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Validity of Project-Based Electronic Worksheets to Improve Students' Critical Thinking Ability

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ABSTRACT

Project-Based Learning is one of the learning approaches that can improve students' critical thinking skills. The aims of this study are to 1) design a Project-based e-worksheet in Biology to improve students' critical thinking skills, and 2) describe a Project-based e-worksheet in Biology to improve students' critical thinking skills. The model used in this study is a 4-D development model which has 4 stages, namely: 1) the definition stage, 2) the design stage, 3) the development stage, and 4) the disseminate stage. However, this research only reached the development stage, namely the expert validation stage due to limitations in the study. Validity assessment criteria include the appropriateness of content, systematics, graphics, and language. The data on the validity of the e-worksheet were obtained from the results of the assessments of three expert validators, namely one biologist and two biology subject teachers. The results showed that the average obtained in the aspect of content feasibility was 79.6%, systematic feasibility was 88.1%, graphic feasibility was 98.3%, and language feasibility was 83.3%. The overall average percentage of Project-based e-worksheets on Biology subjects to improve students' critical thinking skills is 87.3%. with very valid categories based on the eligibility criteria of content, systematics, graphics, and language. because the percentage score is above 70%. Thus, it can be concluded that the Project-based e-worksheet on Biology subjects to improve students' critical thinking skills has been designed to meet the validity criteria.

Keywords: Validity; E-Worksheet, Project-Based Learning, Critical Thinking, Biology.

Introduction

We are currently entering the era of the industrial revolution 4.0, where education expectations for the quality of students have changed. Not only knowing the material but students are required to be able to apply the theories that have been obtained from the school, which is known as 21st-century education (Tvenge & Martinsen, 2018). In 21st century education, technology has an important role, including obtaining the right literacy and information to support learning. To be able to fulfill 21st-century education, teachers are required to be more proficient with increasingly rapid technological advances (Ongardwanich et al., 2015; Tsybulsky & Levin, 2019).

In carrying out teaching and learning activities, it is closely related to the use of learning models and media (Haug & Mork, 2021; Meyer, 2020). There are lots of learning media that can be used and developed to support the learning process in the classroom, one of which is the Student Worksheet (Laar et al., 2020). Student Worksheet is a teaching material that is arranged to determine the effectiveness and creativity of a student in learning (Bak et al., 2011; Labib, 2018). To meet the demands of 21st-century education, the learning media used must contain things that can hone students' skills such as critical thinking, problem-solving, communication skills, collaboration, creativity, and discovery (Piawa, 2010; Srisakda et al., 2016). However, the facts on the ground show different things, there are still many teachers who use student worksheets that do not contain 21st-century education skills. The student worksheets used are student worksheets that are sold freely in the market (Nugroho et al., 2021).

The solution that can be given to overcome the problems of 21st-century education demands is the development of student worksheet learning media using innovative learning models, one of which is project-based learning (*PjBL*) (Anazifa & Djukri, 2017; Jagantara et al., 2014). This development product is different from other development products because in this product there are links or links that direct students to learning materials found on the website, Google Form, and Google Drive. Project-based learning models provide opportunities for students to plan, design, research, and reflect on the creation of technology projects according to their fields (Citradevi, 2017; Kubiatko & Vaculová, 2011; Sasson et al., 2018). So using project-based learning will give a deep impression to students because they can practice in the real world, provide value for understanding concepts, and improve critical thinking skills (Dimmitt, 2017; Du & Han, 2016).

Mangroves are one of the most productive ecosystems that have ecological, biological, and socio-economic functions (Muharamsyah et al., 2019). The term "mangrove" refers to a group of heterogeneous woody shrubs and trees that grow taxonomically in the intertidal zone of Tropical and Subtropical Coasts which are well adapted to life in tidal habitats (Noor et al., 2015). There are so many students who do not know the benefits of mangroves, therefore an electronic-based student worksheet was developed about the mangrove ecosystem.

