JPPIPA 11(6) (2025)

Jurnal Penelitian Pendidikan IPA

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

Development of Web-Based E-Module Learning with SSI Approach on Hormone Material in Human Reproduction to Improve Critical Thinking Skills and Self-Awareness of High School Students Phase F

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Received: March 10, 2025
Revised: May 11, 2025
Accepted: June 25, 2025
Published: June 30, 2025

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DOI: 10.29303/jppipa.v11i6.11317

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Abstract: This development research uses the ADDIE model. The development design consists of five stages, namely, Analysis, Design, Development, Implementation, and Evaluation. The learning approach used in this e-module is the SSI (Socio-scientific Issue) approach. The learning web-based e-module with the SSI approach was evaluated by material experts, media experts, practitioners and tested its effectiveness on students of class XI IPA SMA N 1 Jebus using a quasi experiment with a random control group pretest-postest design. Data collection techniques used in this study were observation, interview, questionnaire, test, and documentation. The data from this study were analyzed by descriptive and inferential stastics with the MANOVA test. The results showed that: 1) web-based e-module learning with the SSI approach is feasible to use in learning biology based on the assessment of material experts and media experts; 2) web-based e-module learning with the SSI approach is practical to use in learning biology based on the assessment of biology teachers and students; 3) web-based e-module with the SSI approach effectively improves students' critical thinking skills and self-awareness, as evidenced by the results of the MANOVA test which shows significant differences (Sig value 0.000 <0.05) between students who use and do not use the e-module.

Keywords: Critical thinking skills; E-module; Self-awareness; SSI (Socio-scientific Issue)

Introduction

The rapid development of science and technology has brought significant changes in the world of education in the 21st century, including in Indonesia (Rohmaya, 2022). In facing global challenges, the national education system is required to be able to adapt and innovate, considering that conventional learning approaches that are oriented towards memorization are no longer considered adequate to prepare students to face the complexity of real-world problems (Siregar, 2019).

The integration of technology in the learning process has great potential in creating an adaptive, interactive, and learner-centered education system. Technology not only functions as a tool, but also plays a strategic role in the development and management of effective learning methods, both in the short and long term. Several applications of technology in education, such as distance learning, web-based learning, and e-learning, have begun to be adopted (Siregar, 2019).

How to Cite:
Nirwana, P. N., & Octavia, B. Development of Web-Based E-Module Learning with SSI Approach on Hormone Material in Human Reproduction to Improve Critical Thinking Skills and Self-Awareness of High School Students Phase F. *Jurnal Penelitian Pendidikan IPA*, *11*(6), 167-175. https://doi.org/10.29303/jppipa.v11i6.11317

However, their utilization is still not optimal in many educational units. In the field, teachers often face various time constraints in teaching and learning activities (KBM), which have an impact on the lack of comprehensive material delivery. This limitation is exacerbated by the lack of media and teaching materials available in schools, so that the learning process tends to focus on memorization rather than conceptual understanding, and does not encourage the development of higher-level thinking skills such as critical thinking and self-awareness.

The use of web-based e-modules is one of the relevant solutions to overcome these problems. E-modules allow the presentation of material more effectively, efficiently, and flexibly, because it can be accessed at any time through the internet network, and encourage students' learning independence (Kuncahyono et al., 2019).

In the context of 21st century learning, the development of critical thinking skills and self-awareness is an important aspect, especially in biology subjects. Critical thinking skills help learners to analyze information, evaluate arguments, and solve problems logically. Zakiah et al. (2019) explain that critical thinking includes the ability to assess various points of view, be open to new ideas, think logically without being influenced by emotions, and draw conclusions based on valid evidence. Learners with critical thinking skills tend to be more careful in analyzing problems and more systematic in developing solutions (Sari et al., 2023).

