14 (3) (2025) 450-460

Unnes Science Education Journal
Accredited Sinta 2

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Development of Electronic Modules Based on Socioscientific Issues on Biotechnology Material to Improve Argumentation Skills

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DOI: http://dx.doi.org/10.15294/usej.v13i1.25676

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Article Info

Submitted 2025-07-23
Revised 2025-08-20
Accepted 2025-12-15

Keywords

Biotechnology; Electronic modules; Socio-scientific issues

Abstract

This study aims to develop an electronic module based on socio-scientific issues on biotechnology material using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. This module is designed to improve high school students' argumentation skills and perceptions of biotechnology. The subjects of the study consisted of 76 grade XI students in West Bandung Regency. The three-tier test instrument was used to identify student misconceptions, with the results showing the highest percentage of misconceptions in the concepts of STEM cells (22%), recombinant bacteria (21%), and cloning (19%). Needs analysis was carried out through data triangulation, including diagnostic tests, teacher interviews, and student questionnaires. The electronic module developed includes material features, practicums, socio-scientific issues, perception space, and evaluation. Validation by material experts, technology, teachers, and students produced an average score of 3.31 (valid criteria) with a feasibility percentage of 83%. Field trials on 20 students showed an average effectiveness score of 3.19 (80%), included in the very valid category. The results of the study indicate that this module is effective in improving student understanding, interesting to use, and feasible to be applied in distance learning. The implications of this study emphasize the importance of developing innovative learning media to overcome misconceptions and encourage scientific literacy based on contemporary issues.

How to Cite

Mardiyah, F. H., Purwianingsih, W., Solihat, R., Widianingsih, A. A., Astriningrum & Khoerunnisa, R. S. (2025). Development of Electronic Modules Based on Socioscientific Issues on Biotechnology Material to Improve Argumentation Skills. *Unnes Science Education Journal*, 14(3), 450-460.

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p-ISSN 2252-6617
e-ISSN 2502-6232

INTRODUCTION

The rapid advancement of technology and science in the 21st century cannot be separated from the important role of quality education in increasing global competitiveness (Manzuoli et al., 2019). The world of education continues to undergo transformation in order to produce the next generation of nation who are competent and have various 21st century skills. The United States Department of Education identifies main skills that need to be possessed, namely communication, collaboration, creative thinking, and critical thinking (Tsai, 2018). 21st century skills also include problem solving, creativity, critical thinking, and ability to cooperate and communicate (Permana et al., 2016).

The results of the study showed that students' argumentation skills are still very low, especially in biotechnology material. This condition is caused by less innovative learning methods and minimal opportunities for students to express their opinions actively (Bögeholz et al., 2017). Argumentation is a critical scientific literacy skill, necessary for modern learners to navigate and evaluate real-world problems especially in sensitive areas like biotechnology (Mardiyah et al., 2022). Students are rarely given space to discuss or debate in the learning process . Therefore, argumentation skills need to be trained so that students are able to analyze science issues based on accurate evidence and data(Máñez et al., 2019).

Argumentation skills play an important role in forming models, explanations, and theories related to the material being studied (Macagno et al., 2015). When students are accustomed to putting forward arguments, they indirectly train cognitive abilities that support deep understanding of concepts(Sitanggang et al., 2024). Ideal learning is learning that not only emphasizes cognitive aspects but also equips students with skills such as argumentation. This process involves active discussions strengthen students' understanding of the material (Cavlazoglu & Stuessy, 2018).

One of materials in biology lessons can train critical thinking skills is biotechnology, which is also closely related to socio-scientific issues. This is in line with Dawson & Venville, (2013) that topic of biotechnology is controversial because it combines scientific aspects social, economic, and political dimensions. Socio-scientific issues in biotechnology include topics such as tissue culture, cloning, genetic engineering, conventional biotechnology, biotechnology in health, animal husbandry, agriculture, environment, and ethical aspects(Sitanggang et al., 2024).

In Indonesia, there are various socio-scientific issues relevant to biotechnology, such as genetic engineering in agriculture and health (Andrade, 2021). Because biotechnology has a direct impact on society, it is important for students to understand its concepts thoroughly in order to make informed decisions. The controversy surrounding the application of biotechnology has prompted public debate, so the world of education also needs to participate in providing adequate understanding (Hanegan & Bigler, 2009).

