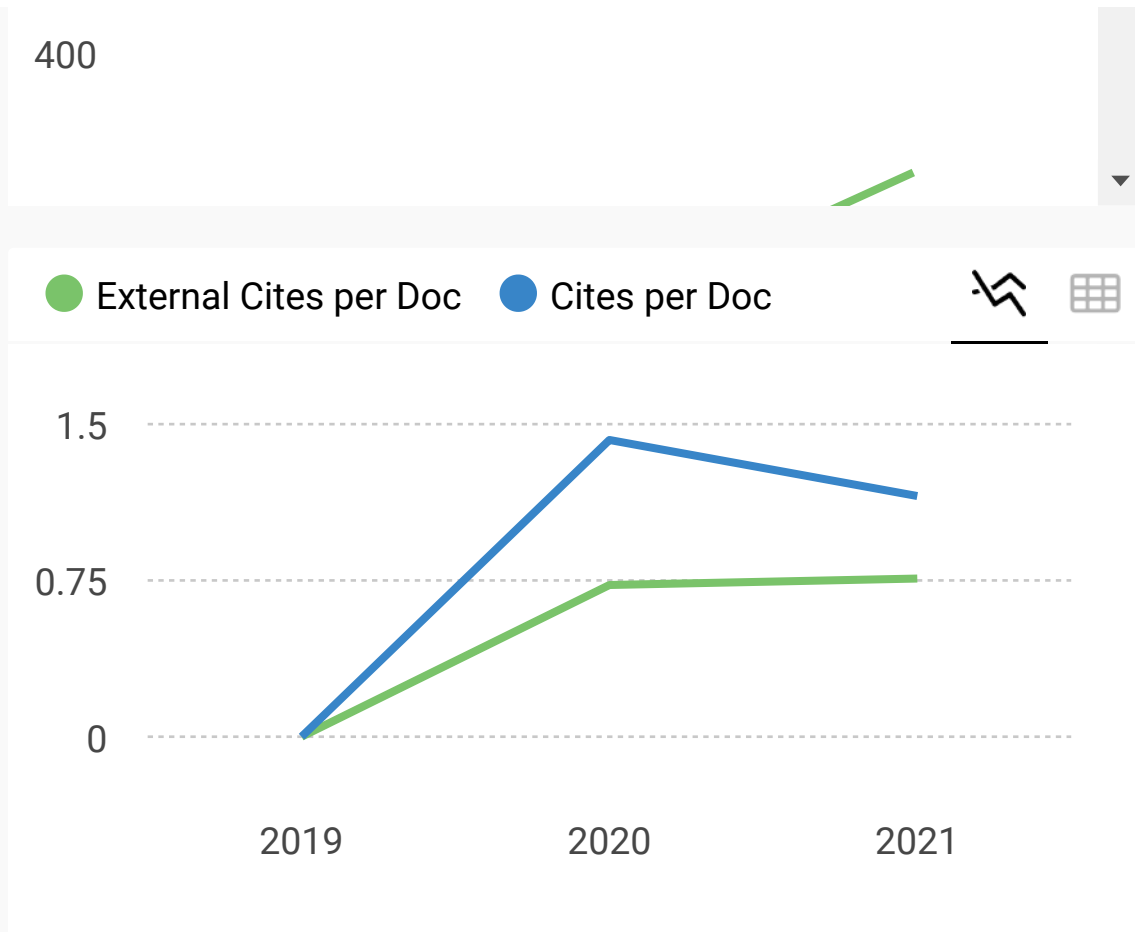


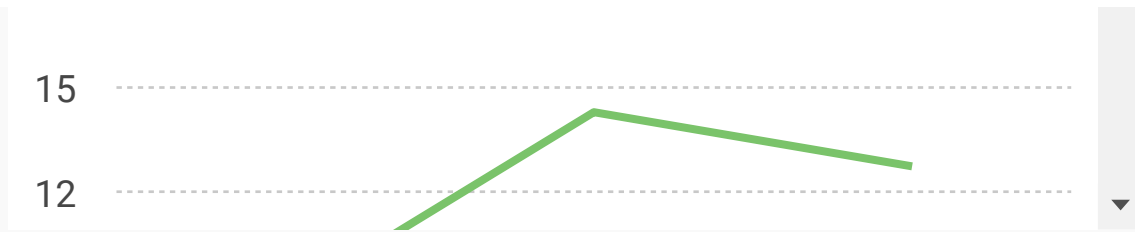




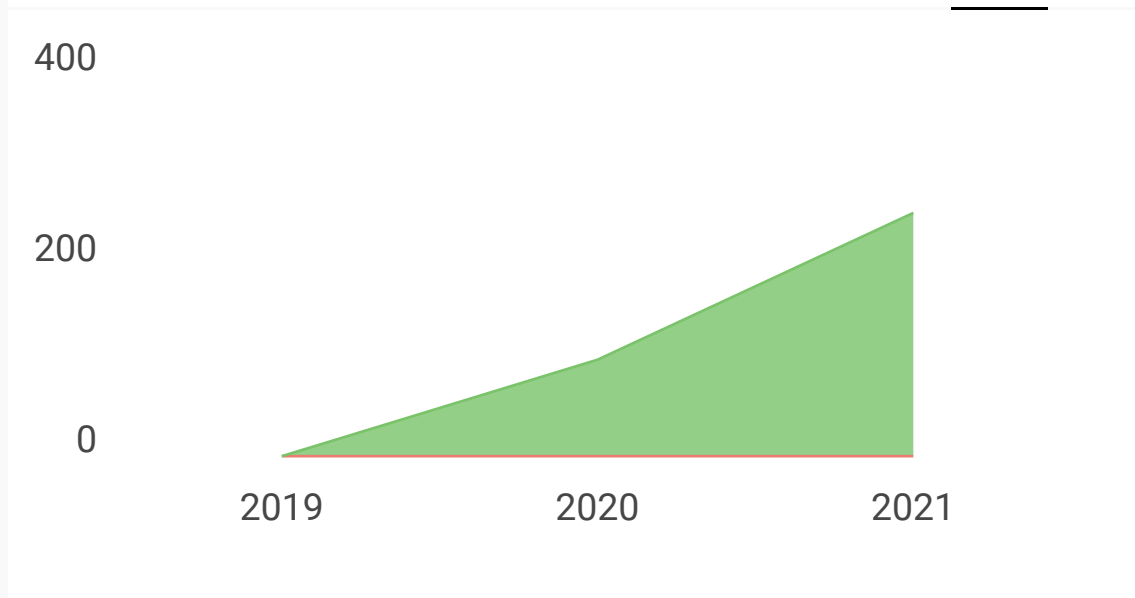
