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META-ANALYSIS OF THE EFFECT OF ICT-BASED LEARNING MEDIA ON STUDENTS' BIOLOGY LEARNING OUTCOMES

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Abstract. The use of ICT-based learning media can improve student learning outcomes. Re-analysis was carried out in this study regarding the use of ICT-based learning media in improving student learning outcomes from the theses that had been selected and selected in line with the topics studied. This study aims to determine the meta-analysis of the effect of using ICT-based learning media on students' biology learning outcomes. This type of research is descriptive survey research. Using a purposive sampling technique, 20 theses of Biology education students at FKIP Untan for the 2017-2021 period were summarized. The calculation of the effect size of 20 undergraduate thesis students in biology education resulted in an average effect size of 0.85 (SD = 2.80). It shows that ICT-based learning media contributed 32.89% to improving student biology learning outcomes. The ICT-based learning media type with the most significant influence is video media, with an average effect size of 1.18 (SD = 4.34). Video media contributed 37.08% to increasing student biology learning outcomes. The relationship between variables obtained from research results based on the material taught and the use of ICT-based learning media that has the most significant influence is applied to the digestive system material with an average effect size of 1.18 (SD = 4.34). ICT-based learning media can improve students' biology learning outcomes in digestive system material by 37.08%. Based on the school level, ICT-based learning media that significantly influences students' biology learning outcomes is implemented in junior high schools. Using ICT-based learning media can improve student biology learning outcomes in junior high schools by 42%.

Keywords**:** Meta-analysis; ICT Based Learning Media; Biology Learning Outcomes

I. INTRODUCTION

Advances in Information and Communication Technology (ICT) positively impact the world of education. It can be seen from the many developments and applications of ICT-based learning media in schools. In learning biology, teachers have also begun to utilize various ICT-based learning media, such as video, PowerPoint, interactive multimedia, virtual reality, and augmented reality, to use the internet and big data. ICT-based learning media helps teachers achieve predetermined learning objectives (Rahmadana, Gani, & Ismail, 2018; Bahar, Syamsiah, & Bahri, 2018). ICT-based learning media also makes it easier for teachers to present learning in a more varied, engaging, and interactive manner (Fahman & Sibuea, 2015; Oktavia, 2020).

The benefits of using ICT-based learning media are for teachers and students. ICT-based learning media can help reduce verbality so that students can clearly understand the message's meaning (Kustandi & Darmawan, 2020). Learning media such as virtual labs, virtual reality, and animated videos can help display various abstract objects to become

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real (Yuniarti, Yeni, & Yokhebed, 2017) to facilitate students' understanding of abstract concepts to become more concrete. The ability to display objects that are too big or small (Aripin & Suryaningsih, 2020), show movements that are too fast or slow (Aprilinda et al., 2020), and present objects that are too dangerous or difficult to obtain into the learning environment (Kustandi & Darmawan, 2020) so that it can help students to acquire knowledge.

Appropriate use of ICT-based media will increase students' attention to the topic being studied, increase student motivation and concentration, and improve the learning process. So that student learning outcomes can be improved (Yudasmara & Purnami, 2015; Yuniarti, Yeni, & Yokhebed, 2017). Therefore the use of media as a tool in learning must be selected according to and help students understand the material presented.

Research on applying ICT-based learning media to biology learning outcomes was also carried out by prospective teacher students in the Biology Education Study Program, FKIP, Tanjungpura University (Untan). The research was conducted to fulfill the undergraduate student's final assignment. The research results obtained will be published as a thesis. Every year the findings obtained from research results will continue to increase, but other researchers need to know the results. It can be a limitation that allows the repetition of similar research. Therefore it is necessary to synthesize research results so that researchers can obtain initial information from the various studies conducted. Researchers can also obtain information about issues that have been studied or have not been touched on at all.

Based on the search results for all Biology Education FKIP Tanjungpura University students' thesis at the Tanjungpura University Library, it is known that from 2017 to 2021, there were 20 theses on the use of ICT-based learning media on student learning outcomes. The research results obtained have yet to be discovered by other students who want to do similar research. As a result, research was conducted using the same learning media. Therefore, a summary of research results is needed to discuss various research problems with ICT-based learning media used for students' biology learning outcomes.