As a solution to the limited time and teaching materials in schools, innovation is needed in the form of learning media that support the learning process, one of which is an electronic module. This module allows students to access materials flexibly anytime and anywhere, thus supporting distance learning. Students can also use one learning resource for free. This learning module innovation integrates the Problem-Based Learning (PBL) approach which is able to encourage students to think critically and solve problems (Saifuddin et al., 2020). Therefore, the development of an electronic biotechnology module based on socio-scientific issues integrated with PBL is believed to be able to improve students' argumentation skills (Fadha et al., 2023). The document identifies several key gaps in previous research. Previous educational modules, especially in biotechnology, often lack integration of real-world socioscientific contexts that challenge students to think critically and ethically(Viehmann et al., 2024). Prior studies and learning tools inadequately target the enhancement of argumentation skills, particularly through technology-enhanced learning platforms. While digital learning tools are growing, there is a shortage of electronic modules that are specifically designed with SSI-based frameworks in biotechnology content (Uçar & Demiraslan Çevik, 2020).

Novelty of this research are the module incorporates socioscientific issues not just as case studies, but as a pedagogical framework, which is still relatively rare in biotechnology learning materials, the module explicitly aims to develop students' scientific argumentation skills, integrating prompts and tasks that train students to build claims, use evidence, and justify reasoning this distinguishes it from general e-learning content, and the research develops electronic (digital) learning modules, enhancing accessibility, interactivity, and engagement unlike many previous printed or static materials (Martin et al., 2021).

The electronic module developed in this study is designed in the form of an Android-based application, so that students can learn independently and do exercises directly through the application, which also makes it easier for teachers

to evaluate learning outcomes. This application is equipped with a socio-scientific issue discussion room feature that allows students to exchange opinions and review emerging ideas. The socio-scientific issues raised in module include cloning, food biotechnology, health, agriculture, animal husbandry, the environment, and biotechnology ethics. This module can be used both in distance learning and face-to-face learning in classroom.

METHOD

This research is categorized as research and development (R&D), aiming to develop and validate a learning product in this case, an electronic module based on socioscientific issues for biotechnology material. The development stage of socio-scientific issue-based electronic modules using the ADDIE model is an abbreviation of Analyze, Design, Development, Implementation and evaluation (Branch, 2009). This study involved 76 grade XI high school students in West Bandung Regency. The instrument used was a three-tier test consisting of 33 questions referring to 33 propositions. This three-tier test was adapted from Anam et al., (2019) with three levels of assessment: (1) the first level measures conceptual understanding, (2) the second level assesses scientific reasoning abilities, and (3) the third level tests respondent's level of confidence.

Data collection methods are three-tier diagnostic test (Anam et al., 2019) to identify misconceptions in biotechnology; interviews with biology teachers to gather contextual insights into existing learning barrier; student questionnaires to collect perceptions of media use and evaluate developed module; expert validations involving material experts, media experts, practitioners, and teachers; module effectiveness test using student feedback questionnaires during trial phase.

Data analysis validation scores from experts were analyzed using mean scores and feasibility percentages. Criteria from Syaharuddin & Mandailina, (2017) were applied to determine validity. Effectiveness analysis was based on student response averages and categorized using the Content Validity Ratio (CVR) and criteria from Hamdi et al., (2013). Misconception data from the diagnostic test were analyzed by calculating percentage of incorrect conceptual understanding with high confidence and inaccurate reasoning.

RESULT AND DISCUSSION

The development of an electronic module based on socio-scientific issues follows the ADDIE model, which is an acronym for Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). This electronic module is designed to be used in the classroom learning process to examine the impact of its implementation on improving students' argumentation skills and perceptions of biotechnology.

