

Enhancing creative thinking skills on biotechnology materials: Development of an e-module using Google Sites

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ABSTRACT

Updates are not yet available for media learning based on electronic learning, which incorporates creative learning into biotechnology material and has a positive impact on otherwise boring lessons. The lack of such innovative digital teaching resources makes it difficult for students to engage actively and think creatively during biotechnology lessons. Therefore, this study aims to: 1) determine the validity of e-modules on biotechnology material to improve students' creative thinking skills; 2) determine the effectiveness of these e-modules; and 3) assess their practicality in real classroom settings. This research utilized the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) and involved 95 third-semester students from the Biology Education Study Program. Data collection instruments included questionnaires and tests, with analyses conducted descriptively and statistically. The results show that: 1) the Google Sites-based e-module is highly valid, with validation scores of 86.36% from media experts, 93.75% from material experts, and 81.94% from small group trials; 2) the module is effective in improving students' creative thinking, supported by a Wilcoxon test significance value of 0.000 (<0.05); and 3) the module is practical to use, with a practicality score of 88.18% based on student responses in large-scale trials. In conclusion, the e-module developed using Google Sites is valid, effective, and practical, making it suitable for wider application. These findings support the integration of technology in education and encourage teachers to develop similar digital resources. Further research is recommended to explore the development of Google Sites-based e-modules using neurobiology content and critical thinking as variables.



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INTRODUCTION

21st-century skills have been running for approximately two decades and are known as the knowledge age, namely, efforts made to achieve skill proficiency based on habits and life needs based on knowledge (Angga et al., 2022). This knowledge is supported by the application of technology, so that 21st-century skills require humans to be more sensitive to information technology, one of which is in learning (Sukatiman et al., 2024; Tok et al., 2022). Learning in the 21st century requires skills that must be mastered by students, so efforts are needed to master 21st-

century skills. One of the skills that students must have is creative thinking skills (Mariana & Kristanto, 2023; Ardiansah & Zulfiani, 2023; Suwistika et al., 2024).

It is important for students to have creative thinking skills because creative thinking skills are one of the skills that should be possessed in facing the 21st century. Creative thinking skills are also very important in supporting competence in the global or modern era due to the increasing level of complexity of problems, in addition, universities must prepare their graduates to have competent skills, if only knowledge is not enough to prepare students to survive in the world of work (Karunarathne & Calma, 2024; Santia, 2018). This is by what was stated by Susanti et al., (2022), that students' creative thinking skills are very much needed in facing 21st century learning, because if students have creative thinking skills, it is certain that students can create thoughts that are original, authentic, creative or innovative, imaginary and scientific (Smyrnaoui et al., 2020). The ability to analyze, relate, and synthesize various concepts to solve a problem is also included in creative thinking skills (Liline et al., 2024; Sugandi et al., 2021).

Creative thinking skills have four indicators in their application. First, fluency: This first indicator focuses on the correctness or fluency of students in answering questions and the ability of students to provide ideas for solving problems. Second, diversity: This indicator refers to the diversity in applying new ways or ideas to solve a problem or the ability of students to think flexibly. Third, new ways (originality), this indicator refers to new ways that emerge from one's own unique or unusual thoughts in solving a problem. Fourth, elaboration: this indicator refers to enriching an idea or product (Ernawati et al., 2023; Torrance, 1974; Zakiah et al., 2020). In essence, all humans have creative talents, but to foster creative thinking skills, stimulation or supporting power is needed to support these creative thinking skills. This is according to research by Gunawan et al., (2018), which states that improving creative thinking skills is a major challenge for every educational institution because educators must be able to stimulate students' creativity.

