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Using 3D-Pageflip Based Learning in Learning Chemistry: How does It Effect on Students' Academic Achievement?

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Abstract Using learning media on technology-based is one of the most crucial aspects of the study process nowadays. Utilizing learning media on technology-based is an effort to integrate technology into the study process. The research aimed to investigate the use of 3D-Pageflip-based learning media (3DP-LM) as the application of technology in chemistry learning toward students' academic achievement (SAA). This research used a quasi-experimental approach with a non-equivalent control group and post-test only. The sample in this study consisted of 65 eleventh-grade students (16-17 years old) in a high school in Yogyakarta, Indonesia. There were two groups of the total sample used in this research; the experimental group with 3D-LM (E-3D-LM group) and the control group with PowerPoint media (C-PPt-M group). The instruments applied in the research consisted of 3DP-LM, validation sheets of 3DP-LM, and student chemistry learning achievement test (SCLAT). The findings in this study indicate that the 3DP-LM was valid and reliable to be applied in the research process. The outcome of data analysis shows that there are differences in SSA between students in the E-3D-LM group and the C-PPt-M group. The E-3D-LM group is better than the C-PPt-M group. Moreover, the effect size estimation based on Cohen'd confirmed that the application of 3DP-LM has a positive impact on SAA. This research suggested that 3DP-LM is a technology-based media that can be applied in chemistry learning widely.

Keywords Technology-Based Learning Media, 3D-Pageflip, Learning Chemistry Process, Learning Chemistry Achievement.

1. Introduction

The rapid development of technology and information nowadays has influenced various fields of work, including in the field of education. In the twenty-first century, the education system has evolved through technology in learning. The use of technology-based learning media in the learning process is one way to incorporate technology into the learning process. Technology-based learning media could help educators and students upgrade the quality of the teaching and learning process to achieve good teaching and learning outcomes [1]. In the Indonesian national curriculum (K-13) it is stated that teachers should be able to create more innovative and creative in conducting the teaching-learning activities, so the goals of national education can be achieved [2]. The application of learning media on technology-based is one way the teachers could be done in the learning process [3-4]. So, by using learning media on technology-based, students are

expected to be more involved and enthusiastic in the learning process.

The learning process is an interactive activity between teachers and students by involving methods, strategies, and learning resources in a learning environment, which has an impact on enduring change in behavior [5]. The learning process carried out includes subjects matter taught to students at both schools and universities. Chemistry is one of the lessons taught in learning. However, based on previous research, chemistry is said to be one of the difficult subjects for learners to understand [6-7]. This refers to the results of the national examination high school students' level in the field of chemistry in Indonesia from 2017 to 2019, which are still in the low category [8]. This indicates that students have difficulty in learning chemistry. One of several factors that cause chemistry subjects are still considered difficult by students is complex and abstract chemical concepts that require imagination to understand [9-13].]. There are three basic components or levels of representation in understanding the chemical concept, those are; macroscopic, symbolic, and sub-microscopic [14-15]. The macroscopic representation refers to chemical phenomena that can be observed directly, such as changes in color, temperature, and pH. The symbolic representations relate to symbols, chemical equations, mathematics, and graphics. Then, sub-microscopic representations relate to phenomena that cannot be observed directly but are real, such as molecules, atoms, and interactions between molecules and atoms. Therefore, the teacher as the important factor in the learning process is required to be innovative in explaining chemical concepts to students. There are several methods or strategies that teachers can use in the teaching and learning activities such as; the application of the media on technology-based [16-18], and the use of learning models [19-20] in the teaching-learning activities. So, the teacher can explain the chemical concepts optimally and the students can understand them easily.