Meta-analysis research is defined by Glass (1981 in Safitri, 2021) as a quantitative analysis that uses quite a lot of data and involves statistical methods for organizing a large amount of information from a large sample to complete specific purposes. Through meta-analysis, researchers can summarize the findings of two or more studies to combine, review, and summarize previous research. Various questions can be investigated based on data found from the results of previous research that has been published. One of the conditions needed in conducting a meta-analysis is examining the results of similar studies (Rahmawati et al., 2021).

Based on the description of the background that has been described, the researcher is interested in researching a meta-analysis of the influence of ICT-based learning media on students' biology learning outcomes. This study aims to re-analyze the thesis regarding the influence of ICT-based learning media on students' biology learning outcomes.

II. METHODOLOGY

The type of research used is survey research. The type of survey used is descriptive. The population in this study is the thesis of Biology Education FKIP Tanjungpura University students about ICT-based learning media in biology learning in 2017-2021. The samples were 20 Biology Education FKIP Tanjungpura University students' thesis for 2017-2021 about the influence of ICT-based learning media on student biology learning outcomes. Using a purposive sampling technique, the samples taken must meet the following criteria: (1) made by students of Regular Biology Education A and PPAPK FKIP Untan; (2) issued from 2017 to 2021; (3) is quantitative research; (4) discussing ICT-based learning media related to student biology learning outcomes. The data collection technique used in this study was observed with the help of data collection tools in the form of blanks suggested by Leo Sutrisno et al.

The procedure in this study was adjusted to the steps for carrying out the meta-analysis suggested by David B. Wilson and George A. Kelley (in Antoni, Hidayat & Khatimah, 2021): (1) Determine the problem or topic being studied. The problem or topic examined in this study is the influence of ICT-based learning media on students' biology learning outcomes; (2) Determine the period of research results used as data sources. The research results used as data sources were the 2017-2021 Biology Education FKIP Untan student thesis; (3) Looking for research reports related to the problem or topic to be studied. The search was carried out from several sources, one of which was collecting a list of research reports in the Tanjungpura University SIMANTA (Final Assignment Academic System) and then matching them with the Untan Library UPT database; (4) Read the title and abstract of the research report to see the suitability of the contents with the problem to be studied; (5) Focusing research on problems, research methodologies such as types of research, place and time of research, methods, population, samples, sampling techniques, data analysis techniques, and results; (6) Categorizing each study; (7) Comparing the results of all studies according to their categories; (8) Analyze the conclusions found by reviewing the results of the research by reviewing the methods and data analysis in each study so that the strengths and weaknesses of previous studies can be identified; (9) Draw conclusions from the meta-analysis research based on the seventh and eighth steps above.

The things that were done when analyzing the data in this study were: (1) analyzing the effect size (ES) of each thesis application of ICT-based learning media in biology learning; (2) Analyzing the effect size (ES) of the thesis based on the type of ICT-based media used; (3) Analyzing the relationship between variables based on the effect size of each thesis to see its relationship with students' biology learning outcomes. The relationship between variables discussed in this study is the material, the type of ICT-based

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learning media used, and the relationship between school level and the type of ICT-based learning media used.

III. Result and Discussion

A. Effect Size (ES) Use of ICT-Based Learning Media on Student Biology Learning Outcomes

Effect size is essential to the meta-analysis because it can present information from the summary results. The effect size will show the size of the effect of a treatment or the strength of the relationship between the two variables. By determining the effect size of each study, the overall average effect size can be identified. Based on the summarized 20 Biology Education student theses, all have been completed with effect size prices. The details are as in table 1.The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes. Recommended font sizes are shown in Table I.

