IJOLAE Indonesian Journal on Learning and Advanced Education

http://journals.ums.ac.id/index.php/ijolae

Enhancing Cognitive Learning: A Comparative Analysis of E-Learning Media Tailored to Different Learning Styles

Atiek Winarti[1], Almubarak[2], Titi Sundari[3]✉, Bambang Sumardjoko[4], Zakhele Nzuza[5]
[1-3]Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Indonesia
[4]Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Indonesia
[5]Newton Pre-vocational School, South Africa

DOI: 10.23917/ijolae.v6i2.23079
Received: September 18th, 2023. Revised: February 26th, 2024. Accepted: March 5th, 2024
Available Online: May 10th, 2024. Published Regularly: May, 2024

Abstract

This study aims to analyze the effectiveness of *e-learning* media based *on learning style* in the form of *e-posters, podcasts,* and interactive videos on students' cognitive learning outcomes. This type of research is quantitative research. This study used a sample of 32 grade X PMIA 1 SMA Negeri 3 Banjarmasin students. This research uses Google Classroom as a platform for learning activities. Learning media in the form of e-posters, podcasts, interactive videos, and student learning outcomes can be downloaded and uploaded on Google Classroom. The research instrument used is a learning style questionnaire containing 30 statements. Data analysis in this study used a normality test, and *Wilcoxon signed rank test.* The cognitive learning outcomes of students with visual, auditory, and kinesthetic learning styles were 90.66%, 93.33%, and 87.33%, respectively, with *N-gain* values of 0.75, 0.80, and 0.71. Based on data analysis, the results of this study show that e-learning *media* based *on learning style* is efficacious in improving the cognitive learning outcomes of students with visual, auditory, and kinesthetic learning styles. This learning style-based e-learning media can be applied to other chemical materials or subjects. The study employed-N-gain values to analyst the learning outcomes of the students. The - N gain values for students with visual, auditory and kinesthetic learning styles were 0.75, 0,80 and 0.71 respectively. Overall, the data suggests that the learning outcomes of the students were quite positive and that the use of various learning media and Google Classroom as a platform can be effective in enhancing students learning outcomes.

Keywords: media e-learning, google classroom, learning style, learning outcome, learning media

✉***Corresponding Author:***
Titi Sundari, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Indonesia
Email: titisundari76@gmail.com

1. Introduction

Chemistry is one branch of natural science. Chemistry is vital in education and everyday life, meaning that chemistry is fascinating to learn (Ahmad et al., 2021; Redhana & Merta, 2017; Yuliastini et al., 2018). However, most learners consider learning chemistry less interesting and confusing (Yuliastini et al., 2018). Many students have a negative stigma towards studying chemistry (Almubarak et al. 2023). According to Rahayu et al. (2020), one of the causes of students' chemistry learning difficulties is saturation and low motivation towards chemistry learning. It is because students have difficulty understanding complex chemical concepts (Ertikanto et al., 2018; Ijirana & Supriadi, 2018; Redhana et al., 2017); besides, chemical materials are also microscopic, so they cannot be imagined by students (Dewi, Khery, & Erna, 2019; Fitriyana et al., 2020). Current technological

advances should be able to overcome the problem of saturation and low motivation among learning learners (Cano et al., 2023; Froehlich, 2018; Talledo, Fernandez, & Briones, 2020) because there are so many technologies that can be used to support learning (Creer, 2018). However, there are still many students who have not received learning media that are packaged following technological developments (Avalos, Escoda, &Monge, 2019; Froehlich, 2018; Talledo, Fernandez, & Briones, 2020), Thus resulting in saturation and low motivation to learn students which ultimately affects the cognitive learning outcomes of students. It is what causes students' low cognitive learning outcomes in chemistry subjects (Rahayu et al., 2020). Therefore, innovation is needed to overcome these problems. One of the innovations that can be done to improve students' cognitive learning outcomes is the use of learning media (Widarti, Rokhim, & Syafruddin, 2020).

Learning media must be packaged following technological developments and involve and utilize information and communication technology as facilities to facilitate the learning process (Ernawati et al., 2022; Haristiani & Rifa'i, 2020; Miskiah, Suryono, & Sudrajat, 2019). It is following the demands on education in the 21st century (Fitriyana et al., 2020; Soegoto et al., 2022; Wardani, Lindawati, & Kusuma, 2017). Science, especially in Information, Communication, and Technology (ICT), is developing rapidly and is sophisticated (Elina et al., 2016; Saripudin et al., 2020; Wardani, Lindawati, & Kusuma, 2017). Therefore, the use of electronic learning media (*e-learning*) that can be used anywhere and anytime is expected to increase students' interest in learning, as well as increase learning effectiveness and efficiency (Atmojo, Muhtarom, & Lukitoaji, 2020; Sangsawang, 2020; Wardani, Lindawati, & Kusuma, 2017).

E-learning *media* is a learning media that follows technological developments and answers the needs of students for learning that can adapt to the times (Ana, 2020; Suhandiah et al., 2022). However, the use of *e-learning* media alone is not enough to improve students' cognitive learning outcomes if *the e-learning* media does not follow the learning styles of students (Gigzaw & Hirpa, 2020; Mufdalifah et al., 2018). It is because students do not have an optimal understanding of the material. Therefore, it is necessary to have *e-learning media* tailored to learners' learning styles (Hariadi, 2015).

