



Meta-Analysis of the Effect of E Module on Students' Critical and Creative Thinking Skill in Science Learning

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Abstract: The purpose of this study was to analyze the effect of the e-module on students' critical and creative thinking knowledge in science learning. This research uses a quantitative descriptive research type with meta-analysis. Data or sources are obtained from articles published in international and national journals that are selected based on categories, namely those related to the influence of e-modules on students' critical and creative thinking knowledge. There were 20 articles used in this study which were then coded and analyzed for their effect size. Based on the results of data analysis, the effect size results for knowledge of critical thinking are in the very high category, for knowledge of creative thinking also has the very high category, meanwhile, the effect of the e-module on students' critical and creative thinking knowledge based on junior high school, senior high school and tertiary education levels has a very high category. Then in the science field, namely Physics, Chemistry, Biology lessons, they have an effect size in the very high category. The results of the analysis show that the effect of the e-module on students' critical and creative thinking knowledge is very high.

Keywords: Creative thinking; Critical thinking; E-module; Science learning.

Introduction

In the current era of globalization, education is very important to produce qualified, competent and broad-minded human beings. Education is very important, education must be pursued as well as possible to obtain the expected results. In the implementation of education there are several components that can increase success in a learning process, including learning instruments, teaching media learning models and what is no less important, namely teaching materials (Putra, 2022). Following the development of an increasingly advanced era, the teaching materials used have also developed from textbooks to electronic books. So that it can make it easier for students to access the subject matter to be studied (Liana, 2022). Teaching materials play an important role in the preparation of learning. Without teaching materials, it will be difficult to gain effectiveness in learning (Safitri, 2020).

Teaching materials are all types of materials used to support the success of teachers in carrying out teaching

and learning activities in the classroom. Teaching materials must be presented properly, orderly, systematically, contain complete information, be varied and attract students (Haryadi & Nurmala, 2021). Modules are part of the types of teaching materials (Basyaruddin, 2021). According to Zuhlaini et al. (2016) Modules are teaching materials that are compiled by the teacher with the aim of making it easier for students to learn independently. There are two types of modules that can be developed, namely printed modules and electronic modules (Putra, 2022). These two types of modules are very much needed in learning in schools, especially electronic modules.

E modules are teaching materials in digital form that are accessed and used via computers, laptops, tablets or smartphones. E-modules as teaching materials play an important role so that learning runs effectively because it can support students who experience difficulties in understanding lessons (Suastrawan, 2021). The e-module is used by students independently because it is equipped with instructions for use which

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can make it easier for students to use it (Safitri, 2020). E-modules are also equipped with animated and video materials that can support students in learning the subject matter. E-modules are arranged systematically to be able to assist students in independent learning so that learning objectives are achieved (Asrizal, 2013; Haspen 2021).

In the 21st century, students need skills, namely critical thinking skills, communication, creative thinking and collaboration skills or known as 4C skills. These skills can be integrated into the teaching materials to be used, namely e-modules. Learning with the help of e-modules aims to develop students' critical and creative thinking. Creative thinking is a student's ability to use intuition and imagination to create new ideas and solve everyday problems. Creative thinking skills are needed so that students can make decisions on a problem. Creative thinking skills are needed so that students can make decisions on a problem (Umamah, 2019). Creative thinking skills are skills that can produce a new work in the form of a combination of information, data and elements that form new products or ideas (Batlolona et al., 2021).

Critical thinking is the ability to analyze collected and interpreted information and determine its relevance in solving problems. Critical thinking helps someone to solve a problem (Jamaludin et al, 2022). Critical thinking skills are needed in today's global era. If students are accustomed to thinking critically during their studies, especially in science studies, they are expected to be able to survive and survive later in their professional life. Critical thinking is an important thing that must be achieved in education, every student is expected to have critical thinking skills to answer the challenges of the 21st century which focuses on high-level abilities where one of them is critical thinking (Safitri et al, 2020).

The impact of e-modules on the development of students' critical and creative thinking has been studied extensively. According to research of Perdana (2017), based on the results of increasing N gain, the effectiveness of the critical thinking module is moderate. According to research of Putri (2022), the e module improves critical test performance in the high category. Mubarak's research (2022) found an increase in creative thinking based on the n-gain value in the appropriate category. Based on some of these studies, it appears that there are differences in research results in developing critical and creative thinking. For this reason, it is necessary to carry out an in-depth study to determine the effect of the e-module on critical and creative thinking, namely through meta-analytic studies.

Given the importance of critical and creative thinking knowledge and the role of the e-module in it, a meta-analysis is necessary. The purpose of this research meta-analysis is to see the effect of E-module on

students' critical and creative thinking at the educational level, on the ability to think creatively and creatively and in the science field. It is hoped that this meta-analysis study can help the education sector, especially science educators, in applying creative and critical thinking skills in the e-Modules that will be used.

