JPPIPA 9(11) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Meta-Analysis: The Effect of Electronic Learning Media on Students' 21st Century Skills in The Industrial Revolution Era 4.0

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Received: June 19, 2023
Revised: September 14, 2023
Accepted: November 25, 2023
Published: November 30, 2023

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DOI: 10.29303/jppipa.v9i11.4361

Abstract: The industrial revolution era, which is characterized by the entry of technology into all spheres of life, including education, has an impact on 21st century learning. Critical thinking, communication, collaboration, creativity, and innovation are the focus of this 21st century learning. This kind of study is a meta-analysis study, which gathers, examines, and compares data from several previously finished investigations. The research sample was made up of 24 source papers that met the requirements for the problem formulation. The data analysis technique applied in this study reduces the impact of each publication. It has been found that electronic learning media have the following effects on 21st century skills in the industrial revolution era: First, depending on the kind of media, AR is the most successful in affecting 21st century abilities. Second, according to the classification of 21st century skills, technology-based learning materials have an impact on critical thinking, creativity, and communication abilities. In the sense that technology-based learning media has a significant effect size for improving students' 21st century skills in the era of the industrial revolution 4.0

Keywords: 21st Century Skills; Electronic Media; Meta-Analysis.

Introduction

The development of science and technology in the 21st century has brought changes to the world of education. Education, which is the most important part of life, must be able to adapt to the times because education will be a provision for humans in facing the challenges of a changing era entering the 21st century. The 21st century is characterized by the abundance of (1) information that is available anywhere and can be accessed at any time; (2) increasingly fast computing; (3) automation that replaces routine tasks; and (4) communication that can be done from anywhere and anywhere so that it can be said that all aspects of life must be able to adapt to technology including education (Ayu, 2019). Schools that are one of the formal educational institutions that aim to produce the nation's next generation who are not only smart but also have good skills and attitudes must be able to become a place to provide knowledge to students about technology through learning.

One way to provide students with knowledge about technology is to apply technology in learning, namely applying it in learning media (electronic-based learning media). Electronic-based learning media consists of several types including virtual laboratories, AR-based learning media and others so that teachers must be able to choose the right learning media to develop students' skills and knowledge in 21st century education. However, according to (Aulia, Widodo, Subekti, Hidayati, &; Sari, 2022) In the 21st century, teachers experience difficulty choosing and creating practical and efficient learning media. This is because there is still a lack of teacher knowledge in technology used as a learning medium. In choosing 21st century learning media, it is not only about media accuracy but also must pay attention to effectiveness in improving the skills needed and must be developed in the 21st century. It aims to prepare 21st century students to become

How to Cite:
Amanda, F. D., Rahmi, Y., Asrizal, & Akmam. (2023). Meta-Analysis: The Effect of Electronic Learning Media on Students' 21st Century Skills in The Industrial Revolution Era 4.0. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 992–1003. https://doi.org/10.29303/jppipa.v9i11.4361

reliable students in the future in facing the challenges of 21st century development.

21st century skills abbreviated as 4C's are critical thinking, collaboration, creativity, and communication. Where Communication means, learning carried out by teachers and students must occur multidirectional communication. Collaboration means, in the learning process the teacher should create a situation where students can learn together or in groups, so that it will create a democratic atmosphere where students can learn to appreciate differences of opinion, realize the mistakes they make, and can cultivate a sense of responsibility in doing the responsibilities given.

Critical thinking and problem-solving means, the learning process should make students able to think critically by connecting learning with contextual problems that exist in everyday life. Creativity and innovation means that learning must create conditions where students can create and innovate, instead of being dictated and intimidated by teachers (Zulkarnain et al., 2020). By considering the improvement of students' skills based on the needs of the 21st century, the selection of electronic learning media must be effective in improving 21st century skills.

In determining effective and appropriate learning media to be used in improving students' 21st century skills, one alternative is to read some previous research on learning media in improving students' 21st century skills. However, based on the results of searching several journals, different opinions were found about effective and appropriate electronic-based learning media to improve students' 21st century skills, including.