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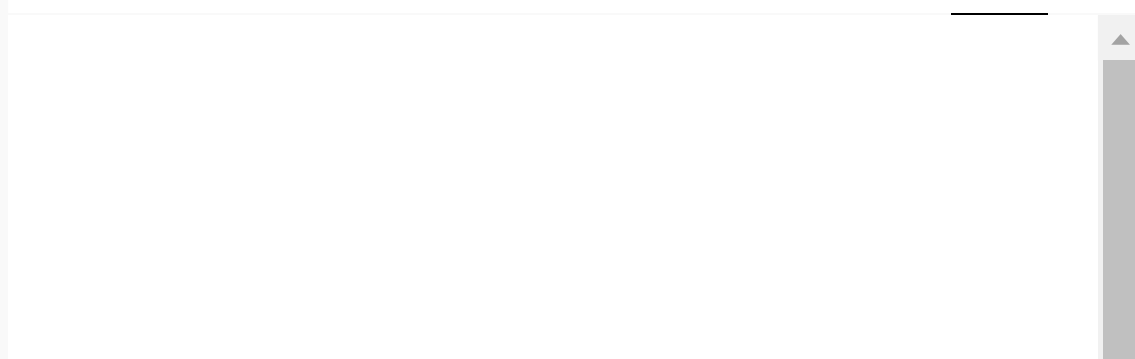