Based on research by Hajrhma et al. (2022), not all students know their learning style, so they are not optimal in understanding the material (Audu, 2020). It means that it is essential that teachers direct students to know the type of learning style they have. Each student can have their own learning style, so differences in learning styles affect the process of receiving student information in learning (Banjarnahor, Sinaga, & Napitulupu, 2017). According to Hariadi (2015), there are three types of learning styles: visual learning style, auditory *learning style*, and *kinesthetic* learning style. Visual learning is a learning style that involves seeing, so the sense of sight plays an important role in this type of learning style. Auditory learning is a learning style that is based on listening, so the sense of hearing plays an important role in this type of learning style. Kinesthetic learning is a learning style through experience, movement, and touch. Based on these three learning styles, there must be three types of *e-learning media* under the three types of learning styles.

According to researchers, learning media in accordance with the three types of learning styles and current technological developments are *e-posters*, *podcasts*, and interactive videos. The three learning media are electronic-based. It is in line with the development of the millennial generation's needs, namely the use of digital/electronic media (Ernawati et al., 2022). It is also in accordance with the current development of the world of education, namely differentiated learning (Rafi &Pourdana, 2023).

Based on the description above, it is necessary to innovate learning media that is packaged according to electronic-based technological developments. In addition, to maximize the process of students understanding the material, the learning media must also be adjusted to the type of learning style of students. This study aims to analyze the effectiveness of *e-learning* media based *on learning style* in the form of *e-posters*, *podcasts*, and interactive videos on the cognitive learning outcomes of learners with visual, auditory, and kinesthetic learning styles. Therefore, the e-learning media based on the learning style developed in this study can be applied to other chemical materials or subjects.

2. Method

This research uses a quantitative approach, a knowledge discovery process that uses data in the form of numbers to find information that someone wants to know (Gunawan et al., 2022). This approach is the most suitable for collecting accurate population information. Research data analyzed with a quantitative approach must be observable, measurable, and in the form of objective reality that can be broken down and studied independently. Analysis in quantitative research is centered on numerical data (numbers), which are then processed using descriptive statistical methods. Descriptive statistics are statistics used to analyze data by describing the data obtained so that through a quantitative approach, objective research results will be obtained (Hashim et al., 2022). Therefore, the quantitative approach is the approach that best suits this study.

The assumption test used in this study is a normality test. The normality test is conducted to determine whether the data obtained by researchers comes from a normally distributed population. The normality test in this study used SPSS 21 as an auxiliary tool. According to (Ranti, Budiarti, & Trisna, 2017), the hypotheses tested are as follows:

H0 : Normal distributed data
H1 : Data is not normally distributed

Hypothesis testing is carried out through the Kolmogorov-Smirnov test. The criteria for taking the above hypothesis, according to (Ranti, Budiarti, & Trisna, 2017), are as follows:

a.If sig<0.05, H0 is rejected
b.If sig>0.05, H0 is accepted

The hypothesis test used is the *Wilcoxon signed-rank test*. The *Wilcoxon signed-rank* test is a non-parametric test based on paired samples. The *Wilcoxon signed rank* test determines whether there are differences in learning outcomes between before and after using *e-learning* media based *on learning style*. This test is also used to determine whether there is an increase in learning motivation after using *e-learning* media based *on learning style* in learning. This test is used if the data is abnormally distributed (Bina, 2021). In this study, the hypotheses used are:

1. If *Asymp sig < 0.05*, H0 is rejected; this means that there is a difference in cognitive learning outcomes of students before and after the use of *e-learning* media based *on learning style* in learning.
2. If *Asymp sig > 0.05* H0 is accepted, this means that there is no difference in students' cognitive learning outcomes before and after the use of *e-learning* media based *on learning style* in learning.

The decision-making on the *Wilcoxon signed-rank* test can be obtained using the *Asymp sig value.* The basis for decision-making is the same, namely:

1. If *Asymp sig* < 0.05, H0 is rejected; this means that *e-learning* media based *on the learning style* developed is effective in improving the cognitive learning outcomes of students.
2. If *Asymp sig* > 0.05, H0 is accepted; this means that *the e-learning* media based *on the learning style* developed is not effective for improving the cognitive learning outcomes of students.

Based on the Wilcoxon signed rank test analysis, data were obtained on whether *e-learning* media based *on learning style* had a significant effect on the cognitive learning outcomes of students. Then, this *N-gain* analysis was conducted to determine how much influence the *e-learning* media based *on the developed learning style* on students' cognitive learning outcomes (Cohen & Swerdelik, 2010). This N-gain analysis shows the effectiveness of *e-learning* media based *on learning styles* developed on students' cognitive learning outcomes. The calculation formula used is as follows:

$$< g >= \frac{Sf - Si}{ls - Si}$$

Information:
<g> = normalized gain
Si = skor *pre-test*
Sf = *post-test score*
Is = skor maximum ideal

The criteria used to represent the normalized *N-gain* value, according to Cohen & Swerdelik (2010), can be seen in Table 1.