Based on research conducted by Mat, Aji, &; Kurniawati (2023) Technology-based learning media such as virtual laboratories can improve students' 21st century skills, especially critical thinking skills, while according to research conducted by Yanti, Marzuki, &; Sawitri, (2020) It was found that virtual laboratories are not always effective for use in improving 21st century skills such as momentum and photoelectric materials, the use of virtual laboratories does not have a very high effectiveness for improving students' 21st century skills. Further search results regarding effective technology-based learning media to improve students' 21st century skills, found the fact that based on research conducted by (Robbia &; Fuadi, 2020). It was found that interactive multimedia is an effective learning medium to improve students' 21st century skills. Therefore, to find out which electronic-based learning media are the most influential and effective on students' 21st century skills, it is done meta-analysis of the effect of electronic learning media on students21st century skills in the industrial revolution era 4.0.

Method

By offering quantifiable data in the form of effect sizes from each trial, this research qualifies as a meta-analytic study. The research cited in the meta-analysis comes from both domestic and foreign journals. The keywords used in the search were electronic media, 21st century skills, and industrial revolution 4.0 on Google Scholar and similar search engines.

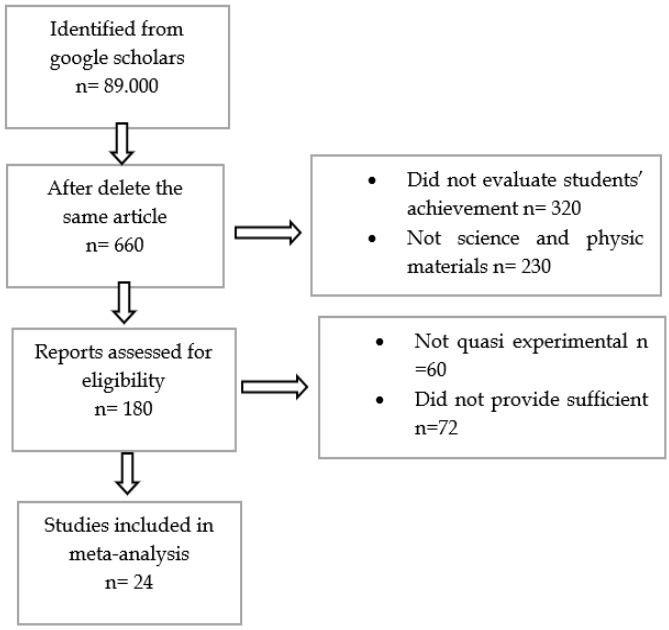

Figure 1. Meta-analysis research flow

To determine the size of the effect can be using statistical parameters according to table 1 and table 2 categorize the following results: For the size of determining the summary effect of the fixed effect and random effect models, you can use the formulas in table 1 and table 2.

Table 1. Effect Size Determination Method

Statistics	Formula
The effect size formula for the two-sample comparison test relates to the pretest-posttest mean and pretest-posttest standard deviation	$ES\ (d) = \frac{\overline{X}_{post} - \overline{X}_{pre}}{SD_{within}}$
	$SD_{within} = \sqrt{\frac{SD_{Pretest^2} - SD_{Posttest^2}}{2}}$
The effect size formula for a comparison test of two independent samples. Used if it is known only the posttest data from the mean and standard deviation of the two sample groups.	$ES\ (d) = \frac{\overline{X}_E - \overline{X}_C}{SD_{within}}$
	$SD_{within} = \sqrt{\frac{(n_E - 1)SD_{E^2} + (n_c - 1)SD_{C^2}}{n_E + n_{c^{-2}}}}$
The effect size formulas for the two independent sample groups for the posttest pretest mean scores and the pretest standard deviation for the experimental class are known, the pretest posttest mean scores, the pretest standard deviations and the control group posttest are known	$ES = \frac{(\overline{X}_{post} - \overline{X}_{pre})_E - (X_{post} - \overline{X}_{pre})_C}{SD_{within}}$
	$SD_{within} = \sqrt{\frac{(n_E-1)SD_{preE^2} + (n_c-1)SD_{preC^2} + (n_E-1)SD_{postE^2} + (n_c-1)SD_{postC^2}}{2(n_E + n_c - 2)}}$
t Count	$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$
To obtain the d variance for the two groups	$Vd = \frac{nE + nC}{nEnC} + \frac{d^2}{2(nE + nC)}$
Variance value d for one group data	$Vd = \frac{1}{n} + \frac{d^2}{2(n)}$
Standard error of d	$SEd = \sqrt{Vd}$
The correction factor is J	$J = 1 - \frac{3}{4df - 1}$
	The df values for the two independent groups viz $df = nE + nc - 2$.
	df value for one group ie $df = n-1$.
Effect size value	$g = J \times d$
Variance value	$Vg = J^2 \times Vd$
standard error	$SEg = \sqrt{Vg}$