Biology learning is often misunderstood as learning that is only based on the ability to memorize. To be able to study biology well, a student must have 21st-century skills, namely critical thinking (Intan et al., 2011; Slavkin, 2018). Therefore, it is necessary to design a valid Project-Based Electronic Student Worksheet to Improve Students' Critical Thinking Ability. Meanwhile, the basic problem in this research

activity is how to design a valid Project-Based Electronic Student Worksheet to Improve Students' Critical Thinking Ability. This electronic student worksheet can be designed and created by the objectives to be achieved in the learning process and creativity each teacher, where will the students can access this electronic electronic student worksheet through internet network in the hope that it can help students to better understand the material given by the teacher so that the learning objectives can be achieved (Susilowati, 2013). This research was conducted with the aim of 1) designing Project-based Electronic student worksheets in Biology subjects to improve valid students' critical thinking skills; 2) describe the validity of Project-based electronic student worksheets in Biology subjects to improve students' critical thinking skills that are designed.

Methods

This research is included in research development or Research and Development (R&D), where according to (Kantun, 2013) development research is relatively new research used to develop or perfect a product and not the type of research used to find a theory. The development of this Electronic student worksheet refers to the 4-D development model which stands for define, design, development, and disseminate which was developed by Thiagarajan, Semmel and Semmel (Mulyatiningsih, 2013).

At the defining stage, an analysis of the current curriculum is carried out, an analysis of learning materials, and analysis of the characteristics of students, and the formulation of objectives. Then at the design stage contains making a learning syllabus; lesson plan (RPP); rubric of biology learning skills; critical thinking skills rubric; instrument rubric (validation sheet); and the process of making products using Microsoft Word and Foxit Reader applications. At the development stage, the product can be declared eligible for use if it meets the valid, practical, and effective criteria. However, this study was only carried out at the stage of testing the validity. Product development time is carried out from May to July 2021. The product validity test is carried out on July 11, 2021, at MA Maslakul Huda Dengok. The subject matter used in this study is about Biodiversity but focuses more on Mangrove Diversity.

Research Instruments

The instrument used in this study is a validation sheet in the form of a questionnaire sheet that will be filled out by the validator. On the questionnaire sheet, there are four aspects of research, namely aspects of content or material, graphic, systematic, and linguistic. The type of scale used in this questionnaire is the Likert scale.

Data collection techniques

This study uses data collection methods in the form of distributing validity sheets as research instruments to expert validators. The expert validators consisted of one biologist and two biology subject teachers at MA Maslakul Huda Dengok, Paciran sub-district. Each validator assesses all aspects, namely content or material, graphics, systematics, and language.

Data analysis technique

The results of the assessment by the validator were analyzed descriptively quantitatively. Qualitative data was obtained from comments and suggestions of

validators to improve the product. While the quantitative data was obtained from the score of the validator's assessment of the product. The total score for each aspect of the assessment is averaged in the form of a percentage using a formula that refers to research.

$$\text{Validity } = \frac{\text{Total score for each criterion}}{\text{Maximum score}} \; x \; 100\%$$

After obtaining the average score for each aspect, the score is averaged again to obtain the final product score. The final score is used as a guide whether the product developed has reached validity or still needs to be improved. This can be seen in Table 1.

Table 1. Category validity level

Percentage (%)	Criteria
85 – 100	Very valid
70 - 84,9	Valid
55 – 69,9	Quite valid
40 – 54,9	Not valid
25 – 39,9	Invalid

The determination of the validity level of the developed electronic student worksheet is declared valid if the validation results are at least 70%.

Results and Discussion

This electronic student worksheet is development research whose stages refer to the 4-D development model of Thiagarajan, Sammel, and Semmel. Here in the model there are 4 stages which include the stages of defining, designing, and developing.

Define Stage

At the definition stage, the activities carried out are observations in schools related to the analysis of the curriculum used in schools, learning materials, and student character. At this stage the material has not been delivered in depth.