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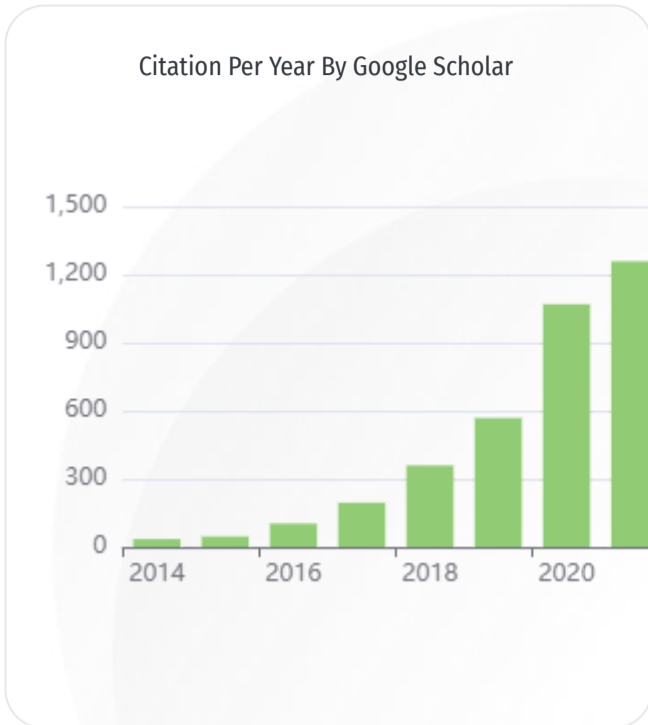
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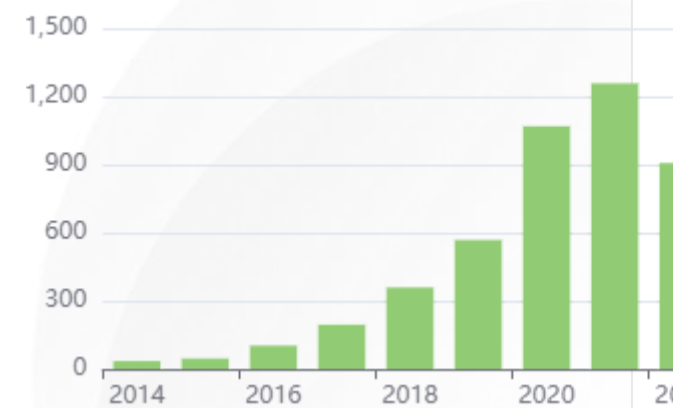
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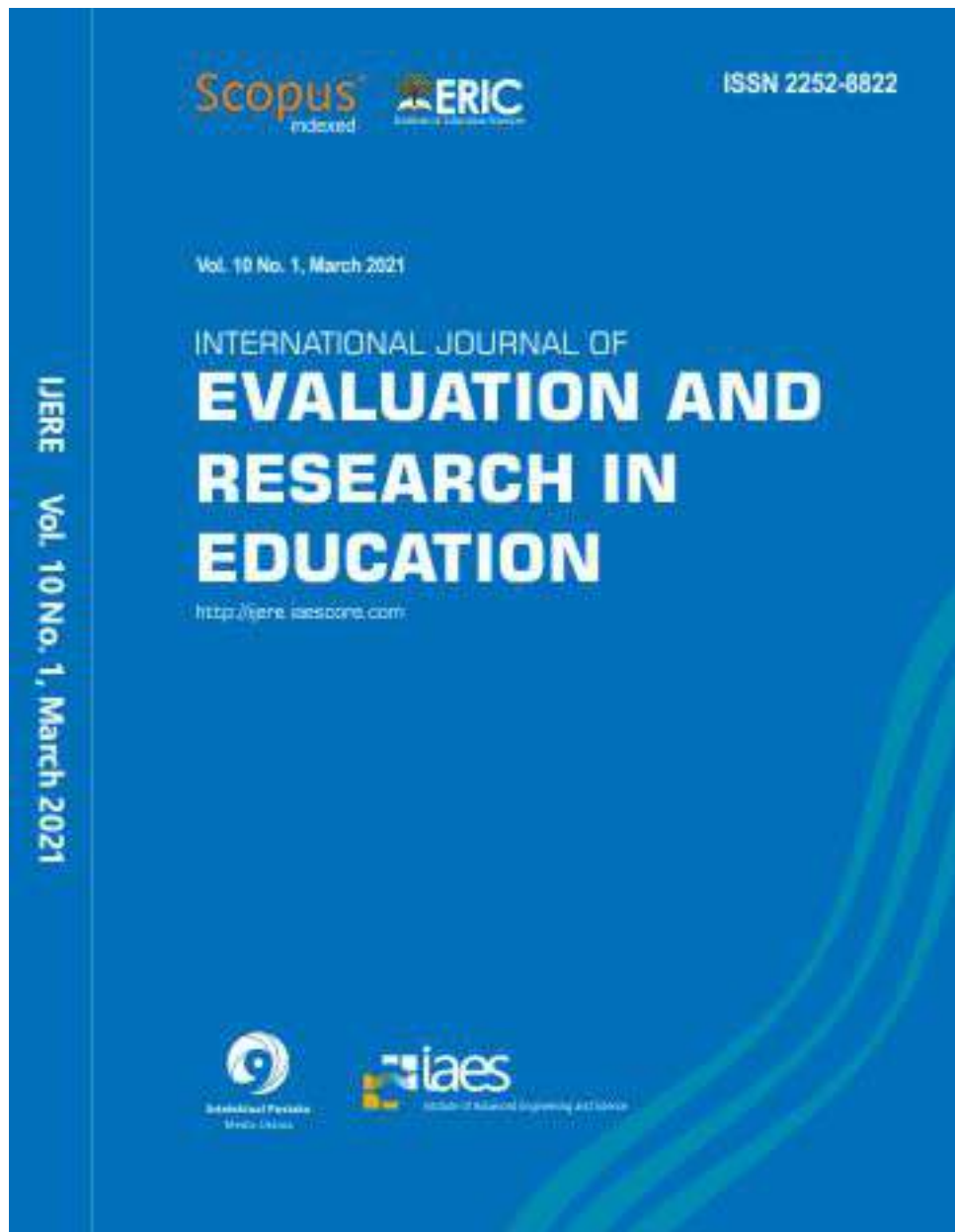
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Articulate Storyline 3 multimedia based on gamification to improve critical thinking skills and self- regulated learning

by Leny Heliawati, Linda Lidiawati, Indarini Dwi P

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Articulate Storyline 3 multimedia based on gamification to improve critical thinking skills and self-regulated learning