Method

The research method used in this study is meta-analysis, where meta-analysis is a quantitative study to process or analyze several research results using statistical methods to summarize and obtain general conclusions (Merriyana, 2006). Meta-analysis is a type of review which is a form of activity identifying, evaluating and interpreting all relevant studies for a particular research question, or a particular topic area or phenomenon that is of interest to the researcher (Green, 2005).

This meta-analytic research method consists of several steps, namely problem formulation, data collection (study), data coding, and data analysis and interpretation. The procedure for the meta-analysis method is the first to formulate the problem, namely the E Module for students' creative thinking knowledge in science learning, then the second step is to collect data (literature study). In the process of searching for the literature studies analyzed in this study, a basic electronic data search was carried out using the keywords "E Module, Creative Thinking Knowledge, Science Learning".

Coding in meta-analysis is the most important requirement to facilitate data collection and analysis. Therefore, the instruments in this meta-analysis were carried out using coding category sheets. The next step after coding is to calculate the effect size value using the following formula:

Average In one group

Experimental research that only uses one class group then what is used is:

$$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}} \quad (1)$$

Average in each group

Experimental research with the assumption that the group is heterogeneous, then the formula used is:

$$ES = \frac{\bar{x}_{ek} - \bar{x}_k}{s_k} \quad (2)$$

Average in each group

Research that uses more than two experimental groups and their interactions, by using:

$$ES = \frac{(\bar{x}_{post} - \bar{x}_{pre})_E - (\bar{x}_{post} - \bar{x}_{pre})_C}{\frac{SD_{preC} + SD_{preE} + SD_{postC}}{3}} \quad (3)$$

T count

Research using only two experimental groups, using the t test. The effect size formula used is as follows:

$$ES = t \sqrt{\frac{1}{n_E} + \frac{1}{n_C}} \quad (4)$$

Furthermore, the results of the effect size are categorized by the following effect size categories

Table 1. Categories effect size (ES)

ES	Category
ES ≤ 0.15	Very low
0.15 < ES ≤ 0.40	Low
0.40 < ES ≤ 0.7	Currently
0.75 < ES ≤ 1.10	Tall
ES ≥ 1.10	Very high

Cohen's suggestion is to interpret the above table with ES ≤ 0.15 being considered a very small effect. 0.15 < ES ≤ 0.40 is considered a small effect, 0.40 < ES ≤ 0.7 is considered a moderate effect, 0.75 < ES ≤ 1.10 is considered a high effect and ES ≥ 1.10 is considered a very high effect. The flow of meta-analytic research used is as Figure 1.

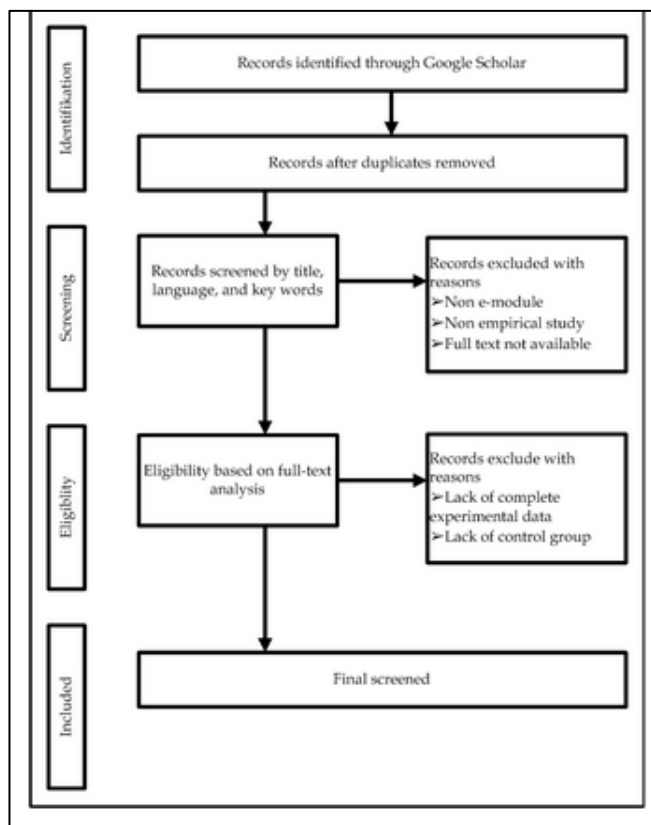


Figure 1. The flow of meta-analytic in article

Result and Discussion

Results

In this study, the data obtained were from several journals relevant to this research, namely e-modules to increase students' critical and creative thinking knowledge. Where the journals obtained are as many as 20 journals selected based on predetermined categories. The moderator variables are educational level, knowledge of critical thinking and knowledge of creative thinking and science field. It has analyzed 20 journals and calculated the effect size, so that it can be classified into several sections. Data from the general analysis of the effect of the e-module on students' critical and creative thinking knowledge is presented in table 2. Based on Table 2, it was found that the average effect size of the effect of the e-module on students' critical and creative thinking knowledge was 2.06 with a very high category.