Table 1. *N-gain* Category

No	Achievement Level (%)	Category
1.	(g) < 0,3	Low
2.	0,3 < (g) <0,7	Medium
3.	(g) < 0,7	High

The research instruments used in this study were learning style analysis questionnaire instruments and learning outcome test instruments. The learning style analysis questionnaire contains 30 statements adapted from Chislett and Chapman (2005). The learning outcome test instrument used in this study amounted to 5 description questions that had been declared valid based on the results of validation that five validators had carried out. The calculation of validation results in this study uses Aiken's V statistics. Aiken (1985) formulated Aiken's V formula for validity values based on the assessment results of validators. Here are Aiken's V statistics formulated:

$$V = \frac{\Sigma(r_i - l_o)}{[n(c-1)]}$$

As for reliability, it is calculated using *the Cronbach alpha* formula, which is as follows:

$$r_{11} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\Sigma\sigma_b^2}{\sigma_t^2}\right)$$

Information:

r11 = Cronbach Alpha *reliability coefficient*
k = many items/question items
Σσ2b = number / total variance per item/item of question
σ2t = number/ total variance.

Based on calculations, the coefficient of reliability of the learning outcome test instrument is 0.98, so it can be concluded that the instrument is reliable.

The population in this study was all grade X students of SMA Negeri 3 Banjarmasin. The sample used was class X PMIA 1 students, totalling 32 students. The determination of samples used in this study used *purposive sampling techniques* because the selection of research samples was based on several criteria. The sample in this study has been following the criteria applied by the researcher, namely students (samples) are class X semester II, students have low cognitive learning outcomes in chemistry learning known from interviews with subject teachers and *pre-test results*, students do not know the type of learning style they have which is known from observations made on students, And students master how to use *Google Classroom* well, this is because students are familiar with online learning using *Google Classroom.* Therefore, class X PMIA 1 can be used as a sample in this study to represent the other class X PMIA. Based on interviews with subject teachers, all class X students have the same criteria.

3. Result and Discussion

This study used a learning style questionnaire containing 30 points of statements adapted from Chislett & Chapman (2005). Each statement has three answer choices: answer choice A for visual learning style, answer choice B for auditory learning style, and answer choice C for kinaesthetic learning style. This learning style questionnaire is presented in Google Forms. The results of the learning style analysis of class X PMIA 1 students are presented in Table 2.

Table 2. Results of Analysis of Learning Styles of Class Students X PMIA 1

No	Learning Style	Number of Students	Percentage (%)
1.	Visual	10	31,25
2.	Auditory	12	37,5
3.	Kinestetik	10	31,25

Table 2 shows that the learning style that most learners have is the auditory learning style. The learning styles of learners are also influenced by their learning experiences. It is because one of the factors that affect learning style is external factors. In this case, external factors that play an essential role are school factors, namely learning methods. The lecture method is the most frequent and most commonly used method of learning. Thus, if it is associated with auditory learning styles, the lecture method, which is the method most often encountered by students, makes them accustomed to learning and requires them to concentrate on understanding the material delivered orally. It makes students tend to have an auditory learning style.

Data on learners' cognitive learning test results obtained from *pre-test* and *post-test* in limited trials can be seen in Table 3. Based on Table 3, it is known that at the

time of *the pre-test*, students' knowledge is in the sufficient and good category. After being given treatment, namely learning using *e-learning* media based *on learning style*, the *post-test* results of students are in the good and very good categories. The lowest and highest values of *pre-test* and *post-test* are presented in Table 4.

Table 3. Pre-Test and Post-Test Results of Learners' Cognitive Learning Outcomes

Category	Number of Students	
	Pre-test	***Post-test***
Less	0	0
Enough	17	0
Good	15	3
Very Good	0	29
Sum	32	32

Table 4. Lowest and Highest Scores in Pre-Test and Post-Test Learning Outcomes

Value	Pre-Test	Post-Test
Lowest	46,66	80
Highest	73,33	100
Average	**62,45**	**90,62**

Table 4 shows that after going through the learning process, *post-test* results have improved. It means that the learning process goes well. The application of learning using *e-learning* media based *on learning style* is more interactive because students can learn to use learning media that suits their learning style. Besides that, when in class, students are grouped according to their learning style, then problems are discussed, and the results of their discussions are conveyed according to their respective learning styles, namely simple posters, sound recordings, and videos. Learning by utilizing technology combined with learning styles can increase student participation and independence of learning, and make students more active during discussions (Ernawati et al., 2022). Adaptive learning media is considered to have clear, systematic, logical stages, and can be used to measure critical and creative thinking abilities (Sulistyanto et al., 2022). Students need to be trained to use their thinking skills in learning so that they not only can memorize but also can think critically (Listiaji et al., 2022). The learning atmosphere in the classroom becomes more pleasant and makes students enthusiastic to participate in classroom learning. The results of student discussions on each learning style are presented in Table 5

Table 5 Results of student discussions on each learning style

Problems	When a flood occurs, usually PLN will temporarily cut off electricity for safety reasons. Analyze and explain why it needs to be done, while based on the test, the conductivity of water solutions or *aquades* is non-electrolyte, which means it cannot conduct electric current.
Group 1 visual learning styles	In times of flooding, electricity must be cut off. The relationship of water with electricity is that pure water does not conduct electricity (non-electrolyte), but water already has substances. Dissolved (in the form of substances that ionize or produce ions) is an electrolyte so that it can conduct electric current. Because the water has been mixed with other substances, the water can conduct electric current during a flood, which requires PLN to cut off electricity temporarily.
Group 2 visual learning styles	PLN usually temporarily cuts off electricity during floods because if it is not cut off, there will be a short circuit of damaged electricity,