However, various studies show that the critical thinking skills of students in Indonesia are still relatively low (Rusmansyah et al., 2019). One of the causes is the learning approach that still focuses on memorization, not on developing reasoning and analytical skills (Agnafia, 2019). In addition, self-awareness as part of emotional intelligence also needs to be instilled, especially in the context of learning biology related to reproductive health. Good conceptual knowledge contributes to the mindset and attitude of students in dealing with life issues, including in terms of understanding the impact of sexual violence. Rahmawati et al. (2022) stated that self-awareness is a basic element in the development of emotional intelligence and can be an important strategy in improving learner learning outcomes.

The application of the right learning model or approach is key in fostering students' critical thinking skills and self-awareness. In addition, the success of students is highly dependent on the learning model applied by the teacher (Fihani et al., 2021). One approach that is considered effective is the Socio-Scientific Issues (SSI) approach, which links scientific concepts with contextual social issues that are close to students' lives (Sadler, 2011). Through discussion and analysis of complex issues, this approach encourages learners to not only understand concepts in depth, but also develop critical thinking skills and self-reflection.

On the other hand, web-based e-modules offer advantages in supporting modern learning. In addition to the flexibility of access, e-modules allow the presentation of interactive and interesting content, in accordance with the learning characteristics of the digital generation (Surya, 2023). Therefore, the development of a web-based e-module with the SSI approach on human reproductive hormone material is seen as a potential innovation that can improve concept understanding, as well as foster critical thinking skills and self-awareness of students.

This study aims to develop and evaluate a web-based e-module that integrates the SSI approach in learning the topic of human reproductive hormones. Hopefully, this e-module can be an alternative learning media that not only strengthens learners' conceptual understanding, but also fosters critical thinking skills and self-awareness in dealing with socio-scientific issues relevant to their daily lives.

Method

This study used the Research and Development (R&D) method by adopting the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation (McGriff, 2000).

Analysis

The analysis was conducted to identify problems in biology learning and the needs of students to improve learning outcomes. This stage includes observation, data collection at school, distributing needs questionnaires to students, and interviews with subject teachers.

Design

The design stage includes the preparation of e-modules which consists of selecting designs, preparing drafts, and formulating relevant instruments. The product design at this stage is still an initial concept which is the basis for further development.

Development

The development stage is carried out to realize the e-module product design in accordance with the storyboard. This process involves validation from material experts, media experts, biology teachers (practitioners), followed by limited trials on students. Based on the results of the trial, the product is then revised until it reaches a decent quality and is ready to be implemented in schools.

Implementation

The implementation stage is a product trial in real conditions as biology teaching materials on human reproductive hormone material. The trial aims to assess the effectiveness of e-modules on students' critical thinking skills and self-awareness, using a quasi-experimental method, random control group pretest-posttest design. A total of 58 learners were randomly divided into experimental and control groups through a simple lottery to minimize initial characteristic bias.

Evaluation

Evaluation in the ADDIE model consists of formative and summative evaluation. Formative evaluation is carried out during the analysis, design, development, and implementation stages to assess the feasibility, practicality, and effectiveness of web-based e-modules with the SSI approach. The assessment was conducted by material experts, media experts, biology teachers, and students through validation instruments, practicality sheets, and tests. Summative evaluation was conducted thoroughly after the entire development process, including dissemination, was completed.

The population in this study were 11th grade students of SMA N 1 Jebus, West Bangka. Sampling was conducted using the Quasi Experiment method with a random control group pretest-posttest design. The data collection techniques used in this study were interviews, tests, questionnaires, and documentation. The interview technique was conducted by researchers as preliminary research, which aims to identify various potentials and problems that need to be analyzed in this study. The test technique was used to measure the critical thinking skills and self-awareness of students by using instruments in the form of description questions that include questions about hormones in human reproduction and self-awareness questionnaires that use a Guttman scale.

The test was conducted in two stages, namely: before (pretest) and after (posttest) implementation. The pretest aims to assess the initial ability of students in both groups (control class and experimental class). Meanwhile, the posttests aimed to evaluate the effectiveness of the E-module in improving learners' critical thinking skills and self-awareness. Before being used, the instruments used must go through the validation stage by experts. Questionnaires in this study were used to: (a) find out students' views on biology learning, including teacher approaches, learning resources, and ownership of mobile devices; (b) obtain product feasibility data from material and media experts; (c) assess the practicality of the product according to students and biology teachers; and (d) evaluate the effectiveness of the product after being applied in learning.