Analysis Stage

At this stage, a needs analysis was conducted to identify problems in field. Several activities carried out include analyzing biotechnology materials by evaluating students' initial knowledge to determine learning needs on topic, and collecting data through interviews with biology teachers and distributing questionnaires to a number of students at SMA Kabupaten Bandung Barat. The results of the analysis of students' initial knowledge then become the basis for compiling propositions and macro structures of teaching materials. The needs analysis stage is carried out through data triangulation which includes: 1) diagnostic tests of students' initial knowledge; 2) in-depth interviews with biology teachers, and 3) needs surveys through student response questionnaires on learning media.

a.Results of Student Initial Knowledge Analysis

This stage aims to identify learning needs in biotechnology material through an evaluation of students' initial understanding. Measurements are carried out using a three-tier test instrument that includes three dimensions of assessment, namely the first level assesses basic knowledge, the second level analyzes conceptual reasoning abilities, and the third level evaluates the level of respondent confidence. One of the important findings in the three-tier test is identification of misconceptions. According to Anam et al. (2019), misconceptions occur when students give answers (either right or wrong) with a high level of confidence, but are accompanied by reasons that are not in accordance with scientific concepts.

Based on the results of the initial knowledge analysis, students still experience misconceptions in this biotechnology chapter with a percentage ranging from 13% -22%. This can happen because students who are respondents to initial knowledge are students who have not received or studied the concept of biotechnology. Although it was studied in grade IX of junior high school, there are several new biotechnology concepts that are discussed in more depth and require a good understanding that will be studied in grade XII.

The initial knowledge of students obtained from the data related to misconceptions, it turns out that there are still several concepts that ex-

perience quite high conceptions in biotechnology material, the biggest misconception of 22% of students experiencing misconceptions in the concept of STEM cells (stem cells). In addition to these concepts, students still experience misconceptions of 21% in the concepts of recombinant bacteria, recombinant DNA, and plasmids. In the concept of cloning, students experience misconceptions of 19%. As many as 16% of students still experience misconceptions in the definition of biotechnology and its application, ethics in biotechnology, and biotechnology in agriculture (Capkinoglu et al., 2020).

This is caused by several factors as expressed by several researchers. According to (Anam et al., 2019) misconceptions can be caused by internal and external factors. Internal factors causing student misconceptions can come from students' daily experiences, while external factors can come from textbooks, learning processes, learning media, and language. Previous research has revealed that the factors causing science misunderstandings are language factors, experience factors, observation factors, and thinking skills factors (Taufiq & Hindarto, 2012). Causes of student misconceptions against a concepts can occur through one or a combination of student learning experiences . In general , the causes of misconceptions experienced students namely the cause that came from external knowledge students, context, teachers, teaching methods , and textbooks . Experience and Students' daily events are one of the causes of misconceptions that come from students contextually. Experience can form a concept that is strong enough because it is directly experienced by the students themselves (Macalalag et al., 2024).

Another factor that causes misconceptions in students is their teachers. This is explained in a study conducted by Taufiq and Hindarto, (2012) that if teachers teach students the wrong concept, then this will give students the wrong idea in their efforts to reconstruct knowledge so that there is interference between the concepts that have been learned (wrong) and those being learned (correct). Misconceptions that students have acquired while at school still persist. on himself until they are in college (Rundgren et al., 2016a). Misconceptions usually develop as learning process that cannot change it. In addition, (Permana et al., 2016) also explained the causes of misconceptions including: 1) limited information that can be received, 2) the existence of theories that are updated but cannot be tested, 3) errors in learning resources such as textbooks, 4) the bias of information obtained from media, both print, electronic, and online media, 5) students are passive, accept what is, and are not critical of the teacher's delivery, 6) the material taught is too complex, 7) the material taught to students is not in accordance with their cognitive development.

b.Teacher Interview Results

In the results of teacher interviews, activities were carried out that aimed to obtain an overview of the learning process that occurs in schools, especially in biotechnology material. Based on the results of interviews with teachers, researchers obtained an overview of the learning process that occurs in schools, especially in biotechnology material (Nurtamara & Widyastuti, 2023). Based on the results of interviews with biology teachers who were interviewed, it was stated that learning biotechnology material in class in the previous year was carried out through discussions, students were given assignments to present material that had to be studied in groups. The material presented was about the principles of biotechnology, the definition and types of biotechnology, the impact of biotechnology on life, and practicums on making yogurt based on local wisdom and STEM (Rundgren et al., 2016). However, because it is currently constrained by a pandemic, distance learning is carried out through e-learning such as zoom, whatsapp , and moodle to deliver material that is carried out using lecture methods, practice questions, and independent practicum assignments at their respective homes.