The use of learning media in today's technology-based era is always synonymous with technology-based media, such as the use of computers, tablets, and mobile devices [21]. Then, using the learning media on technology-based provides a new environment for student learning [22]. The chemistry learning process has now led to the application of media in the teaching-learning activities, such as the use of android-based learning media [5,23], the implementation of practicum-based virtual laboratory [24-25], and various technology-based learning media. In addition, technology-based learning media can support students in self-regulated learning students' (SRLs) [26]. The use of technology in classroom learning has a good effect on learning outcomes [27-28]. Technology-based media is one of the ways that teachers can use to explain chemical abstract concepts of macroscopic, symbolic, and sub-microscopic [29]. Thus, the use of media or technological applications in learning is one of the innovations that teachers can apply in learning [22]. Therefore, teachers can use technology-based media to explain chemical concepts to the students in the learning chemistry process. The application of technology-based media in the chemistry teaching-learning process is expected to make an effective, interesting, interactive, and fun learning process environment [30] So, it affects SAA.

This research will introduce an innovative learning media that can be used in the learning process, especially for chemistry learning. This learning media is technology-based media using 3D-Pageflip software. 3D-Pageflip is a computer application program that can be used to convert files in Adobe PDF, Image, OpenOffice, Microsoft Word, PowerPoint, and Excel formats into a flash flip eBook with 3D effects. This application is completed with a background such as a 3D panorama and has additional multimedia, such as features including video, flash, audio, buttons, links, and many other features that can be used in this application. Then, objects in this application can be made in 3D mode. So the product is formed, allowing users to like reading a book in 3D space. Then the 3D-Pageflip can be easily accessed by users via PC (EXE and HTML format) Android and IOs (3DP format) or accessed online if it has been shared to an FTP server [31]. Previous research stated development of learning media with the 3D-Pageflip program had been a very good category for learning media in the teaching-learning process [32]. In addition, using 3D-ML had been a significant effect on students' learning motivation [33]. Therefore, the chemical concepts can be visualized using the 3D-Pageflip application in the media of chemistry learning so, it is expected to have a good impact on students' learning achievement.

The objective of this research has to analyze the use of 3DP-LM as the implementation of technology-based media in chemistry teaching-learning activities toward SAA.

2. Materials and Methods

2.1. Research Design

This study used a quantitative approach with the used quasi-experimental non-equivalent control group with a post-test only design. There were two classes used in this study, one class as the E-3D-LM group and the other as the C-PPt-M group. In this study, each group was given treatment by using learning media in the learning process. The E-3D-LM group used 3DP-LM while the C-PPt-M group used PPt-M, a media commonly which is applied by teachers in the learning process. After the treatment was given, the students in each group were tested using the SCLAT to determine the students' chemical learning progression.

This research was conducted online using the zoom-meeting application and face-to-face in the

classroom. The total of meetings conducted in this study were five meetings; four online meetings to treat each group using the zoom-meeting application and one face-to-face meeting in the classroom to test students' achievement conducted.

2.2. Sample

The total samples involved in this study consisted of 65 students, and they were composed into two groups; the E-3D-PL group, consisting of 33 students (15 male and 18 female), and the C-PPt-M group, consisting of 32 students (14 male and 18 female). These two groups were students from two classes (11^{th} grade of natural science 1 and 2) at Senior High School 4 Yogyakarta. The sample selection was done using cluster random sampling. The selection process was conducted based on the analysis of previous students' learning outcomes on the reaction rate material of five classes in the natural sciences program (11^{th} grade of natural science 1, 2, 3, 4, and 5) at Senior High School 4 Yogyakarta. Based on the results of the analysis with one-way ANOVA. Statistically, there is no significant difference between students' learning outcomes on the previous concept.

2.3. Implementation of Research

This research was prepared by applying learning media in two different groups. The researchers conducted four meetings for treatment and one meeting for post-test in each group. At the first meeting, the researchers gave the concept to each group about dynamic equilibrium and irreversible-reversible reactions in the chemical equilibrium material. At the second meeting, the researchers gave the concept about heterogeneous-homogeneous equilibrium and the laws of chemical equilibrium. At the third meeting, the researchers gave the concept about the calculation of Kc and Kp. At the fourth meeting, the researchers gave the concept about the factors that influence chemical equilibrium in industry. Then, at the fifth meeting, the researchers gave each group a post-test to measure the SAA with the SCLAT instrument.