Problems	When a flood occurs, usually PLN will temporarily cut off electricity for safety reasons. Analyze and explain why it needs to be done, while based on the test, the conductivity of water solutions or *aquades* is non-electrolyte, which means it cannot conduct electric current.
	outages, and even casualties. Water or *aquades* is a non-electrolyte solution, but for flood water is an electrolyte solution because flood water has been polluted with substances containing ions, which function as conductors of electric current in electrolyte solutions so that flood water contains electrical conductivity and extinguishes electricity when a flood occurs.
Group 1 auditory learning styles	During a flood, PLN will usually temporarily cut off the electricity because if it is not turned off, there will be an electrical short circuit that causes electricity to be damaged and go out. Because flood water has been mixed with other substances containing ions, flood water is a conductor of electricity, so when a flood occurs, electricity must be turned off so as not to be electrocuted. Moreover, humans contain much water, which makes them conductors (good conductors of electricity). So, if humans encounter water when flooding when electricity is on, humans can be electrocuted, which is very dangerous for humans.
Group 2 auditory learning styles	PLN turns off electricity when flooding aims to prevent residents from being electrocuted, and a short circuit occurs. This is because electricity can flow through a cable immersed in water. In addition, flood water is also a weak electrolyte because it is mixed with other ionized substances. Even though it is classified as a weak electrolyte, PLN still temporarily cuts off electricity for the safety of residents and prevents other bad things.
Group 3 auditory learning styles	PLN temporarily cuts off electricity during flooding because flood water does not include pure water, so it is an electrolyte, while *aquades* are pure water that is non-electrolyte. If PLN does not temporarily cut off electricity during a flood, a detrimental short circuit will occur. Flood water does not include pure water because it has been mixed (garbage, river water, and rainwater).
Group 1 kinesthetic learning styles	PLN turns off electricity during floods so that residents affected by floods are not electrocuted, although the results of water tests show that *aquades* (pure water) are non-electrolytes. However, water in floods can contain solutes in the form of ionized substances or produce ions that are electrolytes so that they can conduct electricity.
Group 2 kinesthetic learning styles	AIR has electrolyte properties (able to conduct electric current), although classified as a weak electrolyte. For the safety of residents, it would be better if PLN turns off the electricity to prevent other bad things. Senayawa ions in the soil that dissolve in water conduct electricity because the electrical conductivity of a solution depends on the number of ions in it. The reason why *aquades* water solution cannot conduct electricity is because *aquades* are included in non-electrolyte solutions. While the flow of electric charges such as ions and electrons must conduct the electric current.

The average value of learning outcomes in the realm of knowledge of students in each indicator of competency achievement (GPA) can be seen in Table 6.

Table 6 Average Learning Outcomes of Students in Each Indicator of Competency Achievement

Competency Achievement Indicators (IPK)		Achievement Level (%)	
		Pre-Test	Post-Test
(a)	Students are able to explain the reason for a power outage when there is a flood well after using *e-learning* media based *on learning style* (*e-posters, podcasts,* and interactive videos)	56,25	83,33
(b)	Students are able to analyze the electrolyte properties of several solutions that exist in the environment and those in the laboratory correctly after using *e-learning* media based *on learning style* (*e-posters, podcasts,* and interactive videos)	67,70	97,91
(c)	Students are able to group solutions into strong electrolytes, weak electrolytes, and non-electrolytes based on their electrical conductivity correctly after using *learning* style-based *e-learning media* (*e-posters, podcasts,* and interactive videos)	91,67	98,95
(d)	Students are able to explain the event of being electrocuted by someone when there is direct contact with electricity well after using *e-learning* media based *on learning style* (*e-posters, podcasts,* and interactive videos)	34,37	79,16
(e)	Students are able to conclude the function of electrolyte solutions in the human body and how to overcome electrolyte deficiencies in the body well after using *e-learning* media based *on learning style* (*e-posters, podcasts,* and interactive videos)	62,50	93,75

Table 6 shows that there was an increase in the percentage of learning outcomes in all indicators after implementing learning using *e-learning* media based *on learning style*. Of the five indicators, the indicator with the highest level of achievement or percentage is indicator 3, which groups (C2) solutions into strong electrolytes, weak electrolytes, and non-electrolytes. This is because participants already understand the concept of electrolyte and non-electrolyte solutions well, so it is easy to group solutions. In addition, this matter presents solutions not only in the laboratory but also in everyday life. The indicator with the lowest level of achievement or percentage is indicator 4, which explains (C2) the event of a person's electrocution when there is direct contact with electricity. This is because students still have difficulty deeply understanding that electrolytes in the human body can conduct electricity. In addition, this material is microscopic, so students cannot imagine it.

The average *pre-test* and *post-test scores* of learners' cognitive learning outcomes in each learning style are presented in Figure 1.