The reality in the field is that students' creative thinking skills are still lacking. Based on research conducted by Wijayanti et al., (2023), prospective teacher students in the PGSD (Elementary School Teacher Education) study program are still categorized as low in creative thinking skills, especially in the originality indicator, namely the lack of students in generating new ideas or concepts. This was also shown in a survey conducted by PISA (Program for International Student Assessment) in 2015, which proved that Indonesia was in the 63rd position out of 72 countries in the fields of science and mathematics (Mu'minah & Aripin, 2019). Then, equivalent to the results of a survey conducted by The Global Creativity Index in 2015 showed that Indonesia was in 115th position out of 139 countries (Dewi et al., 2017). Furthermore, in the same year, namely 2015, the results of the TIMSS (Trends in International Mathematics and Science Study) research, Indonesia was ranked 69th out of 76 countries (Khoiriyah et al., 2018).

Based on the results of research conducted by Zega (2022), namely the results of the CPMK (course learning achievement) completion test on biotechnology course material with biotechnology course achievement indicators including (1) outline, overview and learning content; (2) conventional biotechnology; (3) selective breeding; (4) antibiotic production; (5) fermentation; (6) bioprocess; (7) bioproduct; (8) modern biotechnology concepts; (9) cloning; (10) gene therapy techniques; (11) genetic engineering; (12) bioethics, so that the results obtained are that students still have difficulty understanding the material so that the learning objectives of the biotechnology course have not met the expected achievement standards. This is due to many factors, one of which is the absence or inappropriate use of learning media in the learning process. So, it requires the development of learning media that are specifically designed to improve 21st-century skills.

Web-based modules, or what are known as e-modules, can be an option to support learning activities. The content of e-modules can be designed to be more varied, not only in the form of writing but can including graphics, images, or videos, and independent practice tests (Moore, 2019). This will certainly make the learning process more interesting, fun, and practical. Based on the results of research conducted by Wahyuliani et al., (2022), the e-module products that have been developed can improve creative thinking skills. According to Pada et al., (2021), the use of e-module media must vary and must be adjusted to the material to be delivered, so educators and e-module developers must be very careful in designing instruction (Yang et al., 2023).

The material that will be used in the development of this e-module is biotechnology material. According to Dawson ([Handoko et al., 2016](#)), there are factors that limit the teaching of biotechnology, namely: lack of educator content in the field of biotechnology, lack of experience and suitability of the learning process, lack of learning resources, and lack of learning time. Based on the results of interviews with lecturers in charge of biotechnology courses in the Biology Education Study Program at Sebelas Maret University, most of the learning has been done using technology systems such as online attendance, online assessments, and e-learning. However, the use of e-learning has not been running as a whole due to the lack of materials in e-learning, so educators only use previous materials that have been used without updating and adjusting to the characteristics of students. One of them is the biotechnology course.

Then in the biotechnology material, there has been no update of electronic-based learning media that contains creative learning that can improve students' thinking skills, besides that biotechnology material seems boring because the material is complex and the study is quite broad starting from discussing microorganisms, cells and tissues that produce various products needed by humans. This is what was stated by [Iza & Fitriani \(2022\)](#), stating that learning related to biotechnology is quite complex because the discussion is about the division of biotechnology, both in terms of conventional and modern biotechnology in life. Therefore, an e-module based on Google Sites was developed to help convey the material and make it simpler and easier to understand.

Several relevant studies have been conducted on the development of Google Sites-based e-modules. [Tompe et al., \(2017\)](#) research on the development of local potential-based biotechnology modules for junior high school students has proven to be effective and practical in improving learning outcomes. The effectiveness of Google Sites-based e-modules has also been studied by [Lativa et al., \(2024\)](#), who studied their impact on creative thinking skills in biology subjects on the topic of plant diversity and obtained the expected results, namely improving creative thinking skills. In addition, several studies on Google Sites-assisted e-modules were also tested to influence motivation, interest, learning outcomes, reasoning abilities, and digital literacy abilities, and the results were proven to improve ([Efendi & Insani, 2024](#); [Ernest & Putra, 2023](#); [Ghozali et al., 2024](#); [Nugroho et al., 2024](#)).

The novelty in this study lies in its use for complex materials such as those used in biotechnology. Although some developed biotechnology material modules, they were still conventional, not electronic or digital. When referring to the novelty of article topics that need to be developed in the Journal of Educational Technology Innovation related to skills, researchers only found one article on the development of an e-module to improve critical thinking skills in chemical law subjects ([Leny et al., 2024](#)). While this study examines creative thinking skills, of course, this is a new article that can increase the literacy of readers of the Journal of Educational Technology Innovation.