2.4. Data Collection Tool

The data collection tool in this study consists of; (1) the validation sheet of 3DP-LM to measure the feasibility of the media, consisting of media validation sheets for experts, material validation sheet for experts, validation sheet for practitioners, and validation sheet for users. (2) the instrument of students' chemistry learning achievement test (SCLAT) to measure students' chemistry learning achievement.

3DP-LM is an instrument used in this study. This learning media was developed by authors using several application programs such as Adobe Photoshop and Corel Draw to create media designs, Adobe Flash to make test in media, ChemDraw to design chemical molecules, Chem-sketch to write chemical reaction equations, and Camtasia Studio and Video Scribe for creating various videos and animations in media. Then, the results of the several application programs are combined into one unit in the professional 3D-Pageflip software to produce 3DP-LM products. The 3DP-LM is developed based on the basic competencies in the Indonesian national curriculum in chemistry subject regarding the concept of chemical equilibrium. The 3DP-LM is written in Indonesian. Figure 1 shows the 3DP-LM.

The validity and reliability of the 3DP-LM products were measured before being used in the study. This learning media was validated by seven validators consisting of one chemical expert who is a lecturer in the Chemistry Education Department, one media expert who is a lecturer in the Learning Technology Department, one linguist who is a lecturer in the Applied Linguistics Department, one practitioner who is a chemistry teacher in High School, and three users who are High School chemistry students outside the research sample. The validity was conducted using a validation sheet instrument adopted from the "*Learning Object Review Instrument (LORI) version 1.5"* [34]. The validation sheet instrument used a Likert scale with the answer choice options (5 = Very Good to 1 = Very Low) with a suggestion column for each indicator. The validity data of the developed learning media were analyzed using Aiken's V formula [35]. Based on the analysis conducted, the results of the validity of the learning media were 0.89. Thus, the validity of learning media can be categorized as a very valid category [36]. Then, the reliability of 3DP-LM products was carried out using analysis that refers to the percentage of agreement [37]. Then, the results of the reliability analysis of the learning media were 0.77 or 77%. Thus the learning media was declared reliable because the results obtained are greater than 0.70 [38]. According to the results of the analysis conducted, the 3DP-LM has valid and reliable criteria to apply in the research.

