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Website-Based Electronic Module With SSI on Human Excretory System Material to Improve Cognitive Abilities and Critical Thinking

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ABSTRACT: This development research aims to determine the feasibility, practicality and effectiveness of website-based electronic modules with socio scientific issue (SSI) on human excretory system material to improve cognitive abilities and critical thinking of class XI high school students. This type of research is R&D (research and development) with the ADDIE model (analysis, design, development, implementation and evaluation). The feasibility of the developed product was assessed by material and media experts, practicality was assessed by biology teachers and student responses. Effectiveness is obtained from the results of field trials by implementing the product to experimental class students and not implemented to control class students. Analysis of product feasibility and practicality was calculated using the feasibility and practicality test formula, while the analysis of the results of cognitive abilities and critical thinking was calculated using Exel and SPSS 23.

The results showed that the web-based electronic module product with SSI on human excretory system material developed was very feasible to use with very good criteria, based on the feasibility test. The product is also very practical to use with very good criteria according to biology teachers and students. The developed product is known to be effective in improving students' cognitive and critical thinking skills. The average result of cognitive ability in the experimental class of 73.44 is greater than the control which is 64.78. The average result of cognitive ability in the experimental class was 72.50 with an N-Gain value of 0.64, indicating that the increase was in the moderate category, while the average critical thinking in the experimental class was 0.60 greater than the control class of 41.28. The average result of critical thinking ability in the experimental class is 0.60 which shows that there is an increase in the moderate category. Based on these results, it is known that the cognitive and critical thinking abilities of students obtained a sig value. (2-tailed) <0.05, which means that there is a significant difference in cognitive abilities and critical thinking of students between the control class and the experimental class.

KEYWORDS: Electronic Module, Website, SSI, Cognitive Ability, Critical Thinking

INTRODUCTION

Since a few years ago until now various contemporary drinks have circulated quite rapidly everywhere ranging from coffee, tea, milk and so on. Without realizing that consuming sugar-sweetened beverages in excess can cause the risk of health problems for our bodies. The impact of dangerous diseases caused by excessive consumption of contemporary drinks is obesity to diabetes (Pramudita et al., 2023). Diabetes mellitus is a metabolic disorder in which the pancreas does not produce enough insulin or the body cannot use the insulin it does produce effectively (Nurdiana & Algifari, 2020). According to the IDF, Indonesia is the fifth most diabetic country with 19.5 million people in 2021 (Kemenkes, 2024). Therefore, efforts to increase awareness of adolescents over 15 years old are important to anticipate and reduce the risk of diabetes. One way to increase awareness of a healthy lifestyle is by linking it to learning. Through contextual learning, students not only understand the material but understand the purpose and function of the material in everyday life (Aminah et al., 2022).

Learning that relates to the real life of students is called contextual learning. One of the contextualized learning in learning is by using Socio-scientific issues (SSI) (Siska et al., 2020). Socio-Scientific Issues are representations of issues in society that relate to science in social aspects. The application of SSI in science education aims to provide a more meaningful learning experience by integrating real-life problems (Fita et al., 2021). Socio-scientific issues stimulate students to debate and solve problems.

Through SSI, students can hone their ability to improve various higher order thinking skills. In line with that, Septianingrum (2021) stated that SSI is effective for improving critical thinking skills.

The human excretory system is one of the biological materials studied in class XI which emphasizes the scope of complex material. Biological material will generally be optimally understood with a real approach and there are visualizations and relevant to the daily lives of students (Wandraini & Selaras, 2024). In addition, many health problems such as diabetes related to the kidneys are still not widely associated in the context of learning, especially in the excretory system. Hidayatullah (2023) argues that teacher-centered learning causes students to be bored and passive in learning activities. In line with the opinion of Afsari (2023), it is stated that with the existence of teaching materials that support the learning needs of students, the better the results obtained..