Design Stage

This design stage is an advanced stage from the previous stage, namely the definition stage. This design stage consists of several activities including making a learning syllabus; lesson plan (RPP); rubric of biology learning skills; critical thinking skills rubric; instrument rubric (validation sheet); and product design. In designing electronic student worksheet products, the first step in the process of making learning media in the form of electronic student worksheets is as follows: electronic student worksheet products are made in PDF form → open the Microsoft Word application on a laptop or computer → open a new sheet on the page Microsoft word → create a student worksheet design using Shapes on the "Insert" menu on the menu bar as desired → fill the page with a series of materials and other things needed in the student worksheet → after the file is finished assembling, save the file in the form PDF by selecting the "File – Export – Create PDF/XPS" menu → after the file has been successfully saved → open the Foxit Reader application to edit the PDF file that has

been created so that it can be connected to the previously prepared website / *Google Form* / *Google Drive* / *YouTube* page → click the "Link" menu on the Ribbon then mark the section you want to connect to the website/*Google Form*/ *Google Drive*/ *YouTube* select "open a web link – next – enter the link that has been copied from the website into the provided column – ok" → click on the section that is already connected to the website to ensure that the hyperlink that has been done has been successful → when the editing process is complete, save it by clicking the "Save" button on the Quick Access Toolbar. The results of the electronic student worksheet product design developed in the study can be seen in Figures 1-7 below.

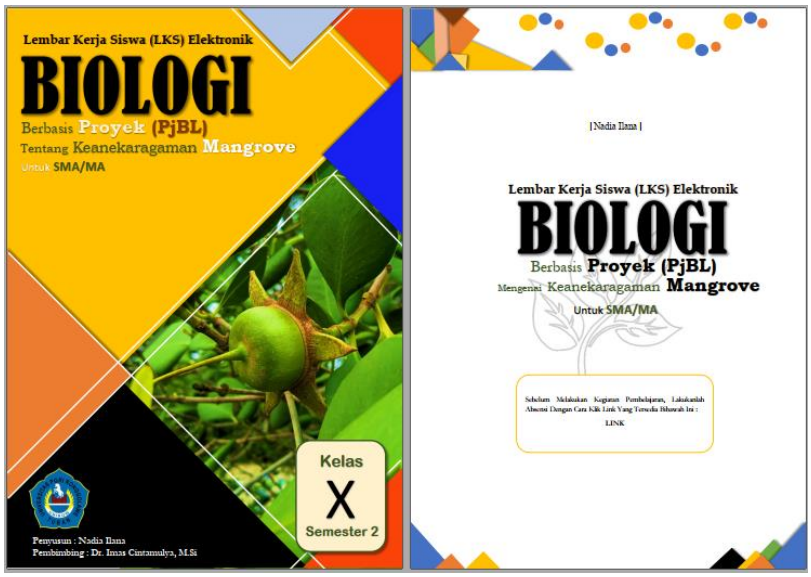

Figure 1. Design of outer cover and inner cover.

The cover page is designed using photos taken during research in the field, filled with titles according to the learning model used in the electronic student worksheet, namely the project-based learning model. On the inside cover, there is a student attendance that can be directed to the google form link that has been created by the student which will be automatically captured in the teacher's email.

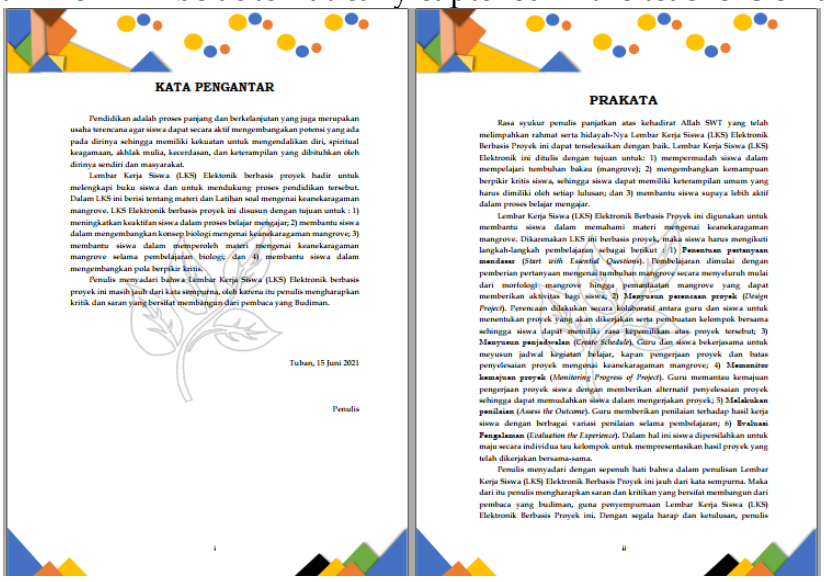

Figure 2. Preface and Foreword

In the preface and foreword, it contains the purpose of making electronic student worksheets and the content framework of the electronic student worksheet itself by the learning model used, namely project-based learning.