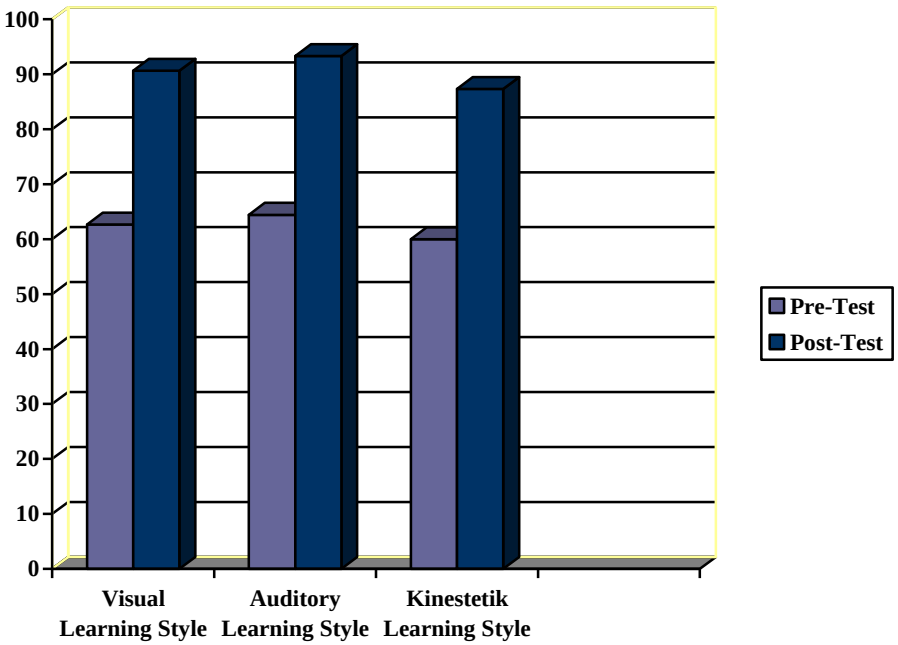

Figure 1. Learners' Pre-Test and Post-Test Scores on Each Learning Style

Based on the data presented in Figure 1, which shows the average *pre-test* and *post-test scores* of cognitive learning outcomes of students in each learning style, it is known that the average post-test scores of students with auditory learning styles have the highest percentage. The results of this study support the results of previous research conducted by Hariadi (2015), which showed that students with auditory learning styles obtain better cognitive learning outcomes compared to students who have visual and kinesthetic learning styles. The results of this study also show that the lecture method makes students tend to have an auditory learning style. When the lecture method is packaged in accordance with technological developments, which are developed in the form of *a podcast*, the cognitive learning outcomes of students with auditory learning styles are better than students with visual and kinesthetic learning styles. It is directly proportional to the data in Figure 2, which shows that the average *N-gain* value of learning outcomes on auditory learning styles obtained the highest value. That is, students with auditory learning styles experience the greatest improvement in cognitive learning outcomes among the three learning styles. However, overall, the difference between the average post-test score and the average N-gain of learning outcomes between learning styles is very small.

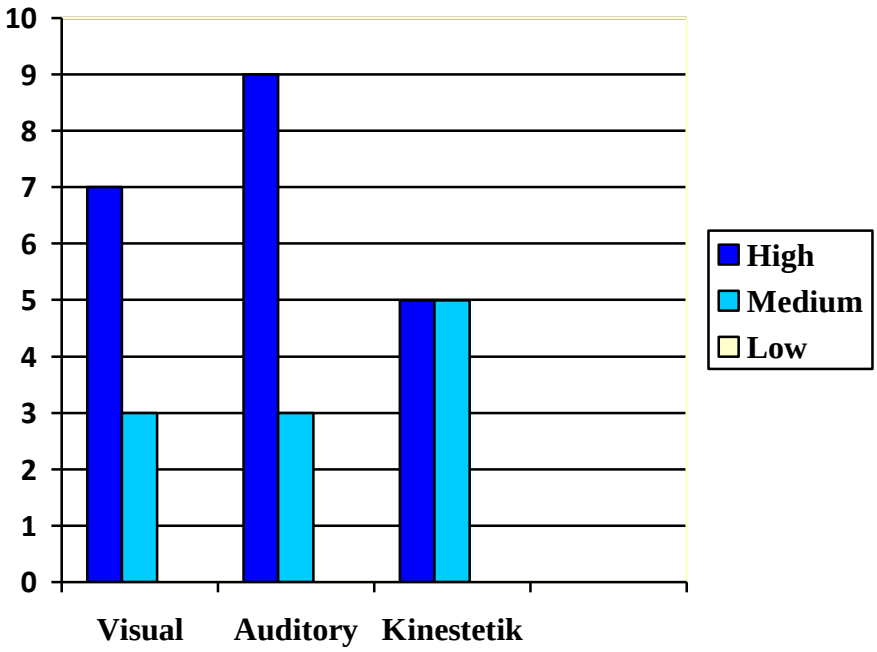

Figure 2. Category *N-Gain* Cognitive Learning Outcomes in A Set of Learning Styles

Figure 2 shows that in each learning style, there are 11 students with N-gain values of learning outcomes categorized as medium and 21 students with N-gain values of learning outcomes categorized as high. It means that there are still some students whose improved learning outcomes are in the moderate category. Figure 2 also shows that the cognitive learning outcomes of learners with auditory learning styles are higher than learners with visual and kinesthetic learning styles. It is the influence of the learning method that students get at the previous level of education, namely the lecture method, that requires them to concentrate on understanding the material delivered orally. Therefore, students with auditory learning styles are accustomed and more receptive to the lecture method, and when the lecture method is packaged in accordance with technological developments, which are developed in the form of podcasts, students with auditory learning styles will find it easier to accept the material delivered. In Table 6, it can be seen that the lowest N-Gain value is found in the kinesthetic learning style, which is 0.71, while the highest N-Gain value is found in the auditory learning style, which is 0.80, while the N-Gain value in visual learning style is 0.75. From these values, it can be seen that the difference in N-gain values between learning styles is not significant, and based on the data presented in Table 7, overall, it shows that the average *N-gain* value of learning outcomes in each learning style is categorized as high. Based on the N-Gain value, it can be seen that the e-learning media based on the learning style developed in this study is very influential on the cognitive learning outcomes of students. The results of this study also support previous research conducted by Hariadi (2015), which found that learning styles affect the cognitive learning outcomes of students.

