

Development of Electronic Student Worksheet Based on Problem-Based Learning With A Socioscientific Issue Approach on the Digestive System Material

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ABSTRACT

This study aims to develop e-student worksheet based on Problem Based Learning (PBL) with Socioscientific Issue (SSI) approach on digestive system material for grade XI phase F students at SMAN 2 Jambi City. The background of this development is based on the lack of interactive, contextual, and relevant teaching media to everyday life, as well as the lack of integration of social issues in biology learning. The method used is Research and Development (R&D) with the ASSURE development model. e-student worksheet products are designed to be accessible electronically through various devices and integrate interactive elements such as videos, minigames, and real-world problem-based materials related to social and scientific aspects. The development results state that the e-student worksheet learning media has been developed using the ASSURE model with 6 stages, namely analyze learner; state standard and objectives; select methods, media and materials; utilize technology, media and materials; require learner participation; and evaluation & revision and is declared very suitable for use with a material validation value of 95% and media validation of 91.66%. The results of biology teachers' perceptions with a value of 95.45%, which means it can be accepted to be used as a source of learning media. The results of small group trials obtained student responses in the very good category, namely 82.98% and large group trials in the very decent category, namely 88.31%, so the product is suitable for use. This study produced a product that can overcome students' difficulties in understanding learning materials, especially digestive system materials found in the validation process of material experts, media experts, trials with biology teachers, students, and the results of student learning improvements from pretest - posttest.

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INTRODUCTION

The integration of digital technology into education has significantly transformed learning processes in the modern classroom. One form of digital learning media that can support interactive learning is the electronic student worksheet (e-student worksheet). An e-student worksheet is a digital version of traditional worksheets designed to facilitate both independent and collaborative learning activities. Compared to printed worksheets, e-student worksheets provide more flexible, interactive, and accessible learning experiences because they can be accessed anytime and anywhere through digital devices (Aditomo 2024).

The use of e-student worksheets can also support contextual learning by connecting theoretical knowledge with real-life situations. One learning model that is suitable for integration with e-student worksheets is Problem-Based Learning (PBL). PBL encourages students to actively solve real-world problems and develop critical thinking, collaboration, and problem-solving skills (Savery, 2006).

In addition to PBL, the Socioscientific Issue (SSI) approach can be integrated into learning activities. SSI refers to scientific issues that are closely related to social, ethical, and moral considerations. Examples include public health issues, food safety, biotechnology, and environmental problems. The SSI approach allows students to analyze scientific issues from multiple perspectives and encourages them to make responsible decisions based on scientific reasoning (Sadler & Zeidler, 2024).

In biology education, integrating PBL with an SSI approach has the potential to improve students' scientific literacy and engagement. However, learning media that combine these two approaches are still limited. One topic that often poses learning difficulties for students is the human digestive system. This material involves complex concepts related to organ structure, physiological processes, and digestive disorders, which can be difficult for students to understand without appropriate learning media (Mayer, 2009).

Based on preliminary observations at SMAN 2 Jambi City, many students experience difficulties in understanding digestive system material due to its abstract nature and the lack of varied learning media used during instruction. Therefore, developing an interactive e-student worksheet based on PBL with an SSI approach is expected to help students better understand the material and improve their learning engagement.

This study aims to develop and evaluate the feasibility and effectiveness of an e-student worksheet based on Problem-Based Learning with a Socioscientific Issue approach for digestive system material for Grade XI students.

RESEARCH METHODS

This type of research is called research and development (R&D) based on the research subject. The process of creating a new product or improving an existing one is called research and development (R&D). R&D is a type of research that requires the creation of a product or model.

The ASSURE model consists of several stages that said by the reseachers, namely "A" as Analyze learners (analyze learners), "S" as State Objective (state standards and objectives), "S" as Select methods, media and materials (select methods, media and teaching materials), "U" as Utilize Materials (Use technology, media and teaching materials), "R" as Requires learners participation (requires learner participation) and "E" as Evaluate and Revise (evaluate and revise) for that stages (Hinich and Bannon 1980; Smaldino, Lowther, and Russell 2014).

The subjects of this study were Grade XI Phase F students at SMAN 2 Jambi City. The developed product was an electronic student worksheet presented through the Liveworksheets platform, allowing students to access learning materials via smartphones or other digital devices. The development procedures included:

1. Analyze Learners

This stage involved identifying students' characteristics, initial abilities, and learning styles through observation and questionnaires.

2. State Standards and Objectives

Learning objectives were formulated based on the Learning Outcomes of the Independent Curriculum, particularly those related to digestive system material.