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ABSTRACT

This study measured the effectiveness of Gamification-based Articulate Storyline 3 multimedia on students' critical thinking skills and self-regulated learning. The research method used is a quasi-experimental method. The research subjects were 64 students and eight science teachers who have used the Gamification-based Articulate Storyline 3 multimedia on the nature of acidic, alkaline, and neutral solutions. Data collection techniques in this study were tests that aim to determine students' critical thinking skills and a questionnaire to measure students' learning independence. The data analysis technique was based on calculating the average score of the test items with high-order thinking skills and student learning independence. The study results obtained an average score of 81.50 for critical thinking skills on the material concept of the nature of the acid, base, and neutral solutions with an N-Gain of 72% in the high category. It was also known that the average percentage of student learning independence was 86.76% which falls into the good category. Therefore, Gamification-based Articulate Storyline 3 multimedia can improve students' critical thinking skills and independent learning on the nature of the acid, base, and neutral solutions.

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1. INTRODUCTION

Historical changes in human life have occurred with the outbreak of the COVID-19 pandemic, which has affected social interaction in the home and work, including in the school environment [1], [2]. This has had a significant impact on social, economic, health and education aspects, especially those related to the teaching and learning process [3]-[5]. Currently, teachers must be able to develop students' socio-emotional competencies, stress management techniques, create a pleasant learning atmosphere, done problem-solving skills through mastery of various online learning methods [6]-[11]. The use of technology in developing teaching materials such as multimedia and other digital platforms can help realize effective and efficient online learning. Science learning related to concrete and abstract concepts can take advantage of the technology of developing these teaching materials to produce 21st-century golden generation students who can think scientifically and critically to be ready to face global challenges.

Science learning in the 2013 Curriculum must develop scientific thinking to produce competent students with a culture of critical thinking with nuances of technology, environment, and society. Students are expected to learn concepts about the universe using 21st-century skills, namely Communication; Collaboration; Critical thinking and problem solving; Creative and innovative (4Cs). An increase in critical thinking skills will positively correlate with students' creative thinking skills and communication skills [6].

However, there is still a gap between the need for teaching materials according to 4Cs skills and existing teaching materials was obtained based on the analysis of the results obtained through online questionnaires to 40 science teachers as respondents. All respondents (100%) use WhatsApp as an online learning medium even though they realize that using this media is very difficult to implement 4Cs-oriented learning.

The use of multimedia can encourage mastery of 21st-century skills [12]. Online learning that uses multimedia can make it easier for students to access information via the internet and gain various learning experiences by providing interesting learning software. For example, authoring tools such as Articulate Storyline 3 can provide a variety of exercise menus according to the time and skills of students and help students get visualizations of abstract objects such as the properties of acid-base and neutral solutions. This software is suitable for use as a learning medium that can compete with adobe flash media [13]. Articulate Storyline 3 also has various advantages, such as ease of use, and the resulting output can be published in multiple formats, including HTML5, to produce attractive tutorial presentations.

The publication of the results of Articulate Storyline 3 is in the form of web-based media. It can also be run on various devices such as software on tablets, laptops, and applications on smartphones [14], [15]. The criteria as a guide in assessing the use of instructional media technology include quality of content and objectives (related to elements of accuracy and suitability to student conditions), instructional quality (increased motivation, the nature of instructional flexibility associated with other learning programs), instructional social quality, test quality and assessment evaluation that can have a positive impact on respondents, and technical quality (aspects of readability, ease of use, and quality of design) [16].

The use of technology such as Articulate Storyline 3 multimedia is easy to use because it is easy to share with students via the Google Drive link or an application that can be downloaded independently with the teacher acting as a facilitator. Self-regulated learning can be identified through an increased ability to solve problems and assignments independently by monitoring by the teacher as a facilitator [17], [18]. The characteristics of self-regulated learning can be seen when individuals can design their learning according to the needs or goals of the individual concerned, have a strategy and carry out their learning plans, also monitor their learning progress, evaluate their learning outcomes and then compare them to specific standards [19], [20]. Independent learning can be trained through a planned learning process on science material given through a fun game approach so that students are motivated to be involved continuously without realizing it.