Table 1. Large Group Trial Design (Sugiyono, 2023)

Group	Pretest	Treatment	Posttest
Experiment	Y1	X	Y2
Control	Y1	-	Y2

Description:

X : Learning using web-based e-module with SSI approach on hormone material in human reproduction in class XI IPA 3 as an experimental class.

_ : Learning using school modules on hormone material in human reproduction in class XI IPA 5 as the control class.

Y1 : Dependent variables (critical thinking skills and self-awareness) measured before learning.

Y2 : Dependent variables (critical thinking skills and self-awareness) measured after learning.

Manova test was conducted to see the effectiveness of web-based e-module in improving critical thinking skills and self-awareness. Before the Manova test, the data must go through normality, homogeneity and linearity tests, followed by an analysis of improvement through the n-gain score method (Hake, 1998).

$$< g >= \frac{Sf - Si}{Smax - Si} \quad (1)$$

Description:

< g > : Normalized gain value

Sf : Pretest score

Si : Posttest score

Smax : Maximum score

Result and Discussion

The result of this research is a web-based e-module developed with Canva Site, focusing on human reproductive hormone material for class XI SMA/MA. This e-module is designed to improve students' critical thinking and self-awareness through the SSI (Socio-scientific Issue) approach with the issue of sexual violence as the main context.

Student Analysis

Analysis of the needs and characteristics of students was conducted through interviews with biology teachers and distributing questionnaires to students of SMA Negeri 1 Jebus. The results show that biology learning is still very dependent on printed textbooks, with limited media and teaching materials available. The textbooks used only contain explanations and practice questions, which causes learning to emphasize memorization rather than understanding of concepts. The teacher also said that the use of electronic devices is allowed, but the available material is not

enough to answer the needs of students. In addition, the teacher also has difficulty in delivering the material thoroughly due to limited learning time, so the material is delivered briefly in class and the rest is given in the form of homework. The material of hormones in human reproduction is one of the materials that is difficult to understand even though students show enthusiasm by asking many questions. The final exam results showed that there were still many students who scored below the KKM, which according to the teacher was caused by the limited learning time.

To overcome these obstacles, the Socio-Scientific Issues (SSI) approach is considered to have the potential to improve students' critical thinking skills and self-awareness in a relevant and contextual manner. Unfortunately, this approach has not been applied by biology teachers at SMA Negeri 1 Jebus, including the linking of material with the issue of sexual violence which can actually be utilized in learning biology. Interviews also showed that 98% of learners agreed on the importance of studying the issue of sexual violence among adolescents, and they considered sexual education very important given the high prevalence of violence cases. A web-based e-module with the SSI approach will be developed to facilitate its use in schools. Based on the questionnaire results, all learners have supporting electronic devices, and there is wifi access at school that can be used for learning.

Competency Analysis

The competencies of student learning outcomes are presented in the learning curriculum, and at SMA Negeri 1 Jebus the Merdeka Curriculum is applied. The preparation of web-based e-modules refers to the biology learning outcomes for phase F in even semesters.

Content Analysis

The developed e-module presents material content that is in accordance with the learning outcomes in phase F, especially on human reproductive hormone material. This e-module contains supporting materials in the form of images, concept maps, material explanations, learning videos, LKPD, and questions to measure students' abilities.

In addition to the subject matter, the e-module also presents issues of sexual violence related to the learning topic in each chapter. These issues are taken from real cases that are currently of concern. The selection of issues is based on their relevance to students' lives so that learning feels more real and contextualized. The supporting material in the e-module consists of three main sub topics, namely: (1) The role of hormones in growth, development, and sexual function; (2) Structure and function of reproductive system organs; (3) Pregnancy and disorders or abnormalities in the reproductive system. Some additional materials are also taken from the IGTSE guidelines to enrich the information content of the module.