The obstacles in teaching biotechnology material are that students lack references, the content of the biotechnology material is not in-depth enough, and the obstacles in implementing the practicum are that the school does not have a special laboratory, and the results of the practicum are less than satisfactory. In addition, the obstacles to learning during the pandemic are that student attendance does not reach 50% and limited time results in students and teachers not being able to discuss much. The learning media used when learning biotechnology material are power points, student handbooks that are loaned from the library during school hours, the number of which is limited (Öz Aydın et al., 2023).

c.Results of Student Attitude Questionnaire in Using Learning Media

In the results of the student attitude questionnaire in the use of learning media, activities were carried out aimed at obtaining an overview of the use of learning media in the classroom. Based on the results of the questionnaire on stu-

dents' attitudes in the use of learning media, the researcher obtained a picture of the use of learning media, from the results of the questionnaire that teachers sometimes use varied learning media, teachers usually use power point learning media . Every time they teach, teachers sometimes use learning other than books. Teachers always use learning media that are in accordance with the learning material.

In terms of student attitudes towards the use of media, it shows that students find it easier to understand lessons after teachers use learning media, students feel bored if teaching and learning activities do not use learning media, students feel that the use of learning media has a very big influence on receiving lessons. However, sometimes students do not understand the concepts taught even though they use learning media. Students are sometimes more enthusiastic about following learning that uses learning media. The frequency of use of learning media shows that sometimes teachers only use learning media at certain times. Every time they teach, teachers sometimes use learning media for difficult materials. Sometimes teachers do not use learning media optimally.

In terms of the benefits of using learning media, it shows that students feel the benefits of learning media. Sometimes students find it easier to understand lessons without using learning media. Sometimes they feel more helped to understand the material after the teacher uses learning media. Students are sometimes more diligent in studying because learning media makes me happy when studying the material. Sometimes learning media makes students more active in participating in learning (Dewi et al., 2019). Students are more active in asking questions about learning materials when teachers use learning media, and learning using learning media makes the material easy to remember (Nurtamara et al., 2019).

2.Design Stage

Based on the results of the analysis that has been carried out on the level of misconceptions of students' initial knowledge, teacher interviews, and students' opinions, the next stage is to design an electronic module based on socio-scientific issues in biotechnology material. At this stage, the researcher creates a framework of the material to be created and a module design that will be used. In addition, the researcher designs the research and evaluation instruments, maps media elements, and creates a design for an electronic module based on socio-scientific issues in biotechnology material in the form of a framework of the material to be created and a module design that will be used.

This development product has specifications including this product is an electronic module application packaged in the form of an application, this electronic module can be accessed offline anytime and anywhere, this electronic module has a more attractive presentation display, easy to understand and practical for teachers and students to use, this electronic module has several features which are explained in Table 1.

Table 1. Design Features in Electronic Module

Feature	Description	Objective
Material features	A feature that provides sources of biotechnology material in it and is equipped with images and videos.	Facilitate students' mastery of concepts and students' perceptions of biotechnology.
Practical activity features	A feature that provides practical steps in biotechnology material.	Presenting a report on results of experiments on the application of electronic biotechnology principles published by Ministry of Education based on scientific method.
Socio-scientific issue features	Features that provide socio-scientific issues. Students are guided to analyze problems by asking relevant questions to build meaningful connections between prior knowledge and key concepts.	Facilitate several stages of PBL , namely the stages of finding problems and analysis.
Perceptual space features	A feature that provides a space for students' perceptions of biotechnology. On this page there are questions that students can answer about their views on biotechnology.	Developing students' perceptions about biotechnology, whether students are pro or con towards biotechnology.
Evaluation/ Quiz feature	This feature aims to measure students' understanding of the material, including practice questions and assignments.	Facilitate students' mastery of concepts and students' perceptions of biotechnology.