TABLE I
Category Thesis Effect Size

No.	Thesis Code	ES	Category
1	HE	0,75	Medium
2	KK	0,98	Medium
3	YE	0,69	Medium
4	UL	0,71	Medium
5	NU	0,71	Medium
6	SS	0,72	Medium
7	NF	0,73	Medium
8	NH	0,8	Medium
9	EP	1,09	High
10	UR	0,94	Medium
11	MI	1,18	High
12	PM	1,1	High
13	ER	0,71	Medium
14	DA	0,84	Medium
15	FY	0,77	Medium
16	FI	0,89	Medium
17	SW	0,94	Medium
18	YU	0,95	Medium
19	YS	0,71	Medium
20	AV	0,79	Medium
∑ES		17	
$\overline{ES}$		0,85	
SD		2,80	

Table 1 shows three studies with high effect size prices, 17 with medium effect size prices, and none with low effect size prices. The calculations obtained showed an average total effect size of 0.85 (SD = 2.80). If confirmed to the list of standard curves, the number 0.3289 is obtained. It shows that using ICT-based learning media in 20 theses contributed 32.89% to improving students' biology learning outcomes. The effect size price is moderate.

The list of ICT-based media types reviewed in the study can be seen in Table 2.

TABLE II
Type of ICT-Based Media Used

No.	Media	ES	$\overline{ES}$	SD
1	Animation based on Adobe Flash	0,75		
2	Interactive media based on Adobe Flash	0,98	0,87	2,63
3	Audiovisual	0,69	0,69	4,24
4	Video	0,8		
5	Video	1,18	0,97	3,27
6	Video	0,94		
7	Prezi	0,73	0,73	1,89
8	Web based on google site	1,09	1,09	2,91
9	PowerPoint Interactive	0,71	0,71	2,56
10	Crossword puzzle HOTs POTATOES	0,79	0,79	3,56
11	Flipbook	0,95		
12	Flipbook	1,1		
13	Flipbook	0,71		
14	Flipbook	0,84		
15	Flipbook	0,77	0,83	2,58
16	Flipbook	0,89		
17	Flipbook	0,71		
18	Flipbook	0,71		
19	Flipbook	0,72		
20	Flipbook	0,94		

Based on table 2, it is known that research using Flipbook is ten theses with an average effect size of 0.83 (SD = 2.58), research using video media is three theses with an average effect size of 0.97 (SD = 3.27), research using interactive animation media based on Adobe Flash as many as two theses with an average effect size of 0.87 (SD = 2.63), as well as research using Prezi media, audiovisual, interactive PPT, TTS based on the HOT POTATOES application, and web-based on google site, each with an average effect size of (0.73; 0.69; 0.71; 0.79; 1.09) and SD (1.89; 1.89; respectively). 4.24; 2.56; 3.56; 2.56). From these data, it is obtained that the type of ICT-based learning media with the largest effect size price is the Google Site-based web.

B. Relations Between Variables

The relationship between variables discussed in this study is the material, the type of ICT-based learning media used, and the relationship between school level and the type of ICT-based media used. In looking at the relationship between these variables, the analysis carried out is to look for the type of ICT-based media with the most significant influence on each of these variables.

In research conducted by Biology Education students, the content taught included the classification of living things, Plantae, respiratory system, ecosystems, cells, plant movement systems, human reproductive systems, biodiversity, environmental pollution, Animalia, digestive systems, circulatory systems, protists, and the human excretory system. Price effect size based on the material taught can be seen in Table 3 below.

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TABLE III
EFFECT SIZE BASED ON THE CONTENT BEING TAUGHT

No.	Content	n Theses	$\overline{ES}$	SD
1	Plantae	2	0,76	2,4
2	Ecosystems	1	0,98	2,34
3	Cells	1	0,69	4,24
4	Plant Movement System	1	0,71	2,56
5	Human Reproductive System	1	0,71	2,67
6	Classification of living things	3	0,92	2,74
7	Biodiversity	1	0,73	1,89
8	Environmental Pollution	1	0,8	3,14
9	Animalia	1	1,09	2,91
10	Circulatory System	2	0,94	2,34
11	Digestive System	1	1,18	4,34
12	Bloodstream system	1	0,71	2,67
13	Plant structure and function	2	0,865	2,735
14	Protist	1	0,71	2,56
15	Human Excretory System	1	0,79	3,56

Based on table 3, it is known that research discusses the classification of living things in three theses. Plantae and the respiratory system are two scripts. Ecosystems, cells, plant movement systems, human reproductive systems, biodiversity, environmental pollution, Animalia, digestive system, circulatory system, protists, and human excretory system each amounting to 1 thesis. The one with the largest average effect size is the content of the digestive system, with an average effect size of 1.18 (SD = 4.34). It means that using ICT-based learning media can improve students' biology learning outcomes in the content of the digestive system by 42.51%.