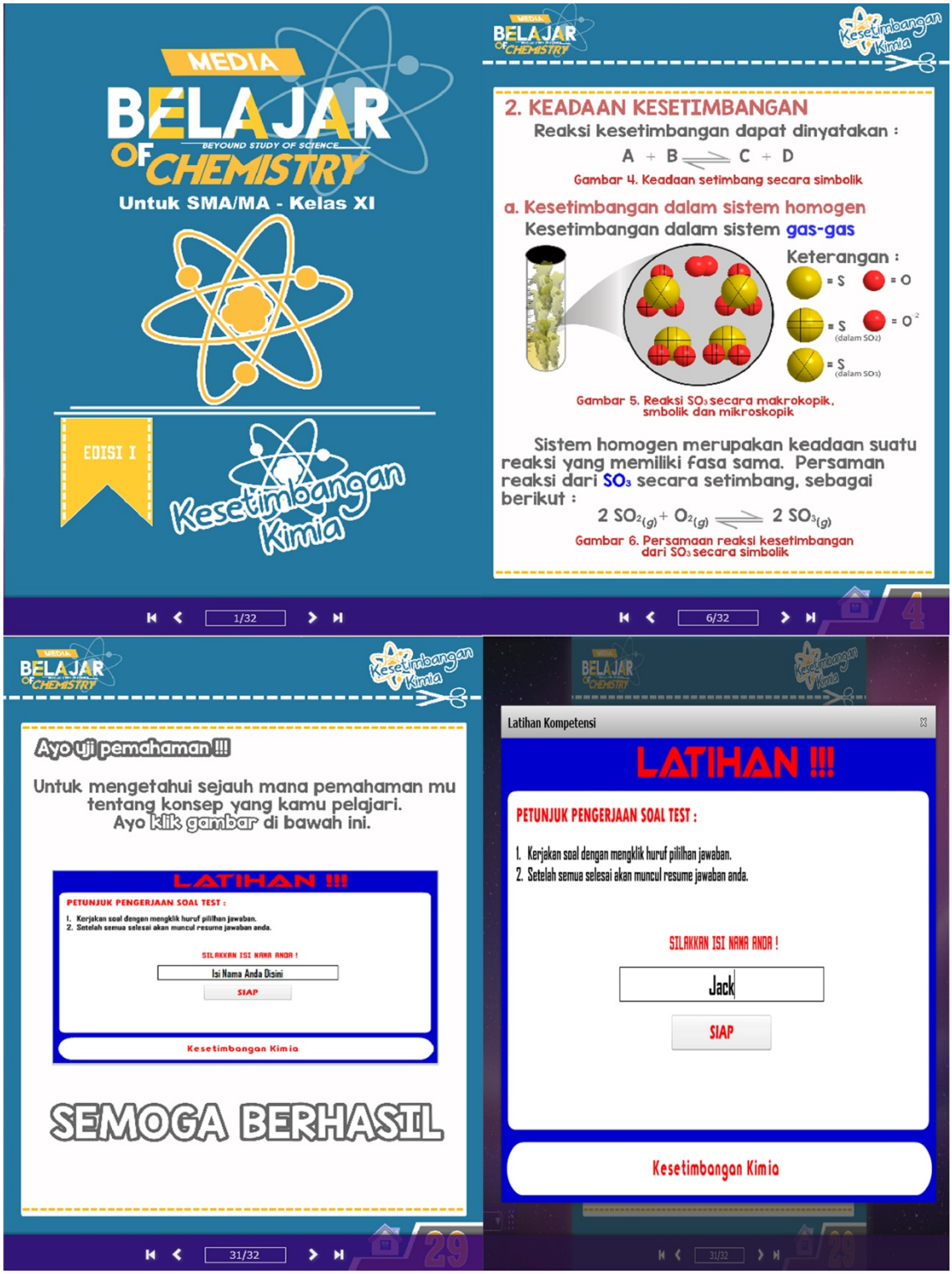

Figure 1. The display form of the 3DP-LM

Table 1. Overview of the SCLAT instrument

Content	Indicator	No Item	Level Cognitive Domain (Bloom)					Total Item
			C1	C2	C3	C4	C5	
Dynamic Equilibrium	Explaining the dynamic equilibrium concept	1	√					1
Heterogeneous and homogeneous in the equilibrium reaction	Distinguishing heterogeneous and homogeneous in the Equilibrium Reaction	2		√				2
		3		√				
	Explaining the concept of heterogeneous and homogeneous equilibrium	10	√					2
		12	√					
Reaction reversibility for equilibrium reaction	Explain of the reaction reversibility for the equilibrium reaction	11		√				1
The law of Equilibrium	Determining the equilibrium constant for the reaction (Kc and Kp)	4			√			3
		40			√			
		14			√			
Calculating the equilibrium constant (Kc and Kp) for the reaction	Analyzing the value of the reaction equilibrium constant (Kc) based on known data	20				√		1
	Determining the equilibrium constant (Kc) of the number of moles of a known substance.	28				√		1
	Determining and analyzing the value of the equilibrium constant (Kc) in the reaction equation	31				√		3
		29				√		
		26				√		
	Calculating the value of the equilibrium constant (Kp) based on known data	13			√			4
		16			√			
		17			√			
		21			√			
	Calculating and analyzing the score of degree of dissociation from the reaction equation	15			√			3
		23			√			
		30			√			
	Calculating the value of the equilibrium constant (Kp) if the Kc value is known.	18			√			2
		22			√			
	Analyzing quantitative calculations related to chemical equilibrium	24				√		2
		25				√		
	Correlating quantitative calculations relating to chemical equilibrium Kc and Kp	32				√		2
		35					√	
The factors that affect of chemical equilibrium	Describing the factors that affect chemical equilibrium.	34		√				1
	Analyzing the effect of changes in concentration on reaction equilibrium	8				√		3
		19				√		
		39				√		
	Analyzing the effect of changes in pressure or volume on the reaction equilibrium.	5				√		4
		7			√			
		9					√	
		36					√	
	Proving the effect of changes in temperature on the equilibrium reaction	38				√		3
		37				√		
		6					√	
Using equilibrium principle in industry	Describing the Haber-Bosch process in ammonia manufacturing	33			√			1
	Describing the contact process in sulfur acid manufacturing	27			√			1