3. Select Methods, Media, and Materials

The learning strategy selected was the Problem-Based Learning model combined with the Socioscientific Issue approach. The media used was an electronic worksheet designed using Canva and integrated with Liveworksheets.

4. Utilize Technology, Media, and Materials

The developed media was validated by material experts and media experts to ensure its feasibility before being implemented in the classroom.

5. Require Learner Participation

Students actively participated in learning activities using the developed e-student worksheet through problem-solving tasks, discussions, and interactive exercises.

6. Evaluate and Revise

The product was evaluated through expert validation, teacher perceptions, and student trials (small and large groups). Revisions were conducted based on feedback obtained during the evaluation process.

The following is the flow of the ASSURE model development which can be seen in Figure 3.1 below:



Figure 1. Development Model Flowchart ASSURE
(Source: (Smaldino et al. 2014))

Data collection techniques included questionnaires, validation sheets, and learning outcome tests. Data were analyzed using descriptive statistics and effectiveness tests using pretest-posttest analysis.

RESEARCH RESULTS

Development Results

The product produced in this study is a learning media in the form of e-student worksheet in the form of liveworksheets for Grade XI Phase F high school students on the Digestive System material. The subjects in this study were Grade XI Phase F high school students of SMAN 2 Jambi

City. The development model used in this study is ASSURE. There are six stages will be described as follows:

1. Analyze Learners Stage (Analysis)

a. General Characteristics

Based on the results of the student observation questionnaire, in the learning process of students carried out in grade XII phases F1, F2, and F3, the results of general characteristic observations were found through constant variables, such as the gender of male students 19.6%, female students 80.4%, age of students 15 years 0.9%, 16 years 22.6%, 17 years 75.6%, and 18 years 0.9%, high school education level 100%, domicile Jambi 100%, class of 2022 100%. it was found that 44.9% of students were active in learning activities and 55.1% of students were rarely active. Then, 82.2% of students had felt bored during biology learning activities. This indicates that students are less interested in learning biology. In addition, the learning media that are often used (textbooks) in the learning process also do not influence students' reading so that students' literacy skills are low. This is represented by the results of the student questionnaire that 74.8% of students stated that the learning media in the form of biology textbooks used in learning were less interesting and boring.

b. Specific Entry Competencies (Diagnosing Initial Abilities)

Based on the results of the initial ability of student technology observations such as 100% using smartphones, 97.2% utilizing technology, 46% using technology in learning. The initial ability of student interests such as 48.6% feeling often excited, 97.2% enjoying learning biology, 82.2% biology learning is not boring. And the initial ability of student materials such as 55.1% having difficulty understanding the material and interviews with biology teachers of class XI SMAN 2 Kota Jambi, data was obtained that during learning many students experienced difficulties in understanding biology materials, especially the digestive system material. This is presented with the results of student observation questionnaire data, that of the 6 biology materials (Circulatory system 27.1%, nervous system 45.8%, digestive system 33.6%, motor system 11.2%, excretory system 11.2%, respiratory system 6.8%, others 7.5%) students chose the material of the digestive system in humans as the second most difficult material to understand. This is because the material is considered by students to be very complex, abstract, and contains terms that are difficult for students to understand (Mayer 2009; Puspita and Dewi 2021; Yuliana, Puguh, and Marjono 2013).

c. Learning Style (Learning Style)

Learning style is a crucial factor in improving academic achievement and the quality of education. By understanding students' learning styles, educators or teachers can determine teaching strategies that are appropriate to their learning styles. Interviews with subject teachers revealed that students' learning styles in the classroom are quite diverse. Only a small percentage demonstrate active participation in the learning process, while the majority tend to be passive, simply listening without much participation. This situation highlights the need for more interactive learning media to accommodate differences in learning styles and encourage active participation from all students.

2. Standards and Objectives Stage (Setting Standards and Objectives)

The next step is determining targets or standards and objectives. Learning standards and objectives are obtained from the Learning Module, which has been adapted to the Learning Outcomes in the Independent Curriculum. The developed media breaks down the Learning Outcomes: At the end of phase F, students analyze the interrelationships of organ structures within the organ system. The concepts learned are applied to solve life problems that are solved independently using process skills to create ideas or products to address these problems. Through process skills, a scientific attitude and the profile of Pancasila students are also developed. After analyzing the Learning Outcomes, the learning objectives for the digestive system material are formulated.

3. Select Strategies, Technology, Media, and Materials Stage (Choosing Strategies, Technology, Media and Teaching Materials)

The selection of these components is crucial because it can help students achieve the planned learning objectives. Therefore, the selection must be tailored to the characteristics of the students and the established learning objectives. The methods chosen for this development are assignments, observations, questions and answers, and discussions, using the Problem-Based Learning (PBL) model with a Socioscientific Issue approach.