This study aims to develop and implement Google Sites-based e-modules to improve students' creative thinking skills. This study enriches the study of digital learning innovation by adding a new perspective on the use of Google Sites as an e-module platform that supports creative thinking skills. The use of Google Sites as an e-module offers a practical and easily accessible solution for digital-based learning so that it can be adopted in various educational contexts. The results of this study can be a reference for educators in developing more interactive and flexible digital teaching materials to improve students' creative thinking skills.

METHOD

This development research uses qualitative and quantitative research methods. Qualitative research is used in analyzing the needs of e-module products to obtain the e-module product format and e-module product design plan. Quantitative research is used to measure the practicality and effectiveness of the product based on validation from experts. This development research procedure is carried out by the stages of the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) by Branch ([Weldami & Yogica, 2023](#)).

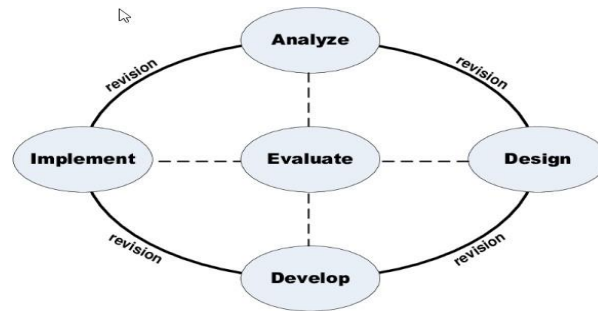


Figure 1. Model ADDIE development

Procedure study this use model study ADDIE, which consists of several stages, namely analyzing, designing, developing, implementing, and evaluating. The ADDIE research model is a systematic product development model that shows the basic details of development in educational products. Which is customized with technology, needs participant education, and content (Weldami & Yogica, 2023).

Activities carried out during the analysis process include identifying gaps or problems that occur. Design activities provide products that can be content/material. The development stage includes producing content or products, selecting or developing products, and conducting small/limited-scale tests or trials with 20 people and large-scale trials with a sample of 95 semester 3 students of the Biology Education Study Program, Sebelas Maret University. The implementation stage includes preparing lecturers and students and measuring the level of practicality and effectiveness. The last evaluation stage is revising the implementation results and determining the success of product development.

The analysis process uses descriptive analysis, analysis prerequisites, effectiveness tests, and practicality tests. Results from test validation are an analysis description of quantitative data, which begins with the conversion of quantitative data to a percentage form. The way to calculate it is by using the following Formula 1.

$$P = \frac{\sum xi}{\sum x} \times 100\% \quad (1)$$

Information:

P = Presentation mark

$\sum xi$ = Amount of value answer from tester

$\sum x$ = Amount mark answer highest

The results of the percentage calculation of all components, then a descriptive analysis was carried out to determine the decision to revise or not to revise, can be seen in Table 1 as follows.

Table 1. Descriptive Analysis

No.	Level of Achievement	Qualification	Information
1	81- 100	Very Good	No need for Revision
2	61- 80	Good	No need for Revision
3	41- 60	Enough	Revision
4	21- 40	Not Enough Good	Revision
5	0- 20	Very Good	Revision

(Irwan et al., 2018; Suwastono, 2011)

In large-scale trials, calculations were carried out through pretests and posttests to determine effectiveness. Data obtained from before and after learning using e-modules and learning without the use of e-modules in class are negative behavioral data and student learning outcomes reflected by pretest and posttest scores. After the experiment is conducted, the data obtained from the test results will be analyzed using a prerequisite test, namely, by using a normality test namely, the Kolmogorov-Smirnov test. In the Kolmogorov-Smirnov test, if the significance is below 0.05, it means there is a significant difference, and if the significance is above 0.05, there is no significant difference.