Table 7. Average *N-gain* of Learning Outcomes in Each Learning Style

Learning Style	*N-gain* Value	Category
Visual	0,75	High
Auditory	0,80	High
Kinestetik	0,71	High

1. Normality Test

The normality test was conducted to determine whether the cognitive learning data of students before and after the use of *e-learning* media based *on learning styles* developed in learning obtained in normally distributed research or not (Ranti, Budiarti, & Trisna, 2017). In conducting normality tests, researchers use SPSS 21 as a tool. The normality test results from *the pre-test* and *post-test* data can be seen in Table 8.

Table 8. Results of the Normality Test of Learners' Cognitive Learning Outcomes

Tests Of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre-Test	.184	32	.008	.910	32	.011
Post-Test	.220	32	.000	.878	32	.002
a. Lilliefors Significance Correction						

Based on the results of the normality test in Table 8 above, it can be seen that the sig value in the *Kolmogorov-Smirnov section table*, both *pre-test* and *post-test*, is *sig.* < 0.05. It shows that H0 is rejected and H1 is accepted, which means that the data on cognitive learning outcomes of students before and after the use of *e-learning* media based *on learning* styles in learning (*pre-test* and *post-test*) in this study are not normally distributed. Therefore, the analysis of results cannot be done with parametric tests, so the analysis of data on cognitive learning outcomes of students is carried out with non-parametric tests, namely with *the Wilcoxon signed rank technique*(Bina, 2021).

a. Wilcoxon Signed Rank Test

Pre-tests and *post-tests* in this study were given to the same learners. Therefore, the analysis of cognitive learning outcomes in this study used the *Wilcoxon signed rank test*. The *Wilcoxon signed rank test* was conducted to determine whether there were differences in students' cognitive learning outcomes before and after the use of *learning* style-based *e-learning* media in learning. In conducting *the Wilcoxon signed rank* test, researchers used SPSS 21 as a tool. The *Wilcoxon signed rank test* results from student cognitive learning outcomes data can be seen in Table 9.

Table 9. Statistical tests *Wilcoxon Signed Rank* Test Data on Cognitive Learning Outcomes of Learners

Test Statistics[a]	
	Post-Test- Pre-Test
Z	-4.960[b]
Asymp. Sig. (2-tailed)	.000

Based on the statistical test *of the Wilcoxon signed rank* test on the cognitive learning outcomes data of students presented in Table 9, *an asymp value was obtained.*

Sig. (2-tailed) which is 0.000 <0.05. These results show that H0 is rejected and H1 is accepted, which means that there are differences in students' cognitive learning outcomes between before (*pre-test*) and after (*post-test*) using *e-learning* media based *on learning* styles in learning in the form of *e-posters, podcasts,* and interactive videos.

4. Conclusion

Based on the results of the research that has been described, it is known that of the three learning styles, students with auditory learning styles with learning media in the form of podcasts experience the greatest increase in cognitive learning outcomes among students with visual and kinesthetic learning styles, with learning media in the form of *e-posters* and interactive videos, namely with N-Gain values on visual, auditory, kinesthetic learning styles of 0.75, 0.80, and 0.71, respectively. However, overall, based on *the N-gain* value and *Wilcoxon signed rank test,* e-learning *media* based *on learning style* in the form of *e-posters, podcasts,* and interactive videos are effective for improving the cognitive learning outcomes of students with visual, auditory, and kinesthetic learning styles. The results of this study show that it is very important for students to know the type of learning style they have and get learning media that suits their respective learning styles so that students are more optimal in receiving the material delivered in learning. Therefore, there is a need for innovations in preparing learning media for students, which is packaged with technology and in accordance with the learning styles of students. In addition, there is a need for a learning style test to determine the type of learning style of students. Learning style tests can be conducted to all students every new school year. So that all teachers have data on student learning styles and can apply differentiated learning based on student learning styles.

5. References

Ana, A. (2020). Trends in expert system development: a practicum content analysis in vocational education for over grow pandemic learning problems. *Indonesian Journal of Science & Technology* , 5(2), 246-260.

Ahmad, N. J.,Yakob, N., Bunyamin, M. A. H., Winarno, N., & Akmal, W. H. (2021). The effect of interactive computer animation and simulation on students' achievement and motivation in learning electrochemistry. *Jurnal Pendidikan IPA Indonesia*, 10(3), 311-324. Doi: https://doi.org/10.15294/jpii.v10i3.26013

Almubarak, Saadi, P., Prayogi, R., & Maldini, P. P. (2023). Assessing Students Understanding of Chemical Bonds Material by Rasch Modeling. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *5*(3), 217–232. https://doi.org/10.23917/ijolae.v5i3.2224

Atmojo, S. E., Muhtarom, T., & Lukitoaji, B. D. (2020). The level of self-regulated learning andself-awarenes in science learning in the covid-19 pandemic era. *Jurnal Pendidikan IPA Indonesia* , 9(4), 512-520. Doi: https://doi.org/10.15294/jpii.v9i4.25544.