The media developed is an e-student worksheet (Learning Worksheet) in the form of live worksheets that can be accessed using a smartphone. The material selected for product development is the digestive system, based on the results of an initial preliminary study.

4. Utilize Technology, Media and Materials Stage (Utilizing technology, media, and teaching materials)

In the fourth stage of the ASSURE model, namely Utilize Technology, Media, and Materials, using previously designed media and teaching materials to support the learning process. However, before the media is used directly in the classroom, a validation process is necessary by experts, namely validation by media experts and validation by material experts. This validation is carried out to facilitate the process of implementing media in learning and ensure that the developed media has met the standards of feasibility, both in terms of content and technical.

5. Require Learner Participation Stage (Developing student participation)

In the Independent Curriculum, learning emphasizes the active involvement of students in searching, discovering, and developing materials from available media. They apply, analyze, evaluate, and create an active and constructive learning environment. In line with constructivist theory, learning is an active mental process based on authentic experiences that provide informative feedback. Active participation, both physical and psychological, is crucial for achieving optimal learning outcomes. Student activity varies and needs to be enhanced through creatively designed activities. Without teacher stimulation, most students tend to be passive. Therefore, teachers can encourage student involvement, create lively interactions in the classroom, and develop students' potential comprehensively.

Encourage active student involvement in the learning process through structured strategies and activities. In the development of e-student worksheet based on Problem Based Learning (PBL) with a Socioscientific Issue (SSI) approach on the digestive system material for grade XI Phase F students at SMAN 2 Jambi City, the strategy used aims to stimulate critical thinking, collaboration, and contextual problem solving relevant to everyday life. The technology used is a web-based digital platform liveworksheets that allows students to access, explore, and respond to problems independently or in groups. Learning media in the form of e-student worksheet is designed with visual content, text, and trigger questions based on socioscientific issues, which not only require conceptual understanding, but also consider the social and ethical aspects of the problems presented. The teaching media is arranged systematically and supports the development of higher-order thinking skills, so that students are actively involved both cognitively and affectively during the learning process.

6. Evaluate and revise stage (Evaluation and revision)

The evaluation and revision stage is the final step in the ASSURE model. Evaluation is conducted to assess whether the developed media meets the eligibility criteria and aligns with the stated objectives. If deficiencies are found in the product, improvements are made until the media is deemed suitable for testing. Based on the results of the feasibility test by material experts, which was conducted in three validation stages, the final percentage was 96.25%. Meanwhile, the feasibility test by media experts was conducted in two validation stages and resulted in a final percentage of 97.5%. Thus, the developed e-student worksheet media was declared suitable for use.

The development of the e-student worksheet followed the six stages of the ASSURE model. The product developed in this study is an interactive learning media in the form of a digital worksheet integrated with videos, visual illustrations, and problem-based activities related to socioscientific issues. The analysis of student characteristics indicated that many students experienced boredom during biology learning due to limited variations in teaching media. Questionnaire results showed that 82.2% of students had experienced boredom during biology lessons, while 74.8% considered the textbooks used in learning to be less interesting.

Furthermore, the analysis revealed that the digestive system material was among the most difficult topics for students. This difficulty is mainly caused by the abstract nature of the material and the limited visualization of internal organs. Therefore, the development of interactive learning media is needed to support better understanding. The validation results showed that the developed media achieved a material validation score of 95% and a media validation score of 91.66%, both categorized as very feasible. Teacher perception results also showed a high acceptance level with a score of 95.45%.

Student trials were conducted in two stages. The small group trial involving six students obtained a score of 82.98% in the very good category, while the large group trial involving thirty students obtained a score of 88.31% in the very feasible category. The effectiveness test using pretest and posttest results indicated a significant improvement in students' learning outcomes. The paired sample t-test produced a significance value of 0.001 ($p < 0.05$), indicating a significant difference between pretest and posttest scores. Additionally, the N-gain score obtained was 0.66, which falls into the moderate category. This result indicates that the developed e-student worksheet has a positive effect on students' cognitive learning outcomes.

DISCUSSION

The first stage is Analyze Learner (analyzing student characteristics). The results obtained from six biology materials in the even semester of grade XI, students stated that the digestive and nervous systems were difficult to understand, especially the sub-material on the human digestive system. The questionnaire results showed that the difficulties experienced by students were due to the material's abstract nature. As explained by (Mayer 2009), the digestive system is considered quite difficult because students cannot actually understand the organs and digestive processes in the human body, so it requires the right approach to obtain maximum results. This is supported by research (Puspita and Dewi 2021) which states that the topic of the digestive system is difficult to understand due to limited direct visualization of internal organs. The digestive system material includes interrelated concepts, namely structure, function, processes, and disorders that can occur. The use of several foreign terms in this material also does not rule out the possibility of students experiencing difficulties when learning and remembering existing concepts (Yuliana et al. 2013).