Based on the above problems, it is necessary to develop teaching materials that can be an alternative to overcome the problems faced, namely by using web-based electronic modules with SSI on excretory system material. Modules with SSI contests that can improve various thinking skills (Srimayeni, 2023). Electronic modules are one of the media or teaching materials that can answer the problems faced because they have many advantages. In addition, the use of modules can be adjusted to the learning speed of each student so as to make the learning process more enjoyable and help students evaluate the abilities that have been learned before. The electronic module features are also designed to be interactive with a website base, making it easier for students and teachers to access without having to install and all types of devices can open it. In addition, the electronic module was developed with practice questions loaded in a google form so that it was possible to get feedback directly after students finished working on it. Therefore, the authors are interested in conducting research with the title Development of Website-Based Electronic Modules with SSI on Human Excretory System Material to Improve Cognitive Ability and Critical Thinking of Class XI High School Students with the hope that it can be used to improve the cognitive abilities and critical thinking of students in class XI High School.

METHODS

This type of research is research and development (R&D). The development model used in this study is the ADDIE development model, which consists of 5 stages, namely: analysis, design, development, implementation, and evaluation (Sugiyono, 2019). The effectiveness test uses experiments, the design used is pre-test post-test control group design. In this study, the instruments used by researchers consisted of a questionnaire sheet for assessing product feasibility by media experts and material experts, a questionnaire sheet for product assessment by biology educators, a questionnaire sheet for assessing readability by students and a questionnaire sheet for assessing students' critical thinking skills. The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 21. The level of statistical significance was set at p-value <0.05.

RESULTS

Analysis Stage

The analysis stage is carried out with the aim of gathering information related to the needs of educators and students, the products to be developed and analyzing the problems in learning that underlie the importance of developing a website-based electronic module of excretory system material with SSI.

The results obtained from interviews with biology educators are the curriculum used at the State 1 Natar Senior High School is the 2013 curriculum and the independent curriculum. Then in learning activities the teacher uses the 5M learning model and several times uses discovery learning. According to the teacher, the use of printed package books from publishers as learning resources has not been able to meet the needs of students because not all students have them. In learning activities, it is known that there has been no development of teaching materials using website-based electronic modules on excretory system material, especially on the topic of the kidneys and urinary system. Regarding the utilization of technology in the school, the State 1 Natar Senior High School can be said to be good. The school also allows students to bring smartphones to school if used for learning purposes. The technology facilities at school also support the existence of LCD projectors and wifi that can be accessed by all students.

The results of the interview stated that the cognitive abilities of grade XI students on average did not meet expectations. For example, at the time of the mid-semester test, the educator targets completeness to be up to 70%, but in reality it has not reached 50%. Likewise, the level of critical thinking ability of students still needs to be improved, because during learning only a few students actively ask questions and argue. The educators' efforts to improve students' critical thinking skills are by asking students to actively ask questions during learning.

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Design Stage

At this stage, the electronic module on excretory system material is created and designed based on the results of the analysis that has been done previously. The design stage includes format selection and design design. At the format selection stage, researchers analyzed the format of the electronic module which was adjusted to the results of the analysis of students' smartphones at school. At the design development stage, researchers compiled several components that would be contained in the electronic module.

Development Stage

The development stage is an activity of realizing the design of the product to be developed. In this study, the product developed is teaching material in the form of electronic modules with SSI on excretory system material. Validation is carried out to ensure that the product developed is suitable for use, so the validation stage of the product that has been developed with the help of experts and biology educators.

1) The results of the material expert assessment for the electronic module developed in the aspect of material feasibility and accuracy of the material, the aspect of presentation of material or content and the language aspect are in the very feasible category with the acquisition of analysis results >81%. Based on the average value of the expert/material expert assessment of the developed product, it is included in the very feasible category with the acquisition of 92.50%.
2) The results of the media expert's assessment of the website-based electronic module with SSI on the material of the human excretory system, namely in the aspect of display quality of 80% in the decent category. Language aspects, aspects of ease of use, and aspects of illustration quality are included in the very feasible category with the acquisition of analysis results above 81%.
3) The results of the limited scale test assessment on the web-based electronic module with SSI developed, namely the material or content aspects, language aspects, media aspects and learning aspects, are included in the very feasible category with a percentage of results >81% in each aspect. Based on the average value of the teacher's assessment of the product developed of 96.88%, it is included in the very feasible category.
4) The results of the limited scale test assessment on the website-based electronic module with SSI developed, namely the aspect of material attractiveness, language aspects, ease of use aspects, display attractiveness aspects and learning aspects are in the very feasible category with a percentage of >81% in each aspect. Based on the average value of students' assessment of the product developed of 97.81%, it is included in the very feasible category.