Based on three studies on the classification of living things, it was found that research used flipbooks, two studies on Plantae were known to use flipbooks and Adobe Flash animation, and two studies on the respiratory system used video media and flipbooks. The use of flipbook media also dominates other learning content. Based on the types of ICT-based learning media, video media has the most significant influence on the digestive system (the average effect size is 1.18, SD = 4.34). The contribution made by video media in improving students' biology learning outcomes in the digestive system was 42.22%.

All of the biology learning content (material on the classification of living things, Plantae, respiratory systems, ecosystems, cells, plant movement systems, human reproductive systems, biodiversity, environmental pollution, Animalia, digestive systems, circulatory systems, protists, and human excretory systems) has different characteristics and complexities. For this reason, the media used must follow the learning content. In terms of digestive system content, the type of media that contributes the most is video media. Objects in biology are abstract, so visualization is needed to help make content more concrete and realistic.

Effect size based on school level can be seen in table 4 below.

TABLE IIV
EFFECT SIZE BASED ON SCHOOL LEVEL

No.	School Level	n Theses	$\overline{ES}$	SD
1	Junior High School	10	0,91	2,84
2	Senior High School	10	0,79	2,76

Based on table 4, the average effect size value for using ICT-based learning media in junior high schools is 0.91 and 0.79 in senior high schools. The contribution of ICT-based learning media to improving biology learning outcomes in junior high schools increased by 28.81% and in senior high schools by 17.24%. It means that the use of ICT-based learning media that has the most significant influence on students' biology learning outcomes is that which is implemented in junior high schools.

The following is a list of the types of ICT-based media used in junior high schools, which are listed in table 5.

TABLE IIIV
EFFECT SIZE BASED ON ICT-BASED MEDIA TYPES IN JUNIOR HIGH SCHOOLS

No.	Media	ES	$\overline{ES}$	SD
1	Flipbook	0,71		
2	Flipbook	0,72		
3	Flipbook	0,94		
4	Flipbook	1,1	0,88	2,66
5	Flipbook	0,84		
6	Flipbook	0,89		
7	Flipbook	0,95		
8	Video	0,8		
9	Video	1,18	0,97	3,27
10	Video	0,94		

Table 5 shows that seven theses used Flipbook media at the junior high school level with an average effect size of 0.88 (SD = 2.66), and three used video with 0.97 (SD = 3.27). It means using video in biology learning has a higher effect.

IV. CONCLUSIONS

Based on the data analysis that has been carried out, several conclusions can be put forward as follows: (1) from the calculation of the effect size of 20 theses of biology education students, the average effect size is 0.85 (SD = 2.80). It shows that ICT-based learning media contributed 32.89% to improving student biology learning outcomes; (2) the type of ICT-based learning media with the most significant influence is video media, with an average effect size of 1.18 (SD = 4.34). Video media contributed 37.08% to increasing student biology learning outcomes. (3) the relationship between the variables obtained from the research results is as follows: (a) based on the material being taught, the use of ICT-based learning media that has the most significant influence is that applied to the digestive system material with an average effect size of 1.18 (SD = 4.34). ICT-based learning media can improve students' biology learning outcomes in digestive system material by 37.08%. (b) Based on the school level, the use of ICT-based learning media that has the most significant influence on

students' biology learning outcomes is that which is implemented in junior high schools. ICT-based learning media can improve student biology learning outcomes in junior high schools.

Based on the conclusions and results of the research that has been done, some suggestions that the researcher can convey include: (1) researchers who wish to study this research further are advised to pay attention to the weaknesses of the research and conduct a large number of source searches in order to obtain more accurate results and complete; (2) for researchers who will research instructional media, it is necessary to pay attention to the suitability of the sub-sectors of the material, the form of the research, the research design, the size of the sample taken and the form of the test used in the research; (3) there is research development in compiling a learning media design to improve students' biology learning outcomes by taking into account this research as a reference.

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