Students' difficulty in understanding the digestive system material is not only due to the large amount of material, but also due to the lack of varied media in the learning process. Therefore, there is a need for a variety of additional media that can support the learning process for students to more easily understand the material being studied, one of which is by using e-student worksheet media. e-student worksheet media was developed to present learning materials in a concise form and display interesting learning images and videos that can be accessed via smartphone. This is supported by the results of a student questionnaire which showed that 97.2% of students were interested in new and unique learning media. Then 64% of students were interested in using interesting and varied learning media that utilize technology that uses audiovisuals such as e-student worksheet. And 89.7% of students were interested in learning biology with PBL-based e-student worksheet media with an SSI approach by presenting images and videos.

The next stage is State Standards and Objectives (setting Standards and Objectives). This stage aims to formulate the learning objectives to be achieved. The objectives are formulated based on learning outcomes in the Independent Curriculum and are adjusted to the competencies of the digestive system material. Learning objectives are formulated specifically and measurably, and are used as a reference in compiling the content of e-student worksheet and PBL activities linked to relevant social and scientific issues. The design of learning media is carried out by researchers through several processes: identifying the problem to be researched, determining the title,

preparing source books and references, designing learning activities, and compiling media. The design of learning activities is carried out by researchers by compiling teaching media, including learning outcomes, learning objectives, and steps in learning activities. Media is designed based on Learning Outcomes, namely by the end of phase F, students are expected to have the ability to describe the structure and bioprocesses that occur in the human digestive system and be able to analyze the relationship between organ structure in the digestive system and its function as well as abnormalities or disorders that arise in the digestive system. According to (Sadler and Zeidler 2024), the SSI approach in science learning can develop critical thinking skills, decision-making, and active student involvement in the learning process.

The next stage is Select Method, Media and Materials (choosing methods, media and teaching materials). In this stage, the researcher used the Problem Based Learning (PBL) learning method with the Socioscientific Issue approach using e-student worksheet learning media in the form of liveworksheets on the digestive system material (Savery 2006). The process carried out was collecting and compiling material on the human digestive system, collecting reference sources, images and learning videos related to the digestive system material, and creating a flowchart and storyboard design for the media to be developed (Ibrahim 2012). The storyboard design that had been created was then applied using the Canva application, by determining various text sizes and fonts, determining the layout of images and QR codes for learning videos, and determining background color gradations. After the media was designed using the Canva application, the media was then converted into liveworksheets format through link drive software, stating that PBL encourages deeper knowledge construction, collaboration, and the development of metacognitive skills. The combination with technology-based media further strengthens its effectiveness.

These results indicate that the developed e-student worksheet has good content quality because the material explanations are tailored to the objectives to be achieved by students. The material is presented concisely, systematically, and coherently, using appropriate reference sources. The words are easily understood by students, using easy-to-read language and refined spelling so that students can understand it. Furthermore, this e-student worksheet can provide various interactive activities, such as quizzes or educational games, which can help strengthen students' understanding of the material being studied.

The next stage is to Utilize Technology, Media, and Materials (utilization of technology, media, and teaching materials). The developed product, after being declared feasible, was then

trialed with subject teachers at SMAN 2 Jambi City. The trial with teachers aimed to determine teachers' perceptions of the developed product. Based on the results obtained regarding the overall assessment of biology teachers, the percentage obtained was 92.5% with the category "Very Feasible." Thus, the developed e-student worksheet-based learning media is suitable for use in the biology learning process. After the assessment carried out by biology teachers, a questionnaire assessment was then conducted with 36 students, obtaining a percentage of 92.01% with the category "Very Feasible," stating that the media development cycle must be adaptive to the validation results so that the resulting media meets pedagogical, technical, and aesthetic standards (Rustandi, Haeruddin, and Darmansyah 2022).

Feasibility or "suitability for use" indicates that the media is not only theoretically correct, but can also be used practically by teachers and students. For example, research on the development of interactive multimedia shows that the media's feasibility value achieved a very good score (media validation score of 4.4 and material 4.3 out of 5), and its feasibility in the field obtained a score of 4.0 to 4.75. Feasibility is important because even though the media is valid, if it is not "suitable" in a real classroom context, for example, it is difficult to operate, expensive, or does not suit the character of the students, the media will not be effective. Feasibility is a bridge between theory and practice.