(Becker & Park, 2011)

Table 2. Category of Securities Size Value

Effect Size	Category
ES ≤ 0.15	Very low
0.15 < ES ≤ 0.40	Low
0.40 <ES ≤ 0.75	Currently
0.75 <ES ≤ 1.10	Tall
ES≥1.45	Very high

(Dincer, 2015)

Table 3. Effect Size Determination Summary Fixed Effect Model

Statistics	Formula
Fixed effect model	$M = \frac{\sum_{i=1}^{k} W_i Y_i}{\sum_{i=1}^{k} W_i}$ Where, $W_i = \frac{1}{VY_i}$
Variance effect (VM)	$V_M = \frac{1}{\sum_{i=1}^{k} W_i}$
Standard error effect (SEM)	$SE_M = \sqrt{V_M}$
Lower limit (LLM) and Upper limit (ULM)	$LL_M = M - 1.96 \times SE_M$ $UL_M = M + 1.96 \times SE_M$
Test the hypothesis by calculating the value of Z	$Z = \frac{M}{SE_M}$ p – value one – tailed test: $p^* = 1 - \phi(\pm \lvert Z^* \rvert)$ p – value two – tailed test: $p^* = 2[1 - \phi(\pm \lvert Z^* \rvert)$

Table 4. Determination of Effect Size Random effect model

Statistic	Formula
Random effect model	$T^2 = \frac{Q - df}{C}$ Q represents the variability between study means (a measure of heterogeneity). $Q = \sum_{i=1}^{k} (W_i Y_i)^2 - \frac{\sum_{i=1}^{k} (W_i Y_i)^2}{\sum_{i=1}^{k} W_i}$ Where, $C = \sum_{i=1}^{k} W_i - \frac{\sum_{i=1}^{k} W_i^2}{\sum_{i=1}^{k} W_i}$ And, $W_i = \frac{1}{V_{yi}}$
Significant or heterogeneous differences in effect size	$df = k - 1$ $I^2 = \text{maksimum}\ (0, \frac{Q - df}{Q} X\ 100\%$
Weighted mean effect (M*)	$M^* = \frac{\sum_{i=1}^{k} W_i^* Y_i}{\sum_{i=1}^{k} W_i^*}$ Where, $W_i^* = \frac{1}{V^* Y_i}$ And, $V^* Y_i = V_{yi} + T^2$
Standard error effect (SEM*)	$SE_{M^* = \sqrt{VM^*}}$
Lower limit (LLM*) and Upper limit (ULM*)	$LL_{M^*} = M^* - 1.96 \times SE_{M^*}$ $UL_M^* = M^* + 1.96 \times SE_M^*$
Calculating the Z value to test the null hypothesis (H0: true effectθ= 0)	$Z = \frac{M^*}{SE_{M^*}}$ p – value one – tailed test : $p^* = 1 - \phi(\pm \lvert Z^* \rvert)$ p – value two – tailed test : $p^* = 2[1 - \phi(\lvert Z^* \rvert)]$

Result and Discussion

By reviewing and evaluating several previous studies, this research was conducted to determine the effect of science electronic learning media on students' 21st century skills. The information to be studied is drawn from several relevant recent articles which also provide evidence for calculating the effect size of each article. Data is collected by researchers from a variety of sources, including Google Scholar and others.

A total of 24 journals were selected based on certain standards. Several keywords, including learning media, IT media, and 21st century skills, were used in the search. The selection of articles that appear is done after several articles related to the searched keywords appear based on these keywords. After that, selecting articles that meet the criteria for analysis.

The magnitude of the effect and the aggregate effect size of the influence of scientific electronic learning media on students' 21st century abilities are based on the findings of data processing and the study that has been done, respectively. Three categories are used to group the results from the analysis of the 24 journals. First, consider how scientific electronic learning mediums affect students' overall 21st century competencies. The second is how the type of learning media affects the impact of scientific electronic learning medium. The impact of scientific electronic learning medium based on the different 21st century abilities is the third. Table 5 below shows how articles have been codified.