Table 2. Overall Effect Size Value of The Articles

Code	ES	Category
A1	0.65	Currently
A2	0.80	Tall
A3	4.78	Very high
A4	4.35	Very high
A5	4.22	Very high
A6	0.74	Currently
A7	4.13	Very high
A8	0.20	Low
A9	5.06	Very high
A10	0.62	Currently
A11	0.65	Currently
A12	3,16	Very high
A13	2.35	Very high
A14	0.4	Currently
A15	0.27	Low
A16	0.5	Currently
A17	4,13	Very high
A18	1.09	Tall
A19	1.84	Very high
A20	1.44	Very high
Mean (Σ ES)	2.06	Very high

The effect size of the e module on science learning is based on educational level

The results of data analysis based on the level of education, can be seen in table 3, 4 and 5.

Table 3. Effect Size Value of E Module Based on Educational Level on Knowledge Critical and Creative Thinking of Junior High School Students

Educational stage	Article Code	ES	Category
Junior High School	A2	0.8	Tall
	A9	5.06	Very high
	A16	0.51	Currently
Means	A19	1.84	Very high
		2.05	Very high

Table 4. Effect Size Values Based on Educational Level on Knowledge Critical and Creative Thinking of Senior High School Students

Educational stage	Article Code	ES	Category
Senior High School	A1	0.65	Currently
	A4	4.35	Very high
	A5	4.22	Very high
	A6	0.74	Currently
	A7	4.13	Very high
	A8	0.2	Low
	A10	0.62	Currently
	A11	0.65	Currently
	A12	3.16	Very high
	A13	2.35	Very high
	A14	0.4	Currently
	A15	0.27	Low
	A17	4.13	Very high
	A20	1.44	Very high
	Means		1.95

Table 5. Effect Size Values Based on Educational Level on Knowledge of Critical and Creative Thinking of Students at The College Level

Educational stage	Article Code	ES	Category
College	A3	4.78	Very high
	A18	1.09	Very high
Means		2.93	Very high

Based on Tables 3, 4 and 5 it was found that at the junior high school level the average effect size was 2.05 with a very high category while at the high school level the average effect size was 1.95 and at the tertiary level 2, 93, namely the very high category.

The effect size e module on science learning based on knowledge of critical and creative thinking

Based on the article data that has been collected, there articles out of 20 articles that can be calculated for the effect size value of creative thinking knowledge. The following is the results of the average value of the effect size e module on knowledge of creative thinking.

Table 6. The Value of The Effect Size E Module on Knowledge of Creative Thinking.

Effectiveness	Article code	ES	Mean ES	Category
Creative	A3	4.78	3.08	Very high
	A4	4.35		
	A12	3.16		
	A13	2.71		
	A14	0.4		

Based on the Table 6, the average value of the effect size of the module on knowledge of creative thinking is 3.08 with a very high category. Based on the article data

that has been collected, there are 15 articles out of 20 articles that can be calculated for the effect size value of critical thinking knowledge. The following is the result of the average value of the effect size e module on critical thinking knowledge.

Table 7. The Value of The Effect Size E Module on Knowledge of Critical Thinking.

Effectiveness	Article code	ES	Mean ES	Category
Critical	A1	0.65	1.77	Very high
	A2	0.80		
	A5	4.22		
	A6	0.74		
	A7	4.13		
	A8	0.2		
	A9	5.06		
	A10	0.62		
	A11	0.65		
	A13	2		
	A15	0.27		
	A16	0.5		
	A17	4.13		
	A18	1.09		
	A19	1.84		
	A20	1.44		

Based on the Table 7, the average effect size e module on critical thinking knowledge is 1.77 with a very high category. This means that there is a positive influence of the e-module on knowledge of creative thinking.

The effect size e modules on science based on science subject matter

Based on the science subject matter, it can be categorized into three science fields, namely Physics, Biology and Chemistry. In the field of Physics there are articles, biology as many as 7 articles and chemistry as many as 4 articles. The following is the result of the average effect size based on the IPA field.

In Table 8 it can be seen that the average effect size based on the science field on the remaining critical and creative thinking skills obtained the average effect size value in the fields of Physics (2.19), biology (2.14) and chemistry (1.65) with each category is very high.

Table 8. The value of the effect size e module based on the Science Field on knowledge of thinking Critical and creative.