Implementation Stage

The implementation stage in this research is the stage for implementing the product design that has been developed in a real situation. The results of the implementation in this study are described as follows:

Hypothesis Test of Cognitive Ability

The results of testing the cognitive abilities of experimental and control class students are presented in Table 1:

Table 1. Test Results of Cognitive Ability of Experimental and Control Classes

Classes	Mean	t_{ht}	Sig.	Decision
Experiment	72.50	3.744	0.000	Ha accepted
Control	62.22			

Based on table 1, it is known that the p-value (0.000) and t_{count} = 3.744. By comparing the p-value (0.000) < (0.05) then these results show Ho is rejected and Ha is accepted so it can be concluded that the hypothesis reads “There is a significant effect of web-based electronic modules with SSI on human excretory system material on cognitive abilities”, accepted. Based on the average value of the posttest between the experimental and control classes has a difference of 10.28 so it can be concluded that the cognitive ability of the experimental class with the treatment of the use of web-based electronic modules with SSI on the material of the Human Excretory System is better than the control class based on the average value of the posttest and the N-gain value.

Critical Thinking Hypothesis Test

The results of testing the critical thinking ability of experimental and control class students are presented in Table 2:

Table 2. Critical Thinking Test Results for Experimental and Control Classes

Classes	Mean	t_{ht}	Sig.	Decision
Experiment	73.44	4.244	0.000	Ha accepted
Control	64.78			

Based on Table 2, the p-value = 0.000 and t_{count} = 4.244 were obtained. By comparing the p-value (0.000) < (0.05), these results show that Ho is rejected and Ha is accepted so it can be concluded that "There is a significant effect of the website-based electronic module model with SSI on the material of the Human Excretory System on critical thinking". Based on the average posttest value between the experimental and control classes has a difference of 8.67, it can be concluded that the critical thinking of experimental class students with the treatment of using a website-based electronic module model with SSI on Human Excretory System material is better than the control class based on the average posttest value and n-gain.

Correlation Test

The correlation test is used to determine the presence and absence of a relationship between the dependent variables in the study. The results are as follows:

Table 3. Correlation Test Results

Correlations			
		Cognitive	*Critical_thingking*
Cognitive	Pearson Correlation	1	.464**
	Sig. (2-tailed)		.000
	N	72	72

Based on the results of the correlation test above, it is known that the significance value or sig. (2-tailed) of 0.000, it means that there is a significant relationship between critical thinking variables and cognitive abilities. From the table above, the strength of the relationship between critical thinking skills and problem solving ability can be seen by looking at the correlation coefficient number which is 0.464 with a moderate category, it can be interpreted that there is a moderate correlation between critical thinking and cognitive ability.

Evaluate Stage

The evaluation stage of the product is carried out at every step of development to improve the quality of the product. This evaluation is carried out continuously so that even the slightest mistakes can be corrected immediately without waiting for the final product to be produced. Evaluation is carried out based on the results of the analysis of material experts, media experts, teacher assessments, and student assessments.

DISCUSSION

This research is a research and development that produces learning products in the form of electronic modules with SSI on excretory system material. The development of electronic modules with SSI on the material of the excretory system is based on the results of observations at the State Senior High School 1 Natar. Biology learning at school previously only used textbooks that have not accommodated students' learning thoroughly and have not optimized the use of technology in learning. Meanwhile, the school has provided adequate technology facilities such as LCD projectors and wifi that can be accessed by teachers and students.

Another problem found is that the results of students' daily test scores have not been achieved, especially on the excretory system material which is targeted to be 70% complete but in reality only reaches 50%. with the use of C1-C4 category questions. In addition, the results of the initial measurement of critical thinking ability showed that it was still relatively low with the results on each indicator, namely providing simple explanations, building basic skills, concluding, providing further explanations and developing strategies and tactics of <50%. This can occur because biology is a science concept that has a lot of memorization and learning that is often not contextualized. In addition, the lack of habituation in practicing higher order thinking skills to students in learning results in students later being unable to adapt to the times. In line with this, Syafitri (2021) revealed that critical thinking skills are important to be trained in learning activities because it is one of the competencies that must be mastered in 21st century education.