The characteristics of the electronic module based on socio-scientific issues in biotechnology material include material features. This feature provides sources of biotechnology material in it and is equipped with images and videos. In this menu, the media displays a selection of materials loaded on the media from beginning to end according to learning objective. Students can repeat the material from one page/material selection listed on the media. In the video menu, a video of biotechnology material will be displayed that will help students understand the material. The video is very interesting to watch and allows students to repeat it several times until they understand. The purpose of this material feature is to facilitate students' mastery of concepts and students' perceptions of biotechnology.

The next characteristic of socio-scientific issue-based electronic module in biotechnology material is that there is a socio-scientific issue feature. This feature provides socio-scientific issues. Students are directed to analyze problems by asking relevant questions to build meaningful relationships between prior knowledge and key concepts. The socio-scientific issue feature facilitates several stages of PBL (Problem Based Learning), the stages of finding problems and analysis. The purpose of this feature is to develop argumentation skills through identifying and describing socio-scientific issue problems by considering various aspects such as social, economic and ecological aspects. This feature also facilitates the stages of PBL, namely the presentation and reflection stages of solutions. At this stage, students are directed to present in front of the class and reflect on learning. Through collecting information about problems and discussions in groups to use information relevant to problem as evidence to support solution (Türk & Çam, 2024).

The application of socioscientific issues in the classroom provides a meaningful learning environment to engage students in improving argumentation skills (Jho et al., 2024). One of the outcomes of socioscientific issue-based learning is the improvement of students' argumentation skills in debate, criticism, discussion, and negotiation based on evidence (Bögeholz et al., 2017). As stated by (Norris & Phillips, 2023), this socioscientific issue-based environment engages students in conveying diverse ideas to achieve argumentation skills when they work cooperatively through application of their epistemic understanding of arguments to a science issue or topic. Students are stimulated to debate, discuss, defend, and argue with an understanding of what is considered good evidence and what makes a good claim in such an environment (Yapıcıolu, 2018).

The next characteristic of the socio-scientific issue-based electronic module on biotechnology material is that there is a perception space feature. A feature that provides students with a perception space about biotechnology. On this page there are questions that students can answer about their views on biotechnology. The purpose of this feature is to compare and evaluate several alternative solutions by considering the positive and negative effects or pros and cons of the chosen solution. Developing students' perceptions of biotechnology, whether students are pro or con biotechnology (Zeidler et al., 2019).

Public concerns about biotechnology products are one of the most important factors in an individual's decision making. Risk and technology have the potential to be very important in science literacy and science learning. Not only is content important in biotechnology learning, but this perceptual space can provide students with the opportunity to form their own views, based on their understanding, the benefits and disadvantages of modern biotechnology are also important (Gardner & Jones, 2021). Schools have a crucial role in promoting biotechnology understanding that enables students to recognize what is being discussed in a given controversial issue, students can express their opinions and participate in discussions, debates and decision-making processes (Reis, 2004). Advances in modern genetics and biotechnology are of great importance, creating opportunities on one hand but carrying risks on the other. Therefore, future generations must be provided with accurate information in educational institutions about genetic engineering techniques and practices and become individuals who are aware of the issues and problems they may often face in the future (Herlanti, 2024).

The next characteristic of electronic module based on socio-scientific issues in biotechnology material is that there is an evaluation/quiz feature. This feature aims to measure students' understanding of the material, including practice questions and assignments. The purpose of this feature is to facilitate students' mastery of concepts and students' perceptions of biotechnology.

3.Development Stage

The development was carried out based on the previous stage including providing reinforcement related to concepts that experienced quite high misconceptions according to the findings at the stage of analyzing students' initial knowledge. At this development stage, all the components needed were combined into a unit according to

their function. Furthermore, the validator assessment was carried out to test the validity consisting of aspects of media/design, content/material content, readability, and ease of access of the previously designed product. The learning module was validated by two expert validators, two material experts, two media experts, two teachers, and seven students. The validators carried out assessments and provided suggestions/input for product improvement. The formula for finding the average validation results was adopted from (Syaharuddin & Mandailina, 2017). After validation, the next step is to revise the module. This revision is done based on the assessment results and suggestions given by each validator. At this stage, expert validation assessment is carried out. The summary of the module validation results shows valid values, among which can be seen in Table 2.