Design

At the design stage, product design is carried out which consists of several stages and the formulation of test instruments that will be used to measure critical thinking skills and self-awareness questionnaire items.

Development

At this stage, the designed product will be tested through validation by media experts, material experts, and practitioners (teachers and students). After that, the product will be improved until it is ready to be implemented. The development steps include: 1) pre-development stage with literature review on making web-based e-modules, 2) making e-modules using Canva and Canva Site applications, 3) drafting modules that include the main components, suitability of material, visualization, writing techniques, language, graphics, and suitability of content to achieve the expected competencies, 4) making the main page (Dashboard) which includes a login icon for the identity of learners and a discussion forum connected to the WhatsApp group. The main page is designed to be simple but attractive with color elements that motivate learners.

Figure 1. Dashboard of the learning web

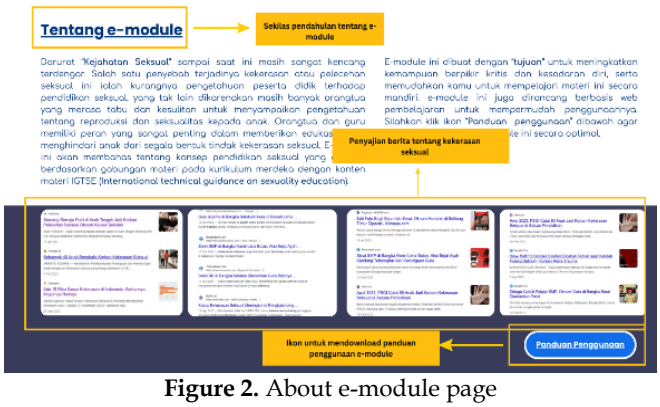

Figure 2. About e-module page

The "About E-module" page contains an explanation of the learning web content and a brief introduction to the science issues raised in the material, and is equipped with a usage guide icon that students can click on to get complete instructions for using the web-based e-module.

Figure 3. Learning activities page

The "Learning Activities" page is the main menu in the web-based e-module which consists of three parts, namely Learning Activities I, II, and III, which can be accessed online or offline through the download feature. Although discussing different topics, the three activities still focus on hormone material in human reproduction and are equipped with contextual issues according to the Socio-Scientific Issues (SSI) approach.

Figure 4. LKPD page

The LKPD page contains learning activities organized based on the syntax of the Character and Values Development Approach, which consists of several steps: 1) introduction of the biology concept being taught, 2) expression of initial opinion on related issues, 3) assessment of biology concepts relevant to the issue, 4) reflective exploration of the moral aspects of the issue, and 5) making consensus or joint decisions.

Product Trial Results

Product Feasibility Results

Based on the results of the feasibility assessment by material experts and media experts consisting of various criteria, the following results are of the feasibility test assessment of the web-based e-module with the SSI approach by material experts showed very good results, with an average score on the aspects of the feasibility and accuracy of the material of 3.8, the material

presentation aspect of 3.6, the aspect of the relevance of facts and concepts of material 4, and the language aspect of 4. The material is presented clearly, systematically, and supported by appropriate images and videos, so it is considered feasible to use in learning. In addition, the results of the assessment by media experts also show that the e-module has excellent display quality, communicative language, ease of operation, quality illustrations, and ease of use, with an average score of 4 and excellent criteria. Therefore, this e-module is valid for use as biology teaching material and can be directly tested in the field without revision.

Product Practicality Results

The practicality assessment of the web-based e-module with the SSI approach was conducted by two biology teachers from SMA N 1 Jebus and SMA IT Daarul Iman, as well as by 25 students of class XII SMA N 1 Jebus. This test aims to evaluate the effectiveness, ease of use, and benefits of the product.

The assessment results showed that the e-module was very practical, with an average score of 94% from teachers and 93% from students, covering aspects of material, language, media, and learning. The e-module is considered feasible as teaching material because it is effective, easy to use, and as needed. The material is presented attractively through pictures, videos, contextual issues, and easy-to-understand language. The interactive web platform and attractive visual design also support ease of use.