RESULTS AND DISCUSSION

Results

This development research produces a product in the form of a Biotechnology E-Module using Google Sites. The development of the Biotechnology E-Module using Google Sites is self-instructive with the hope that students can learn independently, and there is hyperlink access for each word that contains terms, words that are difficult to understand/unfamiliar, and words that require explanation. The purpose of this development research is to determine the feasibility, effectiveness, and practicality of the Biotechnology E-Module product using Google Sites. The variables to be achieved in this study are to improve students' creative thinking skills. The use of Google Sites makes it easy for students to learn anywhere and anytime, and various components in it make this product an interactive learning medium. Google Sites is in the form of a web, so that in its use, there is no need to download and can be accessed via laptop/computer and smartphone.

Analysis

The results of the initial analysis and observations in the field showed problems or gaps, including the absence of updates to electronic-based learning media that include creative learning, especially in biotechnology material, and biotechnology material seems boring because the material is complex and the studies are quite broad, resulting in low empowerment of students' creative thinking skills.

Design

The design of the biotechnology E-Module product using Google Sites is adjusted to the developer's objectives based on the analysis that has been carried out, namely to provide products that can provide biotechnology materials so that students' creative thinking skills increase. This design is made in the form of instructions for use, learning objectives, materials, student activities, videos, games, and bibliographies.

Development

The development stage is carried out to produce and validate the product. Activities carried out at the development stage include completing the media content and validating the media and content experts. Validation of media and content is selected based on expertise and experience in designing, creating, and developing technology-based learning software, and experts in biotechnology material, to determine the feasibility of the product. Furthermore, a small-scale product trial is carried out to determine the feasibility of the product. Then, the last procedure, a large-scale group test, is used to assess the effectiveness and practicality of the product on a wider scale.

The design of the Biotechnology E-Module prototype using Google Sites begins with the design of the E-Module storyboard. Then, it is continued with the design of the systematic presentation of the material and the learning objectives to be achieved during learning activities on biotechnology material. Here are some displays of the components in the Biotechnology E-Module.



Figure 1. Opening Page



Figure 2. Menu



Figure 3. Material

Figure 4. Student Activities

The feasibility or validity of the media on the Biotechnology E-Module product using Google Sites was obtained through quantitative data conducted by a media expert lecturer, namely, Mr. Bowo Sugiharto, S.Pd, M.Pd, from the Biology Education Department of Sebelas Maret University by filling out a questionnaire. The following is a description and analysis of validity data based on the assessment indicators, which can be displayed in Table 2 below.

Table 2. Results Validation Expert Media

No.	Aspect	Indicator	$\sum xi$	$\sum x$
1	Screen Design View	Composition Color Writing to Color Background behind Already Appropriate and Readable with Clear Proportional order Location (Layout) (Text in the Picture) Page beginning Already Appropriate Proportional order Location (Layout) of every part in the E-module is Already Appropriate. Synchronization or Linkage between Illustrations, Graphics, Visuals, and Verbal Content Own Power Pull on Design E-module, which Displayed (Color, Images/Illustrations, and Letters)	4 3 3 4 3	4 4 4 4 4
2	Ease of Use	E-module served in a Coherent way according to the parts E-module is easy to Operate with a Laptop/PC/HP Content in the E-module is easily Accessed Operational buttons Work Properly	4 4 3 4	4 4 4 4
3	Consistency	The Words, Terms, and Sentences in the Learning Materials are Consistent The Shape and Letters are Consistent The Layout of the Display is Consistent	4 3 3	4 4 4
4	Graphics	Use the Color on the E-module Already Appropriate and no Excessive The Font Size used is easy to Read and Clear Type Letters which used easy to Read Clearly Illustration/Picture used on E-module is Clear (no Blurry/Broken) The Video that is on the E-module can run Smoothly and can be seen Clearly The Narration Video can be Heard as well as Understood Background Noise is not Disturbing to Learners	4 3 4 3 4 3	4 4 4 4 4 4
5	Benefits	The Steps in the E-module make it easier for Students to Learn Independently. Educators/Students can Interact using E-modules easily Improve Creative Thinking Skills	3 4 2	4 4 4
Amount			76	88
Percentage Value			86.36%	

Based on the validation conducted by media experts on the development of the Biotechnology E-Module product using Google Sites, a feasibility score of 76 was obtained from the maximum expected score of 88. In this regard, the Biotechnology E-Module product using Google Sites was assessed as very good by media experts, with a value obtained of 86.36% very worthy of continuing to the next stage.