Table 5. Processing Effect Size of Each Article

Article Code	D	Vd	Sed	Df	J	g(Yi) (Effect Size)	Vg (Vyi)	sec
A1 (Suparno et al., 2020)	22.89	24,41	4.94	0.02	178.00	1.00	0.02	24.21
A2 (Istighfarini et al., 2022)	10.00	9.22	3.04	0.84	62.00	0.99	0.84	9.00
A3 (Fatma et al., 2019)	12.00	356.35	18.88	0.00	54.00	0.99	0.00	346.47
A4 (Nugroho et al., 2019)	15.38	3.95	1.99	2.13	51.00	0.99	2.13	3.84
A5 (Suryani et al., 2020)	8.90	2.00	1.41	1.60	62.00	0.99	1.60	1.95
A6 (Laili et al., 2022)	23.44	11132.38	105.51	0.00	62.00	0.99	0.00	10863.60
A7 (Rahmawati et al., 2022)	6.14	1.16	1.08	2.14	58.00	0.99	1.14	1.13
A8 (Sapriadil et al., 2019)	18.81	6,86	2.62	2.39	53.00	0.99	2.44	6.67
A9 (Safitri et al., 2021)	10.75	1.13	1.06	2.00	58.00	0.99	2.00	1.10
A10 (Mahadi et al.,2022)	0.75	0.06	0.24	0.56	54.00	0.99	0.56	0.06
A11 (Lubis et al., 2021)	17.00	8.68	2.95	1.43	65.00	0.99	1.43	8.48
A12 (Rahmanudin et al., 2017)	23.69	20.09	4.48	1.49	48.00	0.98	1.49	19.46
A13 (Agustika, 2021)	0.16	7.43	2.73	0.03	62.00	0.99	0.03	7.25
A14 (Wahyu et al., 2020)	18.29	0.26	0.51	3,15	516.00	1.00	1.15	0.26
A15 (Çetin et al., 2022)	3.33	0.41	0.64	3.05	28.00	0.97	1.15	0.39
A16 (Astuti et al., 2020)	11.91	90.52	9.51	0.31	62.00	0.99	0.31	88.34
A17 (B et al, 2023)	7.70	4.70	2.17	0.92	58.00	0.99	0.92	4.58
A18 (Cai et al., 2021)	0.08	0.02	0.13	0.12	96.00	0.99	0.12	0.02
A19 (Hadiati., 2019)	13.94	74.60	8.64	0.04	74.00	0.99	0.04	73.09
A20 (Simanjuntak et al., 2021)	13.38	2.06	1.44	1.23	130.00	0.99	1.18	2.04
A21 (Heliawati et al., 2021)	9.00	1.04	1.02	2.08	70.00	0.99	2.08	1.02
A22 (Rembulan et al., 2021)	10.53	9.45	3.07	0.90	62.00	0.99	0.70	9.22
A23 (Guan et al., 2021)	0.23	0.01	0.12	0.09	62.00	0.99	0.09	0.01
A24 (Putra et al., 2021)	2.76	3.36	1.83	0.35	71.00	0.99	0.35	3.29

The table shows the effect size of each article addressing the impact of use science electronic learning media on students' 21st century skills based on the processing of the effect size of each article. The average effect size of scientific electronic learning medium on students' 21st century abilities is in the high category, with an average of 0.91, according to the data. This means using science electronic learning media influence on students' 21st century skills. To strengthen the results of research on the influence of science electronic learning

media on students' century skills, heterogeneity tests and hypothesis tests were carried out.

The First, Effect of Science Electronic Learning Media on Students' 21st Century Skill. Results in this study related to heterogeneity testing on science electronic learning media on students' 21st century skills can be seen in Table 6 as follows.