Empirical Validity and Reliability of Instrument

Validity and reliability are carried out to ensure that the items used in testing the effectiveness of the developed e-module are valid and reliable. Before being used in the large group test, the questions were tested empirically first. The questions have been validated by material experts and improved based on suggestions and input. The tested instrument consisted of 10 essay questions to measure critical thinking skills and 24 questionnaire items to measure self-awareness. The empirical test was conducted on 25 students of class XII who had learned about hormones in human reproduction. The validity test results of 10 questions showed valid results, with a Sig. (2-tailed) <0.05, so the 10 items of critical thinking ability were declared valid. Furthermore, reliability was tested using Cronbach's Alpha, with the result of 0.743 > 0.60, which indicates that the question is reliable or consistent. The results of the validity test of the self-awareness instrument consisting of 24 question items also showed valid results, with a Sig. (2-tailed) < 0.05. The reliability test using Cronbach's Alpha resulted in a value of 0.938 > 0.60, which also indicates that the self-awareness questionnaire is reliable or consistent. Thus, it can be concluded that both instruments (10 critical thinking questions and 24 items of self-awareness questionnaire) are valid and reliable to be used in testing the effectiveness of using web-based e-modules with the SSI approach.

Product Trial Results (e-module)

Data on the results of critical thinking skills of experimental and control class students can be seen in the following table.

Table 2. Critical Thinking Ability Results

Description	Experiment class		Control class	
	Pretest	Posttest	Pretest	Posttest
Minimum	16	58	30	48
Maximum	76	94	76	78
Mean	41.24	77.55	54.28	65.9
Std. Deviation	14.60	10.85	10.93	8.49

The experimental class pretest score was lower than the control class. But after using the web-based e-module with the SSI approach, the experimental class posttest score increased to 77.55, higher than the control class which was only 65.9. This shows that the e-module is effective in improving learning outcomes. Data on the results of the self-awareness attitude of experimental and control class students can be seen in the following table.

Table 3. Self-awareness Questionnaire Results

Description	Experiment class		Control class	
	Pretest	Posttest	Pretest	Posttest
Minimum	16	18	16	17
Maximum	23	24	23	23
Mean	19.72	21.28	19.1	20.45
Std. Deviation	2.25	1.7	1.78	1.76

Based on the data in the table, the minimum and maximum pretest scores of both classes are the same. However, after treatment with the web-based e-module, the minimum and maximum scores of the experimental class increased. The mean posttest score of the experimental class (21.28) was higher than the control class (20.45).

Normality Test

The normality test was conducted to determine whether the critical thinking and self-awareness data were normally distributed, using the Shapiro-Wilk test and comparison of the Mahalanobis distance with the Chi-Square value through SPSS. The results show a significance value> 0.05, so the data is normally distributed. in the correlation table, the mahalanobis and chi square values also obtained a pearson correlation value of 0.989, which indicates that the data is taken based on a multivariate normally distributed sample.

This is also shown very clearly in the scatter plot display which shows that the mahalanobis distance is in the same direction as the chi square value.

Linearity Test

Linearity test is conducted to determine the linear relationship between variables. Based on the Test for Linearity test results, the F value in deviation from linearity is 0.138 with a significance of 0.709 (> 0.05), so it can be concluded that the two variables have a linear relationship.

Homogeneity Test

Multivariate homogeneity test is conducted to ensure that the data has a homogeneous distribution before further analysis. Based on the test results, the significance value is 0.156 (> 0.05), so it can be concluded that the data has a homogeneous variance and meets the assumptions for MANOVA analysis.

Hypothesis Test of the Effectiveness of Web-based E-module with SSI approach in Improving Critical Thinking Ability and Self-Awareness of Learners

The MANOVA analysis results show a significance value of 0.000 (<0.05), which means H0 is rejected. Thus, there are significant differences in critical thinking skills and self-awareness between grade XI students who use web-based e-modules with the SSI approach and those who do not use e-modules. This proves that the use of the e-module is effective in improving both aspects simultaneously.