The validity of the material in the Biotechnology E-Module product using Google Sites was obtained quantitatively by a material expert lecturer, namely Ir. Yudi Rinanto, M.P., from the Biology Education Department, Sebelas Maret University, used a questionnaire. The following is a description and analysis of the validity data of the material based on the assessment indicators shown in Table 3 below.

Table 3. Results Validation Expert Material

No.	Aspect	Indicator	$\sum xi$	$\sum x$
1	Content	Truth Draft Material Reviewed from Scientific Aspects	4	4
		Material in E-module is easy to Understand	4	4
		Clarity Topic Learning	4	4
		Completion of Material	3	4
		Suitability of the Level of Difficulty and Abstractness of the Concepts of Semester 3 Students	3	4
		The Relationship between Material Examples and Conditions in the Surrounding Environment	4	4
		Accuracy of Materials and Examples to Improve Creative Thinking Skills	4	4
		Suitability of Image/Video Illustrations to the Material Presented	3	4
2	Linguistics	All Information in the E-module is Readable	4	4
		Clarity of Information Delivery in E-modules	4	4
		Conformity of Sentences with Correct Indonesian Language Rules	3	4
		Use of Language that does not give Rise to Multiple Interpretations	3	4
		The Language does not Contain SARA, Pornography, or Biased meanings and Terms in Local/Regional Languages.	4	4
3	Presentation	Clarity of E-module Objectives	4	4
		The Overall Sequence of Material Descriptions in the E-module	4	4
		The Contents of the E-module are Interesting, so they can Motivate Students to Learn.	4	4
		Completeness of Information in the E-module (Summary of Material, Worksheets, Practice Questions)	4	4
		Student Learning Interactivity using E-modules	4	4
		Suitability of Image and Video Illustrations in E-modules	4	4
Amount			75	80
Percentage Value			93.75%	

Based on the validation conducted by material experts on the development of the Biotechnology E-Module product using Google Sites, it obtained a score of 75 out of the maximum expected score of 80. In this regard, the Biotechnology E-Module product using Google Sites was assessed as very good by material experts, with a value obtained of 93.75%, very worthy to continue to the next stage, namely, small group trials.

Before conducting trials on a large-scale group, a trial was first conducted on a small-scale group. This small group trial involved students of the Biology Education Study Program, semester 3, Sebelas Maret University, to measure the validity of the Biotechnology E-Module product using Google Sites, with a sample size of 20 students. The following is a description and analysis of the small group trial shown in Table 4 below.

Table 4. Results Small Group Trial

No.	Aspect	$\sum xi$	$\sum x$
1	Affective	70	80
2	Affective	66	80
3	Affective	65	80
4	Interactive	65	80

No.	Aspect	$\sum x_i$	$\sum x$
5	Interactive	72	80
6	Efficient	69	80
7	Efficient	62	80
8	Creative	63	80
9	Creative	58	80
Amount		590/20	720/20
		29.5	36
Percentage Value		81.49	

Based on the results of small group trials using samples from 3rd semester students of the Biology Education Study Program, they obtained a score of 29.5 out of the maximum score of 36. Therefore, it can be concluded that the Biotechnology E-Module product using Google Sites is considered very good, with a score of 81.94% very worthy to continue to the large group product test stage.

The product testing stage was carried out in large groups, or more precisely, by 3rd-semester students of the Biology Education Study Program with a sample size of 95 students. This stage was carried out to determine the effectiveness and practicality of the Biotechnology E-Module product using Google Sites. In addition, to find out whether the use of the Biotechnology E-Module using Google Sites can improve students' creative thinking skills or not. Meanwhile, data collection was carried out quantitatively with a test sheet. Data was seen from the results of the pretest and posttest scores, before and after using the Biotechnology E-Module product using Google Sites. The following is a description of the processing of data on the effectiveness and practicality of using the Biotechnology E-Module product using Google Sites to improve students' creative thinking skills.