Table 6. Testing Students' 21st Century Skills Heterogeneity

Article Code	Effect Size (Yi)	Variance (Vyi)	Wi-weight	Wi²	WiYi	WiYi²
A1 (Suparno et al., 2020)	0.02	24,21	0.04	0.00	0.00	0.00
A2 (Istighfarini et al., 2022)	0.84	9.00	0.11	0.01	0.09	0.01
A3 (Fatma et al., 2019)	0.00	346,47	0.00	0.00	0.00	0.00
A4 (Nugroho et al., 2019)	2,13	3.84	0.26	0.07	0.55	0.31
A5 (Suryani et al., 2020)	1.60	1.95	0.51	0.26	0.82	0.67
A6 (Laili et al., 2022)	0.00	10863.60	0.00	0.00	0.00	0.00
A7 (Rahmawati et al., 2022)	1.14	1,13	0.89	0.79	1.01	1.02
A8 (Sapriadil et al., 2019)	2.44	6.67	0.15	0.02	0.37	0.13
A9 (Safitri et al., 2021)	2.00	1.10	0.91	0.83	1.82	3.30
A10 (Mahadi et al.,2022)	0.56	0.06	17,43	303.89	9,82	96.52
A11 (Lubis et al., 2021)	1.43	8,48	0.12	0.01	0.17	0.03
A12 (Rahmanudin et al., 2017)	1.49	19.46	0.05	0.00	0.08	0.01
A13 (Agustika, 2021)	0.03	7.25	0.14	0.02	0.00	0.00
A14 (Wahyu et al., 2020)	1.15	0.26	3.84	14.72	4,41	19.47
A15 (Çetin et al., 2022)	1.15	0.39	2.56	6.57	2.95	8.69
A16 (Astuti et al., 2020)	0.31	88.34	0.01	0.00	0.00	0.00
A17 (B et al, 2023)	0.92	4.58	0.22	0.05	0.20	0.04
A18 (Cai et al., 2021)	0.12	0.02	57.98	3361.80	7.08	50,12
A19 (Hadiati., 2019)	0.04	73.09	0.01	0.00	0.00	0.00
A20 (Simanjuntak et al., 2021)	1.18	2.04	0.49	0.24	0.58	0.33
A21 (Heliawati et al., 2021)	2.08	1.02	0.98	0.96	2.03	4,13
A22 (Rembulan et al., 2021)	0.70	9.22	0.11	0.01	0.08	0.01
A23 (Guan et al., 2021)	0.09	0.01	70.42	4959.17	6.64	44.07
A24 (Putra et al., 2021)	0.35	3.29	0.30	0.09	0.11	0.01
Amount			157.54	8649.52	38.81	228.86
Q						227.41
C						102.64
df						23.00
Q²						1.99
I²						89.89%

According to the results of the heterogeneity test, if Q > df, the data is heterogeneous and the assessment of the variance among the articles is relatively high. The random effects model is the one that may be used to determine summary effect sizes. The heterogeneity test also revealed that I^2>25%, or 89.89%, further demonstrating that the result was reached using random effects.

The random effects model is most suited for determining the extent of the influence of technology-based scientific learning media on students' 21st century skills, according to the findings of the heterogeneity testing that has been done. Table 7 displays the results of the calculation of the overall effect size on students' 21st century competencies.

Table 7. Testing Students' 21 st Century Skills Hypothesis

Article Code	Effect Size (Yi)	Variance (Vyi)	Variance Between Articles (T^2)	Total Variance (Vyi+T^2)	Wi-weight*	(Wi*.Yi)
A1	0.02	24.21	1.99	26.20	0.04	0.00
A2	0.84	9.00	1.99	10.99	0.09	0.08
A3	0.00	346.47	1.99	348.46	0.00	0.00
A4	2.13	3.84	1.99	5.83	0.17	0.36
A5	1.60	1.95	1.99	3.94	0.25	0.41
A6	0.00	10863.60	1.99	10865.59	0.00	0.00
A7	1.14	1.13	1.99	3.12	0.32	0.37
A8	2.44	6.67	1.99	8.66	0.12	0.28
A9	2.00	1.10	1.99	3.09	0.32	0.65
A10	0.56	0.06	1.99	2.05	0.49	0.28
A11	1.43	8.48	1.99	10.47	0.10	0.14
A12	1.49	19.46	1.99	21.45	0.05	0.07
A13	0.03	7.25	1.99	9.24	0.11	0.00
A14	1.15	0.26	1.99	2.25	0.44	0.51
A15	1.15	0.39	1.99	2.38	0.42	0.48
A16	0.31	88.34	1.99	90.33	0.01	0.00
A17	0.92	4.58	1.99	6.57	0.15	0.14
A18	0.12	0.02	1.99	2.01	0.50	0.06
A19	0.04	73.09	1.99	75.08	0.01	0.00
A20	1.18	2.04	1.99	4.03	0.25	0.29
A21	2.08	1.02	1.99	3.01	0.33	0.69
A22	0.70	9.22	1.99	11.21	0.09	0.06
A23	0.09	0.01	1.99	2.00	0.50	0.05
A24	0.35	3.29	1.99	5.28	0.19	0.07
Amount					4.95	4.98
M*						1.01
VM*						0.20
SEM*						0.45
LLM*						-0.43
ULM*						1.33
Z*						2.24
p-value one-tailed test						0.01
p-value two-tailed test						0.03