Following current conditions, namely through online learning modes, learning will be presented differently according to student needs, using multimedia without reducing its purpose [21], [22]. Based on the survey results, the teacher wanted multimedia that accommodated the needs of practicum simulations virtually by providing variations such as quizzes, guessing pictures, guessing words, and crossword puzzles. The science material in grade VII can represent both content and context through the game creation. Interactive multimedia is needed to present science learning materials that require visualization of the object of study, for example, the material properties of acid, base, and neutral solutions. This material involves visualization to identify differences in the properties of solutions and apply them to everyday life by using critical thinking skills. The approach of the game to learning (gamification) can be used according to the learning objectives. This situation should be a challenge for teachers to create innovative learning media by incorporating game elements that students like, such as gamification.

Gamification is a concept that uses game elements in non-game situations. The goal is to motivate someone to do something in a fun way. Techniques commonly used in gamification are differences in game levels, scores, the player character, and competition. These techniques can develop students' thinking skills taught by teachers who do not have mastery of computer language programming, such as coding. Research on gamification has been carried out, such as the effectiveness of gamification in increasing student creativity [23], increasing learning motivation [24], [25], deepening concept mastery [26], [27], behavior change and collaboration between students [28]–[30], and students' critical thinking skills [31], [32]. Gamification research related to student learning independence is by researchers associated with the concept of self-regulated learning [33]–[35] and self-efficacy [36], [37]. While the Gamification research, which focuses on thinking skills and student independence, is still very little, as was done [38], [39]. For this reason, it is crucial to research to determine the effectiveness of Gamification-based multimedia in improving students' critical thinking skills and independence during the implementation of online learning.

The purpose of this study was to measure the level of students' critical thinking skills and self-regulated learning after using the Articulate Storyline 3 based on Gamification on the properties of acid, base, and neutral solutions. The criterion for critical thinking skills in this study was that students could complete 10 multiple-choice questions that met high order thinking skill (HOTS). Meanwhile, students' self-regulated learning can be seen from the students' skills to self-monitor and self-evaluate learning through multimedia teaching materials. The Articulate Storyline 3 multimedia based on Gamification as an innovation in developing online teaching materials can be accessed via laptop/computer or downloaded as an application on an Android smartphone device.

2. RESEARCH METHOD

This research was conducted on junior high school students accustomed to playing games via laptop and android devices. This study used a quasi-experimental research method or quasi-experimental [40]. An experimental group gets treatment and a control group that cannot be fully controlled from outside variables. The research design used the non-equivalent control group design with the pretest-posttest control group design technique [41], which consisted of two classes (the experimental and control classes). The population in the target in the study was 306 students of grade VII, while the sample of this study was 68 students from two different classes. The sampling technique is based on the purposive sampling method.

The researcher chose two groups randomly, and then they were given a pretest question. This aimed to determine the difference between the experimental group and the control group in the initial conditions. The pretest results will be declared good if there is no significant difference between the experimental and control groups. The test used is in the form of 10 HOTS-oriented multiple-choice tests, which have cognitive levels of application (C3) and analysis (C4). Before being tested on students, these questions had been tested for validity and reliability.

The research stage was continued with giving treatment to the experimental group through Articulate Storyline 3 multimedia, while conventional learning using WhatsApp was applied as usual to the control group. Posttests to the experimental group and the control group are given at the final stage to prove the influence of the learning media used on 'students' critical thinking skills and learning independence. The research design is described in Table 1.

Table 1. Research design

Group	Pretest	Treatment	Post-test
Experimental	O1	X	O2
Control	O3	C	O4

In the experimental group, the tests were carried out before treatment (O1) and after treatment (O2) with X as a gamification-based multimedia treatment. The control group also gave tests before conventional learning (O3) and after conventional learning (O4). In the control group, conventional learning took place without special treatment (C).

Quantitative data were obtained through the provision of multiple-choice critical thinking skills tests and questionnaires to measure student responses to the use of multimedia and student learning independence. This study used an instrument of critical thinking skills, consisting of 10 questions covering six indicators of critical thinking skills, referring to certain model [41] known as Focus, Reason, Inference, Situation, Clarity, and Overview (FRISCO). The data is then processed by giving a scale value of 0 for wrong answers and 1 for correct answers. The grid of multiple-choice questions for critical thinking skills can be seen in Table 2.