Table 2. Validation Results of Electronic Modules Based on Socioscientific Issues

No	Validator Types	Score	Category
1	Validators	3.50	Valid
2	Technology Expert	3.42	Valid
3	Subject Matter Expert	3.48	Valid
4	Teacher	3.48	Valid
5	Student	2.68	Valid
Average		3.31	Valid

Based on expert assessment in Table 4 above, it can be said that electronic module based on socio-scientific issues of biotechnology material for high school students shows an average score of 3.31, which means it is declared valid, a percentage value of 83%, which means the product is ready to be used in the field and suitable for use.

a.Practitioner Assessment (Validator)

The assessment at the next development stage is the assessment by learning practitioners, namely by Lecturers of the UPI Biology Education Department. The results of the assessment based on Figure 3.8 obtained an application media score of 3.88; ease of operation of 3.00; visual media of 3.67; two-way communication with users of 2.50; learning pedagogy of 3.00 and content standards of 2.75 so that an average score of 3.50 was produced, indicating that electronic module based on socio-scientific issues of biotechnology material is valid for use and has a percentage value of 88%, which means that the product is ready to be used in the field and is suitable for use.

1) Technology Expert Assessment

The assessment at the next development stage is the assessment by technology experts. The results of the assessment by technology experts based on Figure 3.9 obtained a teaching material design score of 3.50; clear language of 3.50; communicative of 3.00; dialogue and interactive of 3.25; suitability to student development of 3.50; suitability to language of 3.50; and use of symbols/icons of 3.50 so that an average score of 3.42 was produced indicating that electronic module based on socio-scientific issues of biotechnology material is valid for use and has a percentage value of 86% which means that the product is ready to be used in field and is suitable for use.

2) Material Expert Assessment

The assessment at the next development stage is assessment by technology experts. The results of assessment by material experts based on Figure 3.10 obtained a score of material suitability with core competencies and basic competencies of 3.33; material accuracy of 3.67; material up-to-dateness of 3.50; encouraging curiosity of 3.75; presentation techniques of 3.50; presentation support of 3.63; learning presentation of 3.50; coherence and sequence of thought patterns of 3.25; contextual nature of 3.25; and contextual components of 3.30, an average score of 3.48 was produced indicating that the electronic module based on socio-scientific issues of biotechnology material is valid for use and has a percentage value of 87% which means that the product is ready to be used in the field and is suitable for use.

3) Assessment by Teacher

The assessment at the next development stage is the assessment by the biology subject teacher. The results of assessment by the biology subject teacher based on Figure 3.11 obtained a task score of 3.67; communicative of 4.00; dialogue and interactive of 3.50; suitability to student development of 3.00; suitability to language of 3.50; use of symbols/icons of 3.00; presentation techniques of 3.50; presentation support of 4.00; dialogue and interactive of 3.50; presentation of learning of 3.50; and coherence and sequence of learning flow of 3.25 so that an average score of 3.48 was produced indicating that electronic module based on socio-scientific issues of biotechnology material was valid for use and had a percentage value of 87% which means that product was ready to be used in the field and feasible to use.

4) Small Scale Trial On Students

After the electronic module based on socioscientific issues of biotechnology material was declared valid, it was then tested on students. At this stage, the learning media was tested on students to determine the level of interest and feasibility. The small-scale trial used seven student respondents. The results of the small-scale trial to

students based on Figure 3.12 obtained a material readability score of 2.54 and a presentation score of. The average results obtained in the small-scale test were an average value of 2.79 and a percentage of 74%. Based on the results of the small-scale test by students, these results place the media in the criteria of valid, interesting and feasible to use (Syaharuddin & Mandailina, 2017) .

4.Phase I Implementation and Evaluation

In the implementation and evaluation stage, the researcher implemented the module that had been created to the target students, namely 20 high school students in grade 12 majoring in science. The effectiveness of the module was measured using a questionnaire containing things related to the material presented, a clear understanding of biotechnology, increasing insight into socio-scientific issues, the material presented encouraged me to express my opinion, the material presented increased my perception of biotechnology and presentation aspects consisting of the presentation of images accompanied by explanations that students can understand, the presentation of images in accordance with the material presented and clarifies the material, and the appearance of the electronic module. The criteria used in testing the effectiveness of this socioscientific issue-based electronic module use four levels, which can be seen in Table 4 below.