Based on the results of the hypothesis calculation of students' 21st century skills, it was found that the 24 articles used showed that electronic learning media had an influence on students' 21st century skills. The resulting weighted summary effect size of 1.01 shows that the influence of electronic learning media is in the high category, with a confidence interval below -0.43 and above 2.24. The results of the hypothesis test also show that the hypothesis test H0 is rejected as indicated by a p value of. The findings of H0 were refuted, indicating that there was a large variation in the impact of electronic learning media on students' 21st century skills among the 24 articles that were otherwise identical. This is in line with research conducted by Surya ningsih& Nurlita (2021) who conducted research on the importance of electronic teaching materials (E-LKPD) on students' 21st century skills and succeeded in proving that the development of innovative E-LKPD is very important to meet the demands of 21st century learning and improve 21st century skills. The results of this

research are further strengthened by research conducted by Lestari (2022), which based on his research proves that electronic media is effective for improving students' 21st century skills.

The second, for Influence Science Electronic Learning Media Based on Media Type. Results in this study related to heterogeneity testing science electronic learning media based on the type of media can be seen in Table 8 as follows.

Table 8. Heterogeneity Testing Based on Media Type

Journal Code	Media Type	Q	df	I^2
A2	Interactive Multimedia	0.06	5.00	-8296.53%
A3				
A5				
A6				
A11				
A12				
A8	Virtual Laboratory	0.26	3.00	-1049.84%
A19				
A20				
A22				
A13	AR-Based Media	6.10	4.00	34.43%
A14				
A15				
A18				
A24				

The assessment of the variance across articles was not great enough, and the data was not diverse, according to the results of the heterogeneity test, which was conducted on interactive multimedia and virtual laboratories. The fixed effect model is the one that works best for determining the overall effect size. The value calculation findings $I^2 < 25\%$ in interactive multimedia and virtual laboratory, which further underline that decision-making is done using fixed effect model, further support this result.

Based on the heterogeneity test, it was also obtained that the value of Q > df on AR-based learning media, then the estimation of the variance between articles is quite large and the data is heterogeneous. The model that is suitable for calculating summary effect sizes on AR-based learning media articles is the random effects model. Based on the heterogeneity test it was also found that I^2>25% namely 89.89%, so that it further confirms that the conclusion is carried out with random effects

Based on the results of the heterogeneity testing that has been done, it is known that the fixed effect model is most suitable for calculating the size of the effect summary effect size science electronic learning media on students' 21st century skills based on the type of media. Calculation of the summary effect of science electronic learning media on students' 21st century skills can be seen in Table 9.

Table 9. Hypothesis Testing Based on Media Types

Journal Code	Media Type	SEM*	LLM*	ULM*	Z*	p.s
A2	Interactive Multimedia	1.12	-1.43	2.97	0.61	0.27
A3						
A5						
A6						
A11						
A12						
A8	Virtual laboratories	1.15	-1.39	3.10	0.65	0.26
A19						
A20						
A22						
A13	AR-Based Media	0.12	-0.16	0.32	5.18	0.00
A14						
A15						
A18						
A24						

Based on the results of the calculation of the technology-based media hypothesis based on the type of media on 21st century skills, the result is that for AR the p value < which indicates H0 is rejected means that there is an influence of the two types of media on students' 21st century skills. Based on the calculation of the p-value in the hypothesis test, it was found that the p> value for interactive multimedia and virtual laboratory which shows that H0 is accepted means that there is no effect of the use of interactive multimedia in science learning on students' 21st century skills.

According to the findings of hypothesis testing, virtual laboratory media has little to no impact on students' 21st century competencies. This is because, according to a study by Puspita (2020), the effectiveness of virtual laboratory-assisted learning depends on the independence of the learners themselves. Not every kid can learn independently. According to Laia (2022), there are several causes for this. One of the causes that affects a student's ability to study independently is the student's own personal component. Where is this factor, students lack the ability to do their own learning without the help of others, lack responsibility in completing obligations as students and lack the confidence to ask questions and express opinions, so that it can affect the independence of learning.