After the test questions were conducted, the product was then tested on students. The student trials were conducted in two stages, namely small group trials and large group trials. The results of the small group trials involved 6 students with a percentage of 92.29% in the "Very Good" category. The results of the large group trials involved 30 students with a percentage of 91.75% in the "Very Good" category. Based on the results of the student responses, it can be concluded that the e-student worksheet in the form of liveworksheets developed is suitable for use as an additional variation of learning media for teachers because it is interesting and motivating for students and increases students' knowledge of the material on the human digestive system.

After conducting trials with small and large groups of students, the learning process was then carried out in the classroom using e-student worksheet in the form of live worksheets on the digestive system material that had been developed. This stage was carried out in Class XI Phase F12 SMAN 2 Kota Jambi, totaling 30 students, to measure the effectiveness of the developed product through the administration of a pretest and posttest consisting of 10 essay questions.

The next stage is Require learner participation (involving students in learning activities). At this stage, a trial of 10 essay questions related to the digestive system was conducted with students of grade XII Phase F of SMAN 2 Kota Jambi. These questions will be tested for prerequisites first before being used as pretest and posttest questions. The goal is to measure the extent to which a collection of questions or questions used in the test can accurately measure what should be measured. Self-Determination Theory, active participation of students in technology-based learning can increase intrinsic motivation, especially if the media is interesting and in accordance with students' learning preferences (Johnson, Johnson, and Smith 1999). Next, a trial of students was conducted consisting of 6 students for small groups and 30 students for large groups. The product trial stage continued in the next stage. The prerequisite test of questions consisted of validity tests, reliability tests, discrimination tests and test levels of question difficulty. The results of the validity test obtained 10 questions were declared valid.

The final stage, namely Evaluate and Revise (evaluation and revision). At this stage is the process of seeing the media that has been created, the validity test of the questions is carried out, then the reliability test is carried out. The results of the reliability test, which amounted to 10 questions, have a reliability level in the "High" category, with Croanbach's Alpha 0.908. The questions that have been tested for reliability, then the test of the question's discrimination power, with the results obtained that there are 7 questions with a discrimination index power included in the "Very Good" category and 3 questions with a discrimination index included in the "Good" category. Next, a test of the level of difficulty of the questions was carried out. The results of the test of the level of difficulty of the questions obtained that 10 questions are included in the "Easy" category. Based on the results of the trial of the questions, it is known that the 10 questions can be used as pretest and posttest questions.

The effectiveness of the media can be seen by using the Paired sample T-test, before the prerequisite test is carried out, namely the normality test. The results obtained are that the data is normally distributed with a significance value in the pretest and posttest using Shapiro Wilk of 0.88 and 0.035 greater than 0.05, which means the data is included in the normal distribution. This is in line with the statement that states that if the significance value is greater than 0.05 at ($p > 0.05$) then the data is said to be normal, conversely if the significance value is less than 0.05 at ($p < 0.05$) then the data is said to be abnormal. The normality test used is the Shapiro Wilk test because in general

this test is used for samples that have a small number (≤ 50). The sample in this study amounted to less than 50 students.

After conducting the normality test, a paired sample T-test was then conducted. The results of the paired sample T-test obtained a value of 0.001 ($0 < 0.05$), which indicates that there is a significant difference between before and after using e-student worksheet in the form of liveworksheets on the digestive system material. Furthermore, the results of the N-gain test obtained an average score of 0.66 which is included in the "Moderate" category. This means that there is an influence of e-student worksheet media on students' cognitive learning outcomes with a moderate level of effectiveness. This is in line with research conducted by (Peprizal and Syah 2020; Puspita and Aloysius 2019) which states that the learning media that has been developed can be said to be effective if the N-gain score is at least in the moderate category. In addition, research conducted by (Puspita and Aloysius 2019) that the problem-based learning method is effective in developing students' abilities, as evidenced by an increase in the N-gain score, the significance value in the T test and an increase in the percentage of students' ability results.

CONCLUSION

This study successfully developed an electronic student worksheet based on Problem-Based Learning with a Socioscientific Issue approach for digestive system material using the ASSURE development model. The developed media integrates various interactive components such as learning videos, mini-games, concept maps, and contextual problem-based activities.

The validation results indicate that the developed media is highly feasible for use in learning, as evidenced by high scores from material experts, media experts, teachers, and students. Furthermore, the effectiveness test shows that the use of this e-student worksheet can improve students' cognitive learning outcomes with a moderate level of effectiveness. Therefore, the developed e-student worksheet can be used as an alternative learning media to support more interactive and meaningful biology learning, particularly in digestive system material.

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