Table 2. Critical thinking skill indicators

Critical thinking indicators	Sub-indicator questions
Focus	Presented pictures, students can determine the concepts used to solve the problem
Reason	Given various examples of cases, students can provide reasons for the answers put forward
Inference	Presented a problem: students can make conclusions from the information available
Situation	Given a case or table, students can answer following the context of the problem and can answer application questions.
Clarity	Given a table, students can provide further clarity on both the definition and the relationship of concepts.
Overview	Presented a case or table, students can check what has been found, considered, and concluded.

Data were collected twice at the pretest and posttest. The data that has gone through the N-gain calculation process is then interpreted into several categories, then analyzed as a complete unit for each indicator. The N-Gain results were analyzed by categorizing the data [42]. The categories obtained show a general description of the improvement in critical thinking skills [43] after the treatment of Articulate Storyline 3 multimedia based on Gamification.

Data collection of student learning independence response was obtained by providing a questionnaire of 15 items, which were adapted from previous study [19] accompanied by five points of assessment of the use of Articulate Storyline 3 multimedia. Likert scale was applied with four alternative answers: a score of 4 states strongly disagree, a score of 3 states disagree, a score of 2 states agree, and a score of 1 states strongly agree. Indicators of student learning independence are related to students' skills to complete assignments on

Articulate Storyline 3 multimedia based on gamification to improve critical thinking ... (Leny Heliawati)

5. Before being used for research, critical thinking skills and independent learning instruments have been tested for validity and reliability. The instrument validity and reliability test results have shown that all items are declared valid with a reliability coefficient of 0.833. This indicates that the value Cronbach's Alpha > 0.60 is considered reliable or consistent, so this research instrument is valid [44].

Furthermore, the normality test stage was carried out on the results pretest and posttest to determine whether the data distribution was normal or not with the Kolmogorov Smirnov test on SPSS version 26.0. The decision that the data is considered normally distributed at a value of $\alpha=0.05$ will be taken if it matches the provisions of the Asymp. Sig. (2-tailed) > 0.05. If the value is normally distributed, it will be followed by an independent sample t-test to prove whether there is a significant difference between the pretest and posttest results through SPSS version 26. Then a decision can be made based on the results of the Sig. value. (2-tailed) $p < 0.05$, which stated that there was a significant difference between the two. Conversely, if the Sig. (2-tailed) $p > 0.05$, so there is no significant difference in the data. If the data has been declared normally distributed, then the N-Gain test can then be performed. The effectiveness of Articulate Storyline 3 multimedia can be seen through the increase in the pretest and posttest scores (N-Gain value). Articulate Storyline 3 multimedia based on Gamification will be declared effective if the N Gain value ≥ 0.3 is obtained, which is included in the medium or high category [42]. Furthermore, the learning independence data is also categorized through descriptive analysis by calculating the mean [45].

3. RESULTS AND DISCUSSION

The development of Gamification-based Articulate Storyline 3 multimedia on the nature of the acid, base, and neutral solutions have gone through a validation process by experts and teachers with the results obtained. The highest score was in the software engineering aspect (93.75%), followed by the audio and visual communication aspect (91.67%) and the material presentation aspect (90%). This multimedia is given to the validator as an application that can be downloaded via Android or laptop. Figure 1 shows the appearance of the introduction to the media on the Android device of the student's research target. In contrast, the learning evaluation process in the form of the Word Wall educational game is shown in Figure 2. In general, validators from experts and teachers have deemed this multimedia feasible as alternative learning media during the COVID-19 pandemic.



Figure 1. Opening multimedia based on gamification



Figure 2. Word wall educational game integrated with Articulate Storyline 3 multimedia

The consideration of using the Word Wall game in multimedia is because the visual characteristics of the game are following the age of the user, namely junior high school students. Several previous studies have also proven that this game can be used for online learning related to introducing new terms or vocabulary in the language field [46], encouraging student learning independence [47]. Table 3 contains multimedia specifications for Gamification-based Articulate Storyline 3 compared to printed teaching media.

Table 3. Comparison of gamification-based Articulate Storyline 3 multimedia specifications and printed teaching media

Aspect	Articulate Storyline 3 multimedia	Print teaching materials
Appearance	Attractive and interactive	Less attractive and not interactive
Cost efficiency	Can be published online or offline in the form of CD, word processing, web, or LMS	Book
Flexibility	Easy to use to study anywhere and anytime	It tends to be heavy and impractical when brought
Feedback	Can provide learning motivation to students in the form of direct feedback	Feedback is only in writing. No interaction occurs
Learning orientation	Encourages student independence to complete their assignments without help from others	Students need a teacher as a facilitator to explain the contents of the book
Time duration	Can be adjusted to student learning speed	There is no time duration
Ease of use	Easy to use on smartphones or laptops for online learning	Difficult when learning online
Audio visual	Very interesting and suitable for students with visual and auditory learning needs	Less attractive and less suitable for students with visual and auditory
Learning	Constructivist. Students build knowledge through games, videos, and simulations	Students only get factual information
Learning evaluation	It can be done independently through a game approach, and the results are immediately known	Done independently, but students cannot know the results directly
Learning motivation	Encourage learning motivation by giving points or rewards	Cannot encourage learning motivation directly