Audu, C. T. (2020). Learning style as predictors of classroom dialogue among upper basic science students in Taraba State, Nigeria. *Journal of Education & Practice* , 11(11), 23-29.

Avalos, C., Escoda, A. P., & Monge, L. (2019). Lean Starup as a Learning Methodology for Developing Digital and Research Competencies. Journal of New Approaches In Educational Research, 8(2), 227-242. Doi: https://doi.org/10.7821/naer.2019.7.438

Banjarnahor, S., Sinaga, B., & Napitupulu, E. (2017). Analysis of problem solving ability in applying problem based learning reviewed from the learning style. *Journal of Education and Practice* , 8(34), 127-135.

Bina, N. S. (2021). Pengaruh platform Pembelajaran Daring Youtube terhadap kemampuan matematis di masa pandemik covid-19. *Jurnal Pendidikan Matematika* , 4(1),32-39. Doi: https://doi.org/10.31537/laplace.v4i1.461.

Cano, E. V., Lopez, J. M. S., Santamaria, R. O. G., & Garcia, M. P. Q. (2023). Influence of Age, Gender and Years of Experience on Teachers in Promoting Strategies for Digital Sustainability and Data Protection. Journal of New Approaches In Educational Research. 12(2), 307-322. Doi: https://doi.org/10.7821/naer.2023.7.1467

Chislett, V., & Chapman, A. (2005). *VAK Leaning style self assesment questionnaire.* http://www.businnesballs.com, Diakses pada tanggal 24 Februari 2022, pukul 10.00 WITA.

Cohen, R. J., & Swerdlik. (2010). *Psychoology testing and assesment: an introducition to test andmeasurement.* New York: McGraw-Hill.

Creer, A. (2018). Introducing Everyday 'Digital Literacy Practices' Into The Classroom: An Analysis of Multi-Layered Media, Modes, and Their Affordances. Journal of New Approaches In Educational Research. 7(2), 131-139. Doi: https://doi.org/10.7821/naer.2018.7.265

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientifiic literacy. *Jurnal Pendidikan IPA Indonesia* , 8(2), 279-287. Doi: https://doi.org/10.15294/jpii.v8i2.19261.

Elina, E. D., Senam, Wilujeng, I., & Jumadi. (2016). The effectiveness of project-based e-learning to improve ICT literacy. *Jurnal Pendidikan IPA Indonesia* , 5(1), 51-55. Doi: https://doi.org/10.15294/jpii.v5i1.5789.

Ernawati, M. D., Sudarmin, S., Asrial, A., Muhammad, D., & Haryanto, H. (2022). Creative thinking of chemistry and chemistry education students in biochemistry learning through problem based learning withscaffolding strategy. *Jurnal Pendidikan IPA Indonesia* , 11(2), 282-295. Doi: https://doi.org/10.15294/jpii.v11i2.33842.

Ertikanto, C., Rosidin, U., Distrik, I. W., Yuberti, & Rahayu, T. (2018). Comparison of mathematical representation skill and science learning result in classes with problem-based and discovery learning model. *Jurnal Pendidikan IPA Indonesia* , 7(1), 106-113. Doi: https://doi.org/10.15294/jpii.v6i2.9512.

Fitriyana, N., Wiyarsi, A., Ikhsan, J., & Sugiyarto, K. H. (2020). Android-based-game and blended learning in chemistry: effect on students self-efficacy and achievement. *Jurnal Cakrawala Pendidikan* , 39(3), 507-521. Doi: https://doi.org/10.21831/cp.v39i3.28335.

Froehlich, D. E. (2018). Non-technological Learning Environments in a Technological World: Flipping Comes to the Aid. Journal of New Approaches In Educational Research. 7(2), 88-92. Doi: https://doi.org/10.7821/naer.2018.7.304

Gigzaw, P. A., & Hirpa, T. (2020). Students' perceptual learning style preferences, their achievement, and teachers' teaching style (with particular reference to Tana Beles Girls' Boarding School, Pawe Woreda). *Journal of Education & Practice* , 11(10), 47-55.

Gunawan, B., Ratmono, B. M., Abdullah, A. G., Sadida, N., & Kaprisma, H. (2022). Research mapping in the use of technology for fake news detection:

bibliometric analysis from 2011 to 2021 . *Indonesian Journal of Science & Technology* , 7(3), 471-496.

Hariadi, B. (2015). Web-based cooperative learning, learning style, and student's learning outcomes. *Jurnal Cakrawala Pendidikan* , 34(2),160-170. Retrieved from https://journal.uny.ac.id/index.php.

Hajrhma, H. I., Nugedalla, M. A., Hajhamed, R. M., Adam, A. M., Almukhtar, A. A., Mohamed, A. A., et al. (2022). Assessment of the learning styles of MBBS students at the University of Kassala State, Sudan, 2022. *Journal of Education & Practice* , 13(30), 1-5.

Haristiani, N., & Rifa'i, M. M. (2020). Combining chatbot and social media: enhancing personal learning environment (PLE) in language learning. *Indonesian Journal of Science & Technology* , 5(3), 487-506.

Hashim, S., Masek, A., Mahthir, B. N., Rashid, A. H., & Nincarean, D. (2022). Association of interest, attitude and learning habit in mathematic learning toward enhancing student's achievement. *Indonesial Journal of Science & Technology* , 6(1), 113-122.