"**Note:** C1; **R**emembering, C2; Understanding, C3; Applying, C4; Analyzing, and C5; Evaluating"

The SCLAT instrument is a series of tests with chemical equilibrium material which consists of 40 multiple choice questions with five answer options. This instrument was created by the researchers based on basic competencies defined in the Indonesian national curriculum on chemistry subjects regarding the concept of chemical equilibrium. Competency indicators are determined based on basic competencies. Then, the competency indicators are combined with the cognitive dimension based on the revised Bloom's Taxonomy but only limited to C1 to C5; remembering, understanding, applying, analyzing, and evaluating [39]. Table 1 shows an overview of the SCLAT instrument.

The validity and reliability of the SCLAT had been

conducted before the SCLAT was used in the study. The validity of the instrument was tested by theoretical and empirical validity. The theoretical validity was carried out by two judgments from Chemistry Education Department experts, and one practitioner, who is a high school chemistry teacher in Yogyakarta. Theoretical validity was conducted based on the material, construction, and language aspects. Then, empirical validity was conducted by providing the SCLAT instruments to 181 students outside the sample in this study. The results of empirical validity were analyzed using the *Quest* program. Validation with the Quest program was conducted based on the value of infit with MNSQ, 0.77 <MNSQ <1.33 [40]. Based on the analysis, there are three item questions (Items No. 4, 5, and 18) that are not fit with the criteria. Thus, the three-items were not used in the study. Total the 40 questions tested for empirical validation only 37 questions were declared fit with the criteria. However, from a total of 37 questions that fit with the criteria, only 25 items were used in the study. The 25 items were used to represent each competency indicator of the SCLAT. Then, the reliability of the SCLAT instrument can be interpreted on a scale of 0.00 to 1.00 [40]. Reliability was analyzed based on the Reliability Estimate coefficients in the output of the Quest program [41]. The reliability estimate coefficients of SCLAT were obtained to be 0.96. Moreover, the estimation of items reliability with Cronbach's Alpha of SCLAT was found to be 0,71. Therefore, the SCLAT was a good instrument to measure the SAA.

2.5. Data Analysis

The independent sample t-test using SPSS 20 was used in this study to measure differences in SAA statistically between students using 3DP-LM in the E-3DP-LM group and students using PPt-M in the C-PPt-M group. Prior to the independent sample t-test analysis, it is necessary to conduct a pre-requisite test first by testing the normality and homogeneity of each sample. Then, "*the normality test is fulfilled if the significance value is greater than 0.05. The homogeneity test is fulfilled if the significance value is greater than 0.05*" [42]. After the normality and homogeneity tests were fulfilled, the independent sample t-test analysis can be conducted. In addition, The Cohen'd formula was used to analyze how the effect of the 3DP-LM on SAA [43].

$$d_s = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{(n_1-1)SD_1^2 + (n_2-1)SD_2^2}{n_1+n_2-2}}} \quad (1)$$

Note; d_s= index effect size, X= mean score each group, n= total sample each group, SD= standard deviation

3. Result and Discussion

The mean score SAA obtained from two groups in this study is presented in the diagram in Figure 2.