Table 4. MANOVA Test Results

	Effect	Value	F	Df	Error df	Sig.	P. Eta Square
Class	Pillai's Trace	.605	20.560[a]	4.000	53.000	.000	.60
	Wilks' Lambda	.395	20.560[a]	4.000	53.000	.000	.60
	Hotelling's Trace	1.529	20.560[a]	4.000	53.000	.000	.60
	Roy's Largest Root	1.529	20.560[a]	4.000	53.000	.000	.60

N-Gain Score

Gain score is used to measure the improvement of students' abilities from pretest to posttest. Based on the results of calculations and interpretations according to the gain category, experimental classes that used web-based e-modules with the SSI approach showed moderate improvement in critical thinking skills and self-awareness. Meanwhile, the control class that did not use the e-module only showed a low increase in both variables.

Table 5. N-Gain Score Calculation Results

Class	Variable	Average of Pretest	Average of Posttest	Average of Gain score	Category
Experiment	Critical thinking	41.17	77.55	0.61	Medium
	self-awareness	82	89	0.30	Medium
Control	Critical thinking	54.28	65.9	0.26	Low
	self-awareness	80	85	0.22	Low

Discussion

This study uses a character and values development approach model to improve students' critical thinking skills and self-awareness of the impact of sexual violence on reproductive organs. The implementation results showed that the experimental class using the web-based e-module with the SSI approach had a significant increase in critical thinking skills and self-awareness compared to the control class. According to Salsabila et al. (2023), critical thinking skills are influenced by the ability to manage emotions.

The increase in critical thinking skills occurred in all aspects, such as Elementary Clarification (13.1%) to Strategy and Tactics (54.5%). Self-awareness also increased in cognitive (9.8%), affective (10.3%), and conative (2%) aspects. Based on the n-gain value, the increase in critical thinking was classified as moderate, while self-awareness increased low. Novianti (2020) showed that critical thinking skills in the moderate category showed adequate analytical ability, in accordance with Piaget's cognitive development theory.

The comparison of the increase in the average percentage of self-awareness is very far adrift with the percentage of students' critical thinking skills. The increase in self-awareness is higher than critical thinking skills because students' self-awareness of the impact of sexual violence is quite good. Salsabila et al. (2023) state that self-awareness improves cognitive abilities through critical thinking skills. Goleman (2020) also emphasizes the importance of emotion management in improving critical thinking skills. Diana et al. (2021) state that high emotional intelligence contributes to proper decision making.

Web-based e-modules with the SSI approach have proven effective in improving critical thinking skills. Social issue-based learning helps students learn

independently and connect concepts with the reality around them (Shoba et al., 2023). The application of teaching and learning activities that only focus on learning topics without linking the temporal context with the events that occur can result in a gap between abstract concepts and the reality of events around learners. Therefore, a learning approach that is relevant to everyday life is needed, namely by providing appropriate context. One way to achieve this is through learning that uses the Socio-Scientific Issue (SSI) approach. According to Rostikawati et al. (2016), learning integrated with socio-scientific issues can improve students' critical thinking skills.

Conclusion

Based on the data from the research and development of web-based E-module with SSI approach on human reproductive hormone material, it can be concluded as follows: 1) Web-based e-module with SSI approach is suitable for use in biology learning activities because it has met the assessment criteria of material experts and media experts with very good categories. 2) This e-module is practical to use in biology learning, based on the assessment of practitioners (biology teachers) and students, with a very good category. 3) This e-module is effective in improving critical thinking skills and awareness of students in class XI SMA N 1 Jebus, as shown by the results of the MANOVA test with a sig value. 0.000 <0.05, as well as the n-gain calculation which shows a moderate improvement category.

Acknowledgments
I would like to thank my advisor, biology teachers, and students who have helped me in writing this article.

Author Contributions
This research contributes to learning in the form of a web-based e-module with the SSI (Socio-Scientific Issue) approach that can be used by teachers in secondary schools. The authors were involved in the whole making of this article.

Funding
This research did not receive funding from any external source.

Conflicts of Interest
The authors declare that there are no conflicts of interest related to the publication of this article.

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