Based on the results of calculating the p value, AR-based media influences students' 21st century skills. this is because according to Winda (2023) AR is a technology that combines 2D and 3D so that it can help students more easily understand the concepts of existing

experiments, so that the practicum activities carried out can be more efficient in their learning and can make students think more rationally, open to existing problems.

The above-mentioned hypothesis was tested, and the findings indicated that interactive multimedia had little impact on students' 21st century competencies. This is due to Pramuji (2020) assertion that several displays, components, and interactive multimedia content that have not been optimally developed have an impact on the effectiveness of interactive multimedia used in learning, and that the use of interactive multimedia in learning must be supported by other learning.

The there, Influence Science Electronic Learning Media Based on Types of 21st Century Skills. Results in this study related to heterogeneity testing on science learning media on students' 21st century skills based on the types of 21st century skills can be seen in Table 10 as follows.

Table 10. Heterogeneity Testing Based on Types of 21st Century Skills

Journal Code	Media Type	Q	df	I²
A3	Critical Thinking	0.27	7.00	-2450.78%
A4				
A6				
A11				
A12				
A14				
A16				
A17				
A2	Communication	2.65	3.00	-13.39%
A13				
A15				
A18				
A5	Creativity	6.22	4.00	35.73%
A8				
A20				
A21				
A23				

According to the heterogeneity test, it was discovered that Q < df for the various critical thinking and communication skill kinds, indicating that the data was not heterogeneous and that the estimation of the variance between articles was insufficient. The fixed effect model is the one that works best for determining the overall effect size. Value $I^2 < 25\%$, which highlights the use of the fixed effect model in decision-making, strengthens this assertion even more.

Based on the heterogeneity test, it is also discovered that the kind of creativity talent has a value of Q > df, which leads to a substantial estimation of the variance across articles and heterogeneity in the data. The random effects model is a good choice for estimating summary effect sizes in publications on creativity. The heterogeneity test also revealed that I^2>25%, or 89.89%, further demonstrates that the result was reached using random effects.

The fixed effect model is recognized as being the most appropriate for determining the size of the impact summary effect size based on the findings of the heterogeneity testing that has been conducted. Scientific education tools that use technology and are focused on 21st century abilities. Table 11 displays the calculation of the overall impact size depending on the types of abilities used by learners in the 21st century.

Table 11. Hypothesis Testing on Types of 21st Century Skills

Journal Code	Media Type	SEM*	LLM*	ULM*	Z*	p.s
A3	Critical Thinking	0.47	-0.53	1.32	1.76	0.04
A4						
A6						
A11						
A12						
A14						
A16						
A17						
A2	Communication	0.13	0.52	1.02	46.82	0.00
A13						
A15						
A18						
A5	Creativity	0.12	-0.14	0.32	6.31	0.00
A8						
A20						
A21						
A23						

The three forms of 21st century skills are influenced by technology-based learning media, according to the analysis of the hypothesis of technology-based learning media on 21st century skills based on the types of 21st century skills. the three different sorts of 21st century talents and the impact of science electronic media. The findings of the test are consistent with research done by Farida (2019), who discovered that using technology-based media effectively helps students develop 21st century skills as evidenced by improved motivation, learning activities, student learning outcomes, the level of readiness of students to receive learning materials and the flexibility of space and time for student learning and this also encourages increased creativity and collaboration between students because of the flexibility

of time in learning which provides flexibility for students to be creative $p < \alpha$.

Conclusion

Based on the results and discussion that have been presented, it can be concluded that the first, scientific electronic learning media affect students' 21st century competencies. Two categories were conducted, namely the kind of media and types of 21st century abilities, to see the impact of scientific electronic learning media on these skills. The most effective kind of media for shaping 21st century abilities is augmented reality. on the three categories of talents necessary for the twenty-first century: communication, creativity, and critical thinking.

Acknowledgments
The author would like to thank him profusely for the award that has been given to the author, in which this article has been analyzed and referenced. The author is very honored and excited to know that this work has been accepted and recognized by a respectable journal such as JPPIPA. Then thank you to Mr. Dr., Akmam M.Si as Lecturer of Capita Selecta Education Course who has provided knowledge in studying the subjects taught .

Author Contribution
The author's contributions include Asrizal: focus on methodology, and review of writing. And so on; Yelfi Rahmi and Fleony Dea Amanda: collecting data, analyzing data, writing original drafts.

Funding
This research was not funded by a funder.

Conflicts of Interest
The authors declare no conflict of interest.

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