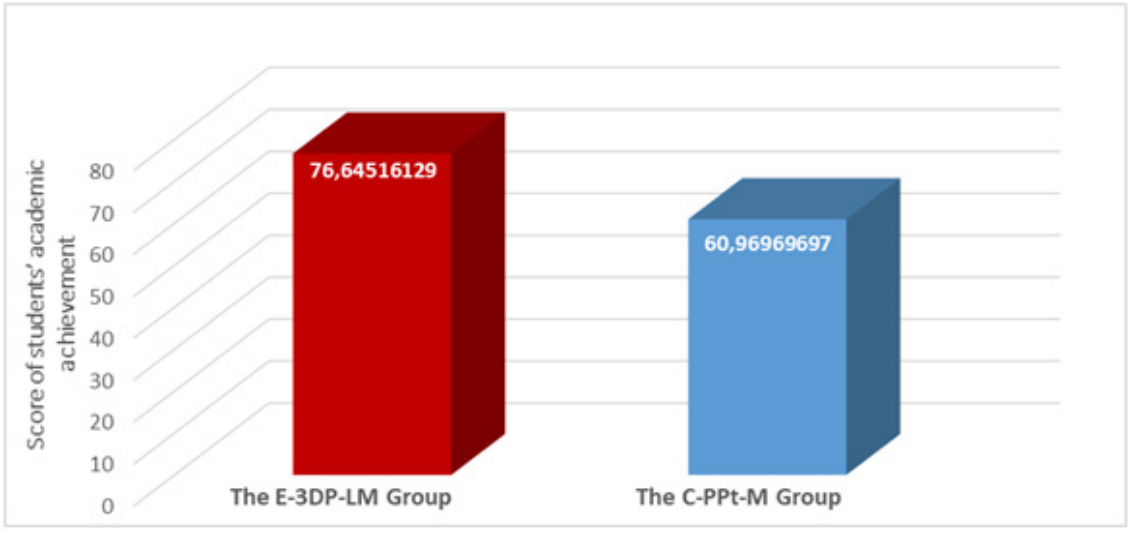

Figure 2. The mean score of two groups

The diagram in Figure 3, showed the difference in the mean score of SAA between the two groups. The E-3DP-LM groups gained a better SAA score compared to the C-PPt-M group. It is not only seen from the mean value of the two groups but also it is seen the significant value through the independent sample t-test analysis with the SPSS program. However, the pre-requisite test was conducted first. Tables 2 and 3 showed the results of the pre-requisite test for the independent sample t-test in this study.

Table 2. The result of the normality test analysis

Group	Sig. Kogomorov-Smirnov	Conclusion
The E-3DP-LM	0.200	Normal
The C-PPt-M	0.200	Normal

Table 2 showed that the value of Kolgomorov-Smirnov obtained is greater than 0.05 in each group. Thus, it indicated that the data are normally distributed and meet the assumptions for performing analysis independent sample t-tests. Then, Table 3 shows the result of the homogeneity test.

Table 3. The result of the homogeneity test analysis

Group	Levene's test		Conclusion
	F	Sig.	
The E-3DP-LM and the C-PPt-LM	0.053	0.818	Homogenous

Based on Table 3 Sig. value of Levene's test obtained greater than 0,05. This indication stated that the data are homogeneous and meet the assumptions for performing analysis independent sample t-tests. After the two assumptions are fulfilled, analysis using the independent sample t-test can be carried out to see the effect of the treatment given. Table 4 showed the results of the analysis independent sample t-test using the SPSS 20 program.

Based on Table 4, the value of sig. (2-tailed) is obtained of independent sample t-test analysis. This indicated that there were differences in SAA between students using 3DP-LM in the E-3DP-LM group and students using PPt-M in the C-PPt-M group. The students in the E-3DP-LM group have a better score than the students in the C-PPt-M group. Furthermore, it is continued by calculating the effect size to determine the magnitude of the influence of variable X on variable Y in the study [43]. The result of the effect size calculation obtained in this study was 1.02. Thus, the effect size obtained is > 0.8, which means that the treatment given has a large effect on the results obtained [44]. Based on the results obtained, it can be stated that the use of 3DP-LM has an effective influence on SAA results.