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To improve higher order thinking skills, learning content that focuses on problem solving is required. The problems used as content should also come from everyday life so that learning becomes contextualized. That way, the learning process carried out has a relationship with the application in everyday life. The contextualized learning alternative is through SSI. Through SSI, students can be stimulated to argue and solve a problem. In line with that, Septianingrum (2021) states that through SSI students can hone their ability to improve various higher-level thinking skills.

Electronic modules with SSI on excretory system material were developed because of the suitability of the problems found by researchers. The electronic module developed aims to improve the quality of learning, especially to improve cognitive abilities and critical thinking. The discussion of the feasibility, practicality and effectiveness of products to improve cognitive abilities and critical thinking is explained as follows.

Feasibility of Electronic Modules with SSI on excretory system material

The feasibility of electronic module products includes product validation assessments conducted by material experts and media experts from biology lecturers at Yogyakarta State University. The results of the assessment by material and media expert validators show that the electronic module is suitable for use and testing with very feasible criteria with the acquisition of analysis results above 81% in each aspect of the assessment. The feasibility of using electronic modules is supported by the assessment by material experts to achieve the learning objectives that have been designed. In line with that, Lastri (2023) rgues that the development of electronic modules is carried out to solve problems in learning materials effectively and efficiently through quality content in it. Product validation by media and material experts is not without reason. The importance of conducting material validation is to determine the accuracy of the selection of material contained while media validation is to determine the suitability of the display with the material (Salim et al., 2021).

The instruments used in the study were also validated by material experts using an assessment questionnaire and declared valid based on the results of the limited trial. Instruments in the form of essay-shaped test questions are used for cognitive abilities and critical thinking. The results of feasibility validation on each instrument used get a score with criteria suitable for use in research. Then after being tested, the construct validity test was carried out for cognitive ability and critical thinking questions. Furthermore, researchers only used 10 questions each that were declared valid for this study.

The next validation test conducted was the teaching module used in the study. The validation questionnaire consists of 8 aspects with 16 statement items. The validation results obtained were 85.93% in the category of very feasible to be applied in learning.. Ulya & Rahayu (2017) state that the results of the development of learning devices are declared feasible for use in the learning process if they are declared valid by expert validators in accordance with the eligibility criteria used. Teaching modules have an important role because they guide teachers in carrying out activities and achieving learning objectives. Salsabilla et al. (2023) states that teaching modules in the independent curriculum have a major role to assist teachers in designing learning, so that learning activities are more effective and efficient.

Practicality of electronic modules with SSI on excretory system material

Electronic modules that have been declared feasible by material and media experts are then assessed for practicality by users (teachers and students). The results of the assessment by practitioners or teachers on the electronic module developed in the aspects of material or content, language, media and learning >81% in each aspect and the average results of all aspects are included in the very feasible category. The results of the assessment of students' responses to the website-based electronic module developed in the aspects of material attractiveness, language, ease of use, attractiveness get a score of >81% in each aspect so that the overall average aspect is in the very feasible category. Kusuma (2019) in his research stated that the practicality of the product developed was obtained from the teacher and student response assessment if the response value> 80% indicated that the product was declared suitable for use in learning with a very practical category. According to Oktavianah & Nurfalah (2023) the practicality of the product can be seen from the teacher and learner response questionnaire based on the attractiveness of the media, the suitability of the content and the quality of the product developed.

The electronic module developed is very feasible and practical for use in learning activities based on the results of teacher and learner assessments for learning activities. This is because the module is packaged with a website that allows ease of use and access without having to worry about full memory storage. In line with this, Solihudin (2018) states that electronic modules have the characteristics of flexibility, namely practical use anytime and anywhere.

The development of electronic modules is tailored to the learning needs of students. The developed product is packaged simply and as interesting as possible by utilizing a website that can be accessed by students easily. The product is equipped with text, video, animation and mini games. All these components are arranged in a storyboard to make all these components into a unified product. So that students are enthusiastic in participating in learning activities. The existence of illustrative images that

support the presentation of material can help students in understanding the concept of material and help in explaining abstract concepts to be concrete (Antara et al., 2022). This is in line with Sitinjak, (2022) research, that interactive learning that displays visualization of concepts through images, animations, audio, video, which involves student responses to learning, supports explanations delivered by teachers, attracts and directs the attention of students to follow learning has an impact on various student abilities (Sitinjak,2022; Trust & Pektas, 2018).