Table 3. Criteria for Electronic Modules Based on Socioscientific Issues

No	Score	Information
1	4	Very good
2	3	Good
3	2	Enough
4	1	Not enough

The data analysis of the results of the learning media effectiveness test from the validators was analyzed using the Content Validity Ratio (CVR) analysis. The results of the module effectiveness test were then categorized according to Hamdi et al., (2013) At the implementation and evaluation stage, researchers conducted a trial of the use of the module to examine the practicality and effectiveness of the electronic module based on socio-scientific issues on biotechnology material. Furthermore, a questionnaire was given to the research subjects to determine the average results of the module effectiveness test. The results of the application of the electronic module based on socio-scientific issues were carried out on 20 students. The following are the results of the trial of the use of the electronic module based on socio-scientific issues which can be seen in Table 4.

Table 4. Results of the Trial of Using Electronic Modules Based on Socioscientific Issues

Indicator	Indicator Points	Average score	Percentage (%)
Readability of Material	I feel clear with the material presented	3.25	81
	The material presented gave me a clear understanding of biotechnology.	3.25	81
	The material presented increases insight into socio-scientific issues.	3.25	81
	The material presented encouraged me to express my opinion.	2.85	71
	The material presented increased my perception of biotechnology.	3.05	76
Presentation	The presentation of the images is accompanied by an explanation that I can understand	3.50	88
	Presentation of images in accordance with the material presented and clarifying the material	3.40	85
	The colors, background, text, and images are in harmony so I am interested in studying it.	3.15	79
	The letters used are easy for me to read and interesting	3.10	78
	The presentation of the material stimulated me to be involved and actively participate in learning.	3.10	78
	The presentation of feedback and answer keys made it easier for me to evaluate my success.	3.20	80
Total		**3.19**	**80%**

The test results obtained an average score of 3.19 which is a valid criterion (Syaharuddin & Mandailina, 2017) and a percentage of 80% which means that the product is ready to be used in the field. Based on the results of the student response questionnaire data processing, the electronic module based on socio-scientific issues of biotechnology material developed in valid criteria as a source of teaching materials and is suitable for use in the learning process in the classroom. This shows that the electronic module based on socio-scientific issues in biotechnology material is a factor that can support the learning process and improve the quality of education (Herlanti, 2014) .

The results of the study showed that students were very interested and helped by learning using electronic modules based on socio-scientific issues in biotechnology material. This is supported by research (Handaru & Pujiriyanto, 2021) which found that students prefer learning with electronic modules compared to learning via Google Classroom, Zoom or YouTube . Learning using electronic modules based on socio-scientific issues makes students satisfied with learning compared to online learning (Coman et al., 2020).

Learning with electronic modules is a solution to the problem of low student motivation. This is because learning with electronic modules can provide full control to students (Basuki et al., 2019) . The use of electronic modules can support students to be able to learn the material optimally, making it easier for students to learn (Zeqiri, 2014). Learning with electronic modules based on socio-scientific issues in biotechnology material is suitable for implementation in distance learning (Damopolii & Kurniadi, 2019).

CONCLUSION

This study successfully developed an electronic module based on socio-scientific issues on biotechnology material using the ADDIE model consisting of the Analysis, Design, Development, Implementation, and Evaluation stages. This module is designed to improve students' argumentation skills and improve their understanding of biotechnology concepts that previously had many misconceptions. The developed module includes material features, practicums, socio-scientific issues, perception space, and evaluation, and was declared valid by experts and practitioners with an average score of 3.31 (83%). The results of the effectiveness test on students showed that this module was very valid and interesting to use in learning, with an average effectiveness of 3.19 (80%). This module has proven effective in supporting the distance learning process and is feasible to be applied to improve students' scientific understanding and literacy through a contextual approach based on contemporary issues. This study provides an important contribution to the development of innovative learning media that support meaningful learning and strengthen students' critical thinking skills.

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