Academic achievement is an achievement obtained by students after carrying out a learning process that involves a more active thinking ability [45]. Then, academic achievement showed the extent to which a person has achieved goals in a learning environment, especially in schools, colleges, and universities [46]. However, the role of the teacher is a dominant factor in helping students improve their learning achievement. The accomplishment of a program is determined by the teachers' ability to learn [47]. This relates to the methods, strategies, and instructions that the teacher uses in learning. The application of ICT-based learning is an innovation strategy that can be used by teachers in learning [22]. Therefore, this study focuses on the use of ICT-based learning media to obtain data on SAA in chemistry learning.

The results obtained in this study showed that the use of technology-based learning media has a good effect on SAA. This result confirmed previous studies on the use of learning media to affect SAA, such as research on the use of ICT-based learning media effectively in improving students' learning outcomes in chemistry learning [48]. Then, the application of technology-based learning media and blended learning has an effective influence on learning achievement and students' self-efficacy in the hydrocarbon concept [23]. In addition, the use of 3D-Pageflip media as instruction in learning provides good results for students' academic performance [49]. Then, the use of technology-based multimedia has an effective effect on academic achievement in chemistry learning in fundamental chemistry concepts [50]. Thus, based on the results of research and previous studies the implication of instructional media on technology-based in the chemistry learning process has a positive effect on increasing students' understanding and SAA.

Table 4. The result of independent sample t-test analysis

	t-test for Equality of Means						
	t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
						Lower	**Upper**
Equal variances not assumed	4.243	63.000	.000	13.00379	3.06476	6.87936	19.12821

This research was conducted by involving technology-based learning media in the teaching-learning process. Previous research stated that the benefits of using learning media on technology-based in the classroom have had a good effect on student learning outcomes [51]. Then, the use of technology-based media has an important role in increasing the ability of students' self-regulated learning and students' self-motivation learning so that it affects learning outcomes [26]. Therefore, based on previous research, it can be seen that technology-based learning media affects improving on the SSA. The results of this study also show that the use of 3DP-LM in the E-3DP-LM group has a higher average score of SSA than the C-PPt-M group, which means that the effect of 3DP-LM has a good effect on the achievement of SSA in chemistry study. The use of 3DP-LM in this research as a learning media instructional, confirms previous research which states that the use of 3DP-LM as instruction in learning provides good results for students' academic performance [49]. Then, the use of 3D-Pageflip media has a significant effect in increasing students' learning motivation [17], but this research did not see the effect on SSA. Then, research on the development of 3D-Pageflip media has a valid and reliable category to be used in teaching [32], but this research was only limited to develop the media and was not tested in learning. Then, the use of 3D-Pageflip media has a good influence on students' interest and motivation in the learning process [52], but this research did not see the effect on SAA. However, the use of 3DP-LM in this research has a good effect on SAA. Therefore 3DP-LM is an innovative learning media on technology-based that can be used in the chemistry learning process. This 3DP-LM can be accessed by students on PC or Android. So, the flexibility and effectiveness of this learning media make it easy for students to access learning material anytime and anywhere, not only in the classroom.

4. Conclusions

This study focuses on the effect of the use of instructional media on SAA. The learning media has a function as a means of connecting that can stimulate the ability of the thinking process to be more active so that it has an impact on the learning outcomes carried out. The results of this study indicate that there are differences in students' achievement between the E-3DP-LM group using 3DP-LM and the C-PPt-M group using PPt-M. The students in the E-3DP-LM group have a better score than the student in the C-PPt-M group. Then, the calculation of the effect size shows that there is a significant effect size between the use of 3DP-LM on SAA in this study. Therefore, the use of 3DP-LM has a positive effect on SAA.

Based on the results obtained in this study, using 3DP-LM can be one of the recommendations that teachers can apply in the chemistry learning process, and using 3DP-LM is expected to be a learning media solution for teachers in carrying out the online learning process, due to the Covid-19 pandemic situation, today.

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