Interactive learning helps learners solve problems encountered in the learning process. Interactive learning makes the learning experience more meaningful and satisfying. Thus, the media or learning materials developed have met the expectations of the learners in terms of convenience and usefulness (Widiyatun, 2020). Harsiwi & Arini (2020) argue that by using interactive media, students have learning that is perceived as effective as a learning tool such as quizzes and immediate feedback helps students can achieve high scores on exams.

Effectiveness of electronic modules with SSI on cognitive and critical thinking skills

The effectiveness test of the developed product is carried out at the implementation stage. This stage aims to determine how the effect of electronic modules with SSI on excretory system material on cognitive abilities and critical thinking. Product effectiveness data were obtained from two classes, namely the control class using LKPD in learning activities, while the experimental class used electronic modules with SSI developed with the PBL model in learning activities in the control and experimental classes.

Electronic modules with SSI on excretory system material developed are effective in improving cognitive abilities and critical thinking. In cognitive ability, the average pretest value of the experimental class was 23.59 and the posttest value was 72.50, while the control class had an average pretest of 21.67 and posttest of 62.22. The N-Gain value in the experimental class was in the medium category (0.64), while the control class was in the medium category (0.52). In critical thinking ability, the average pretest value of the experimental class was 33.39 and the posttest value was 73.44, while the control class had an average pretest of 33.6 and posttest of 64.78. The N-Gain value in the experimental class was in the medium category (0.60), while the control class was in the medium category (0.47). From these results, it shows that the cognitive abilities and critical thinking of experimental class students are greater than the control class. These results indicate that the use of electronic modules with SSI is more effective in improving students' cognitive abilities and critical thinking. This is in accordance with the results of Septianingrum (2021) research, hich states that through SSI students can hone and improve various higher-level thinking and problem solving skills. However, based on mastery learning, learning has not maximally had an impact on completeness because it has not reached a score of 75. Mastery learning is a learning system that wants all students to be able to master the learning objectives completely (Agusman, 2023). This can occur due to the limited number of learning meetings that are only conducted twice face-to-face with complex material coverage so that the improvement is not optimal.

Data on cognitive ability and critical thinking scores were obtained through pretest and posttest results. Pretests and posttests are used to determine the comparison of the extent of the increase or difference in the scores of cognitive abilities and critical thinking of students in both experimental and control classes. Based on the values obtained from the analysis, it can be concluded that the use of electronic modules with SSI can improve the cognitive abilities and critical thinking of students. This can be seen in the difference in the average pretest and posttest scores of cognitive abilities in the experimental class of 48.61 and in the control class also experienced an increase but not as high as in the experimental class, namely 40.55. While the difference in the average pretest and posttest scores on critical thinking in the experimental class was 40.05 and the control class also experienced an increase but not as high as in the experimental class, namely 31.18. This is in line with the results of Rianita (2017) research, which states that the SSI context can have a positive influence on understanding the nature of science, critical thinking skills, and cognitive learning outcomes.

The results of this assessment also show that both classes have good cognitive and critical thinking skills because both classes use the PBL learning model during the learning process. This is in line with the opinion of Panggabean (2022) that the application of the PBL model in learning can provide conditions for active learning, critical and analytical thinking for students. This is also supported by research conducted by Alfiah & Dwikoranto (2022) which found that the PBL learning model can improve various thinking skills of students from contextual problem solving activities.

CONCLUSIONS

Based on the results of the research and the results of data analysis that has been done, the following conclusions are obtained. (1) The website-based electronic module with SSI on the material of the human excretory system is feasible to use in biology learning activities to improve cognitive abilities and critical thinking of class XI high school students, based on the assessment of

material experts and media experts with a very feasible category. (2) The website-based electronic module with SSI on the material of the human excretory system is practical to use in biology learning activities based on the assessment of teachers and students (3) The website-based electronic module with SSI on the material of the Human Excretory System is effective for improving the cognitive abilities of students in grade XI of Senior High School. (4) The website-based electronic module with SSI on the material of the Human Excretory System is effective for improving critical thinking of students in class XI of Senior High School.

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