Science field	Article code	ES	Mean ES	Category
Physics	A4	4.35	2.19	Very high
	A6	0.74		
	A7	4.13		
	A8	0.2		
	A12	3.16		

Science field	Article code	ES	Mean ES	Category
Biology	A13	2.35	2.14	Very high
	A14	0.4		
	A15	0.27		
	A17	4.13		
	A2	0.80		
	A3	4.78		
	A9	5.06		
	A10	0.62		
	A16	0.5		
	A19	1.84		
Chemical	A20	1.44	1.65	Very high
	A1	0.65		
	A5	4.22		
	A11	0.65		
	A18	1.09		

Discussion

The first result, the effect of e-module based on educational level. It was found that based on the effect size based on junior high school and high school and tertiary levels in the very high category, it can be concluded that the e module has a positive effect on education levels. Research conducted by Putri & Syafriani (2020) is in line with research conducted by Putri & Syafriani (2020) where the results of the study show that the use of e-modules at the high school level has an effect on increasing critical thinking skills in the high category. Research by Sugiharti et al. (2019) in the results of his research that e-Madul assisted learning at the junior high school level can improve students' critical thinking skills. research conducted by Nurjayadi et al. (2022), with the results of their research showing that the use of e-modules can improve students' critical thinking skills. It can be concluded that the e-module is very influential on critical thinking skills both at the junior high school, high school and tertiary levels.

Second, the effect of the e-module is based on students' critical and creative thinking abilities. From the results of the analysis it was found that the ability to think critically and creatively has an average effect size of very high category. So, it can be concluded that the e-module has a significant influence on students' critical and creative thinking abilities. The results of research conducted by Paramitha (2021) that the electronic module (e module) is an alternative for educators in learning and as an easy and practical teaching material in improving students' critical thinking skills. Research by Wahyuni (2020), concerning the Effectiveness of Problem Solving Based e-Modules on Students' Critical Thinking Skills, The results of the study show that problem solving-based e-modules can develop aspects of students' critical thinking skills. Research by Budiarti (2016) on guided inquiry assisted by e-modules to improve critical thinking skills concluded that learning

with guided inquiry assisted by e-modules can improve students' critical thinking skills.

Third, the effect of the e-module on knowledge of critical and creative thinking based on science. From the results it was found that all science fields, namely science, biology, chemistry, each had an effect size in the Very High category. So, it can be concluded that the effect of the e-module on knowledge of critical and creative thinking based on the field of science has a significant influence. In the field of physics, in research conducted by Sujane et al. (2022) on the effectiveness of problem-based science e-modules assisted by PhET simulations in limited trials to improve critical thinking skills of high school students who obtained the result that problem-based Science E-modules for class XI assisted by PhET in the online PBL model is able to effectively improve the critical thinking skills of class XI MIPA high school students. in biology, in research conducted by Hidayatun et al. (2015) regarding the application of problem-based learning-based e-modules to improve creative thinking skills and reduce misconceptions about ecological material, the results obtained were that the application of problem-based learning-based e-modules could improve creative thinking skills student. In the field of chemistry, research conducted by Romayanti (2020) on the development of chemical e-modules based on creative thinking abilities using the Kvisoft Flipbook Maker, found that e-modules in chemistry based on creative thinking abilities can make students have higher-order thinking skills. obtained the result that the application of problem-based learning-based e-modules can improve students' creative thinking abilities. In the field of chemistry, research conducted by Romayanti (2020) on the development of chemical e-modules based on creative thinking abilities using the Kvisoft Flipbook Maker, found that e-modules in chemistry based on creative thinking abilities can make students have higher-order thinking skills. obtained the result that the application of problem-based learning-based e-modules can improve students' creative thinking abilities. In the field of chemistry, research conducted by Romayanti (2020) on the development of chemical e-modules based on creative thinking abilities using the Kvisoft Flipbook Maker, found that e-modules in chemistry based on creative thinking abilities can make students have higher-order thinking skills.

Conclusion

From the analysis it can be concluded that the effect of the e-module on students' creative thinking and critical thinking is very high, which is evidenced by the effect size of critical thinking, which is 1.77, while for creative thinking, it is 3.08 with a very high category.

Meanwhile, the effect of e-module on students' critical and creative thinking at the junior high school level was 2.05, high school was 1.95 and university was 2.93. The effect of e-module on knowledge of critical and creative thinking based on the science field was found in the field of physics at 2.19, biology at 2.14, and chemistry at 1.65. So, it can be concluded that the e-module has a significant influence on students' critical and creative thinking, both at the educational level and in the natural sciences field.

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Author Contributions

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Conflict of interest

There is no conflict of interest in carrying out and publishing this study.

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