Based on the research results on 22 male students and 46 female students in the experimental and control classes, there were differences in the pretest and posttest results in the two groups of respondents. Table 4 shows that in the experimental class, the minimum score at the pretest was 20, and the posttest was 60. While the maximum score at the pretest was 60 and at the posttest was 100. The mean score at the posttest was 84.41, much higher than the pretest of 41.47, with an N-Gain value of 0.76 (high category). Different things were shown in the control class where the minimum and maximum scores at the pretest were almost the same as the values in the experimental class, namely 20 and 70. However, the posttest results only produced a minimum score of 40 and a maximum of 100, accompanied by an N-Gain value of 0.50 (medium category).

Table 4. N-Gain descriptive statistic value

	Experimental class			Control class		
	Pretest	Posttest	N-Gain	Pretest	Posttest	N-Gain
Minimum	20	60	-	20	40	-
Maximum	70	100	-	70	100	-
Mean	41.47	84.41	0.76	42.35	70.29	0.50

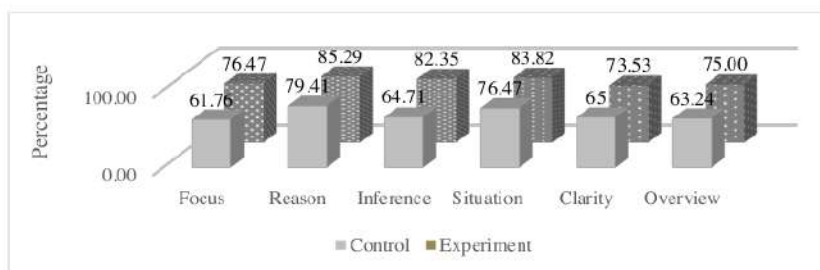
The difference in N-Gain values in the experimental and control classes must then go through the Kolmogorov-Smirnov normality test. In the experimental group and the control group, the normality test value reached Sig. 0.200 > 0.05, which means that the research data is normally distributed. An independent t-test was carried out to determine to what extent this Gamification-based multimedia treatment has significant effectiveness, as shown in Table 5.

Table 5. The results of the independent t-test on n-gain

	f	sig	t	df	sig. (2-tailed)
Equal variances assumed	0.630	0.430	-2.837	66	0.006
Equal variances not assumed			-2.837	64.629	0.006

6 In Table 5, it is known that the significance value (Sig) on the Levene test for equality of variances is $0.430 > 0.05$. It can be concluded that the variance of the N-Gain data (%) for the experimental class and control class is the same or homogeneous. The Sig value (2-tailed) of $0.006 < 0.05$ means that there is a significant difference in effectiveness between treatments using gamification-based multimedia towards conventional classes (control).

Furthermore, based on the analysis results of HOTS-oriented multiple-choice questions during posttest in the control and experimental groups, there are different achievements in average on each of the FRISCO critical thinking indicators [48] as shown in Figure 3. The figure reveals that the achievement of critical thinking skills in the experimental group shows a more significant average in all aspects of the indicators. They included the highest indicators is the Reason (85.29%), Situation (83.82%), Inference (82.35%), Focus (76.47%), Overview (75.00%) and the lowest in the Clarity indicator (73.53%). Whereas for the control group, the highest indicators were achieved by Reason (79.41%), Situation (76.47%), Clarity (65%), Inference (64.71%), Overview (63.24%) and Focus (61.76%) is the lowest critical thinking indicator.



1 Figure 3. Comparison of the achievement of critical thinking indicators between the control and experimental groups

The most significant improvement in students' critical thinking skills was achieved in the Reason indicator, which relates to case examples in the context of everyday problems. Situation indicators rank the second largest, where students can answer questions about the material application, both in pictures and tables. Students in the experimental group became better able to solve problems because, in the Gamification-based Articulate Storyline 3, multimedia simulation of virtual experiments through a constructivism approach was provided. Students are asked to choose the right tools and materials through educational games before finally experimenting with artificial and natural indicators virtually. Questions given through educational games according to HOTS criteria can stimulate students' critical thinking skills. The findings are reinforced by the results of research using virtual simulations and educational games, which are proven to be able to improve students' critical thinking skills, especially in the ability to apply concepts in everyday life [49]–[51]. Students' skills in applying contextual concept applications honed through Articulate Storyline 3 multimedia determine students' quality of life in the future.