Implementation

The product of the development is in the form of a Biotechnology E-Module using Google Sites, and then implemented for users. The researcher first prepares and explains the usage guide to the lecturer. This will help the lecturer in optimizing the use of the Biotechnology E-Module using Google Sites for students in the classroom. This stage is fully supervised from the learning preparation process to the implementation, to see the results of the use of the Biotechnology E-Module on a wider scale. Thus, it will provide implementation experience by lecturers with actual conditions. After implementation, the researcher will determine the level of practicality of the product based on the questionnaire distributed.

The measurement of effectiveness in testing the Biotechnology E-Module product using Google Sites is measured using a test sheet to determine students' creative thinking skills. The processing of this effectiveness data uses a prerequisite test first, namely the normality test using the Kolmogorov-Smirnov test. The following is a description and analysis of the normality test as a prerequisite test assisted by the SPSS application, which can be seen in Table 5 below.

Table 5. Results Normality Test

	Kolmogorov-Smirnov			Shapiro Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Creative Thinking Pretest	.139	95	.000	.977	95	.087
Creative Thinking Posttest	.100	95	.020	.969	95	.022

Based on the results of the normality test above in the Kolmogorov-Smirnov table, the pretest and posttest significance values were 0.000 and 0.020, respectively, and the value obtained was less than 0.05. Thus, it can be said that the data is not normally distributed, so the prerequisite test is not met. Further processing can use a non-parametric test in the form of the Wilcoxon test. Meanwhile, the description and analysis of the results of data processing using a non-parametric test in the form of the Wilcoxon test can be seen in Table 6 below.

Table 6. Results Wilcoxon Test

Z	-8.254 ^b
Asymp. Sig. (2-tailed)	0.000

The significance value of the Wilcoxon test for the creative thinking variable obtained a value of 0.000, which is smaller than 0.05, so it can be concluded that H_a is accepted and H_0 is rejected. Thus, it can be seen that there is a difference between the pretest and posttest results of the creative thinking skills of students in the Biology Education Study Program before and after using the Biotechnology E-Module. Based on the interpretation and explanation, it can be concluded that the Biotechnology E-Module product using Google Sites is effective in improving the creative thinking skills of students in the Biology Education Study Program.

Practicality data collection was carried out after the lecturer implemented the Biotechnology E-Module product using Google Sites to 95 students in the Biology Education Study Program. The practicality of the Biotechnology E-Module product using Google Sites was quantitatively. The following is a description and analysis of practicality data, which can be seen in Table 7 below.

Table 7. Results Practicality of Biotechnology E-Module

No.	Aspect	Indicator	$\sum xi$	$\sum x$
1	Effective	E-module can be used to Explain the Material	358	392
		The Test Contained in the Biotechnology E-module can be used to help Process Evaluation	327	392
		Overall Information on the E-module is Readable	349	392
2	Interactive	All knob on E-module can be used well	346	392
		All say which in Green can Already bring up Clarity	358	392
3	Efficient	E-modules can be used Anywhere and Anytime	357	392
		The Biotechnology E-module is easily Accessible via Smartphone or Laptop	363	392
4.	Creative	Presentation Task in the Form of a Leaflet to Interest Students in Finishing	326	392
		Presentation of the Quiz in the Form of Games Interests Students in doing it.	327	392
Amount			3111	3528
Percentage Value			88.18%	

Based on the results of the description and analysis of data on the practicality of the Biotechnology E-Module product using Google Sites, it obtained a practicality score of 3111 from a maximum score of 3528. Thus, it can be said that the Biotechnology E-Module product, using Google Sites to improve students' creative thinking skills, is considered very practical, with a practical value percentage of 88.18%. Users consider this product practical because it can be used anywhere and anytime, is easily accessible via smartphone/laptop, and there is a very interesting game-shaped quiz.