Ijirana, & Supriadi. (2018). Metacognitive skill profiles of chemistry education students in solving problem at low ability level. *Jurnal Pendidikan IPA Indonesia* , 7(2), 239-245. Doi: https://doi.org/10.15294/jpii.v7i2.14266.

Listiaji, P., Widianingrum, R. A., Saputri, A. A. I., & Rahman, N. F. A. (2022). PjBL Model assisted by Smartphone Sensors to Improve Critical Thinking Skills of Prospective Science Teachers. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(3), 246–256. https://doi.org/10.23917/ijolae.v4i3.18942

Miskiah, M., Suryono, Y., & Sudrajat, A. (2019). Integration of information andk comunication technology into islamic religious education teacher training. *Jurnal Cakrawala Pendidikan* , 38(1), 130-140.

Mufdalifah, Setyosari, P., Widiati, U., & Sihkabuden. (2018). The influence of cognitive loads (low and high) of multimedia in direct learning style to the result of reading comprehension for the second grade of senior high school students. *Journal of education and practice* , 9(1), 32-40.

Rafi, F., & Pourdana, N. (2023). E-Diagnostic assessment of Collaborative and individual oral tiered task performance in differentiated second language instruction framework. International Journal of Educational Technology in Higher Education. 13(6), 1-18. Doi: https://doi.org/10.1186/s40468-023-00223-7

Rahayu, S., Klaudia, E. N., Bambut, & Fajaroh, F. (2020). Do different discussion activities in developing scientific argumentation affect students motivation in chemistry?. *Jurnal Cakrawala Pendidikan* , 39(3), 679-693. Doi: https://doi.org/10.21831/cp.v39i3.32228.

Ranti, M. G., Budiarti, I., & Trisna, B. N. (2017). Pengaruh kemandirian belajar (self-regulated-learning) terhadap hasil belajar mahasiswa pada mata kuliah struktur aljabar. *Jurnal Pendidikan Matematika* , 3(1), 75-83. Doi: https://doi.org/10.33654/math.v3i1.57.

Redhana, I. W., & Merta, L. M. (2017). Green chemistry practicum to improve student learning outcomes of reaction rate topic. *Jurnal Cakrawala Pendidikan* , 36(3), 382-403. Doi: https://doi.org/10.23831/cp.v36i3.13062.

Redhana, I. W., Sudria, I. B., Hidayat, I., & Merta, L. M. (2017). Identification of chemistry learning problems viewed from conceptual change model. *Jurnal Pendidikan IPA Indonesia* , 6(2), 356-364. Doi: https://doi.org/10.15294/jpii.v6i1.9549.

Sangsawang, T. (2020). An instructional design for online learning in vocational education according to a self-regulated learning framework for problem solving during the covid-19 crisis. *Indonesian Journal of Science & Technology* , 283-298.

Saripudin, Djohar, A., Rohendi, D., & Abdullah, A. G. (2020). Developing information technology in opencoursware: from movements to opportunities in Asia. *Indonesia Journal of Science & Technology* , 5(3), 308-320.

Soegoto, E. S., Soegoto, H., Soegoto, D. S., Soegoto, S. W., Rafdhi, A., Saputra, H., et al. (2022). A systematic literature review of internet of things for higher education: architectute and implementation. *Indonesian Journal of Science & Technology* , 7(3), 511-528.

Suhandiah, S., Suhariadi, F., Yulianti, P., Wardani, R., & Muliatie, Y. E. (2022). Online learning satisfaction in higher education: what are the determining factor? *Jurnal Ilmiah Pendidikan* , 41(2), 351-364. Doi: https://doi.org/10.21831/cp.v41i2.35724.

Sulistyanto, H., Anif, S., Sutama, S., Narimo, S., Sutopo, A., Haq, M. I., & Nasir, G. A. (2022). Education Application Testing Perspective to Empower Students' Higher Order Thinking Skills Related to The Concept of Adaptive Learning Media. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(3), 257–271. https://doi.org/10.23917/ijolae.v4i3.19432

Talledo, I. S., Fernandez, N. G., & Briones, E. (2020). The Smartphone as a Pedagogic Tool. Student Profiles as Related to its Use and Knowledge. Journal of New Approaches In Educational Research. 9(1), 91-109. Doi: https://doi.org/10.7821/naer.2020.1.454

Wardani, S., Lindawati, L., & Kusuma, S. B. (2017). The development of inquiry by using android-system-based chemistry board game to improve learning outcome and critical thinking ability. *Jurnal Pendidikan IPA Indonesia* , 6(2), 196-205. Doi: https://doi.org/10.15294/jpii.v6i2.8360.

Widarti, H. R., Rokhim, D. A., & Syafruddin, A. B. (2020). The development of electrolysis cell teaching material based on STEM-PJBL approach assisted by learning video: a need analysis. *Jurnal Pendidikan IPA Indonesia* , 9(3), 309-318. Doi: https://doi.org/10.15294/jpii.v9i3.25199.

Yuliastini, I. B., Rahayu, S., Fajaroh, F., & Mansour, N. (2018). Effectiveness of pogil with SSI context on vocational high school students chemistry learning motivation. *Jurnal Pendidikan IPA Indonesia* , 7(1), 85-95. Doi: https://doi.org/10.15294/jpii.v7i1.9928.