Based on the results of the analysis of the responses of 10 teachers and 68 students regarding the use of Gamification-based multimedia, it is known that this media can increase self-regulated learning (86.76%) or be in a good category. In addition, multimedia is considered to make an essential contribution as an alternative to online learning solutions that are deemed boring as presented in Figure 4. The highest percentage of student responses to the use of Gamification-based Articulate Storyline 3 multimedia is the increased enthusiasm for learning (87.50%) through the use of instructional media with attractive designs (87.01%), containing contextual material (86.76%) and easy to understand (84.19%) to improve student learning independence (86.76%). In addition, learning that uses the gamification approach enhance critical thinking skills (85.66%) and mastery of the material concepts of the properties of acid, base, and neutral solutions (85.29%). As for the media aspect, students think that multimedia is a learning medium with the proper selection of videos, experimental simulations, and educational games (84.19%), equipped with fun music (83.46%). The student response in the experimental group to Articulate Storyline 3 multimedia was very good overall.

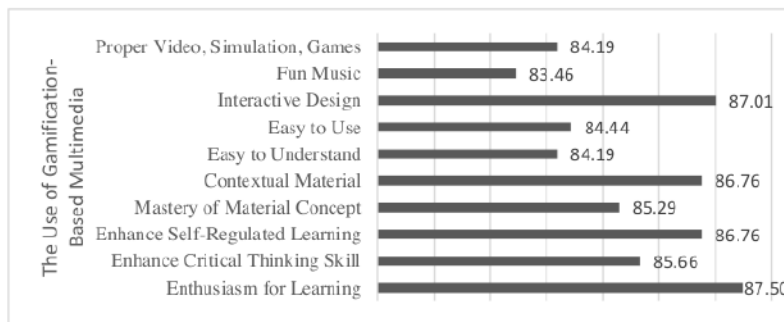


Figure 4. Students' response to the use of gamification-based multimedia

Student responses to the audio and visual aspects of the multimedia state that the design is very attractive (87.6%), providing a pleasant, positive effect to encourage students to be actively involved independently. This is following previous research, which states that visualization of interesting animation and games in multimedia can improve 'students' mastery of concepts independently [52], learning motivation [27], [53] and 'students' self-regulated learning [54], [55]. The addition of video content, simulations, and games has been proven to provide opportunities for students to conduct science experiments independently, even though they are not in the classroom [49], [56]–[58]. Fun online learning by including game elements can stimulate students to learn independently, which reduces special instructions from the teacher during learning. ⁵

The results of the analysis of student responses in the experimental class show that the use of Articulate Storyline 3 multimedia has the characteristics of being easy to use (84.4%) so that the role of the teacher can be minimized. Providing links via laptops and Android applications allows students to learn independently, with their respective learning times and speeds [59]–[61]. One of the aspects of self-regulated learning, namely the implementation of independent learning evaluation through quizzes or games, can have positive implications for the emotional condition of students [62] and their mental health [63]. In addition to doing this online, doing the quizzes can also be accessed offline to save students' quotas. The use of gamification-based multimedia plays a major role in reducing student stress levels when they have to undergo online learning situations without the help of teachers.

The role of the teacher in learning using the gamification approach is to design a learning activity by incorporating game elements such as badges, scores, rewards, and feedback through multimedia technology. The experimental group students showed high enthusiasm for participating in learning (87.50%) through badges, scores, and rewards that encourage a competitive spirit; it is a crucial factor in gamification-based learning, as suggested by previous researchers [63], [64]. As for the feedback in multimedia gamification, some are positive to encourage and motivate the strengths of students [65], [66] and negative feedback, which is more aimed at improving student weaknesses [67]. Gamification-based learning using Articulate Storyline 3 multimedia shows student involvement at a fairly high level, accompanied by an increase in critical thinking and self-regulated learning as components of 21st-century skills. The characteristics of 21st-century learning should pay attention to students' emotional intelligence and mental health aspects and mastery of 4Cs skills, which can be achieved through the implementation of Gamification-based learning.

4. CONCLUSION

Gamification-based Articulate Storyline 3 multimedia is an effective way to improve and deepen knowledge virtually, through constructivist and fun learning. It does not rule out the learning objectives (the mastery of 21st-century skills, including students' critical thinking skills, learning by incorporating elements of games, videos, and practicum simulations that can be accessed via laptops or android smartphones, proven to improve students' self-regulated learning). Mastery of 21st-century skills can be achieved through learning that considers students' emotional and mental health needs, namely by incorporating game elements. This study suggested gamification-based learning using user-friendly multimedia of Articulate Storyline 3 to be a solution in facilitating students to learn both online and offline according to learning needs in the new normal era after the COVID-19 pandemic.

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