Evaluation

Based on the results of expert validation, small and large-scale trials, and effectiveness and practicality tests concluded that the development of Google Site-based e-module products on biotechnology material was declared successful without any revision. So it can be disseminated to be used in teaching and learning activities.

Discussion

The Biotechnology E-Module using Google Sites is said to be valid because it is a user-friendly platform for lecturers and students. So it can be easily used for educational purposes. There are collaborative features offered on the Google Sites platform in real time to facilitate effective learning (Jeyarajaguru, 2023). In addition, the Google Sites platform supports integration with various other Google tools, such as Google Forms, as a pretest, posttest, and assignment page activity that facilitates assignment collection. In addition, the Google Sites platform also facilitates text, images, videos, and links to become dynamic and interactive containers to support involvement in the teaching and learning process (Ramasundrum & Sathasivam, 2022; Songkhro et al., 2022). The Google Sites platform is very suitable/valid to be used as an educational learning medium for learning activities (Arova et al., 2024; Hardianti & Alyani, 2023; Lestari et al., 2024; Valfa et al., 2023).

The implementation of Biotechnology E-Modules using Google Sites is also quite good for improving students' creative thinking skills. This is indicated by a significant increase in pre-test and

post-test scores. In line with research conducted by [Lativa et al., \(2024\)](#), the implementation of E-Modules assisted by Google Sites can improve students' creative thinking skills because it helps lecturers in delivering the material being studied. Digital e-modules based on the Google Sites platform are expected to help students explain abstract concepts, increase absorption, and provide direct experience in learning so that they can improve students' mastery of concepts and creative thinking ([Nasir et al., 2024](#); [Ratnawati et al., 2023](#)). Creative thinking skills are also related to novelty, the ability to create something, be creative in applying new forms, create imaginative skills, or innovate to add something that already exists into something more useful and valuable ([Gcabashe, 2024](#); [Hidayati et al., 2024](#); [Nasution et al., 2023](#); [Taş & Minaz, 2024](#)). Thus, by improving creative thinking skills, it is hoped that students can come up with ideas, insights, perspective approaches, and new ways of understanding things.

The practicality of the Biotechnology E-Module using Google Sites is also quite good because it has a unique and attractive appearance. In addition, it makes it easier to understand the content and saves costs because it does not need to be printed and is easy to access via smartphones, laptops, and computers. Therefore, the Biotechnology E-Module using Google Sites is an alternative to improve creative thinking skills and student learning outcomes. Research conducted by [Valfa et al., \(2023\)](#) stated that the development of E-Modules based on Google Sites makes it easier for students to study material independently via cellphones, tablets, computers, or laptops and can solve problems concretely to train students' creative thinking skills. Then, research conducted by [Lativa et al., \(2024\)](#) found that the use of E-Modules based on Google Sites is very practical for educators and students to use in carrying out learning activities. E-Modules based on Google Sites can trigger, strengthen, and build students' interest in learning independently; the learning process is more effective and efficient and creates a more interactive learning environment ([Nugroho et al., 2024](#); [Yusha & Risnani, 2023](#)). Thus, it can be said that using Google Sites-based E-Modules offers independent, interactive, and effective learning to improve students' creative thinking skills and facilitate the learning process in class.

CONCLUSION

The Biotechnology E-Module product, using Google Sites, is very valid/feasible, effective, and practical to improve critical thinking skills. This is because utilizing digital media and one of the 21st-century skills produces learning innovations that enable students to learn independently anywhere, anytime, generate ideas in solving problems, gain insight, perspective approaches, and new ways of understanding various things. Thus, it can be said that the implementation of the Biotechnology E-Module using Google Sites can provide a positive increase in creative thinking skills. Suggestions that can be used as input based on the results of the research that has been carried out for improvements in further research include researching Google Sites-based E-Modules with neurobiology material and critical thinking skills variables to be able to determine the validity, effectiveness, and practicality of the use of Google Sites-based E-Modules widely.

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