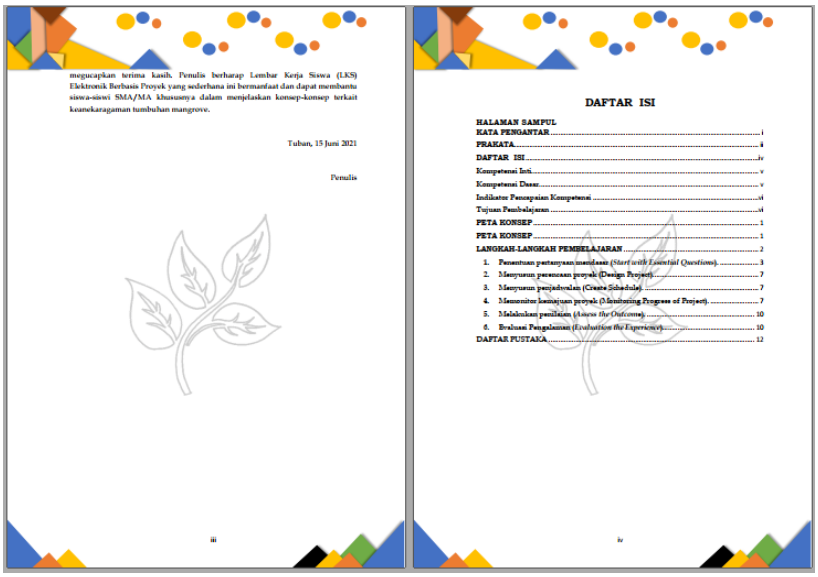

Figure 3. Table of contents

The table of contents section contains the order of titles for each chapter along with the pages contained in the electronic student worksheet, making it easier for students to find information in the document based on the title and page number. Each point in the table of contents can be "clicked" so that it can speed up students in opening the page.

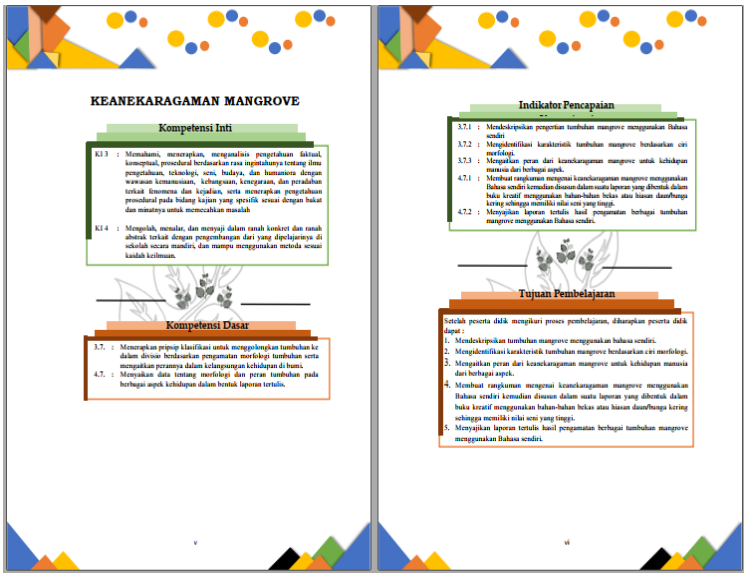

Figure 4. Core Competencies, Basic Competencies, Indicators, and Objectives

This section contains the Core Competencies, Basic Competencies, Indicators, and Objectives that have been analyzed beforehand and have received revisions from the validator for each point.

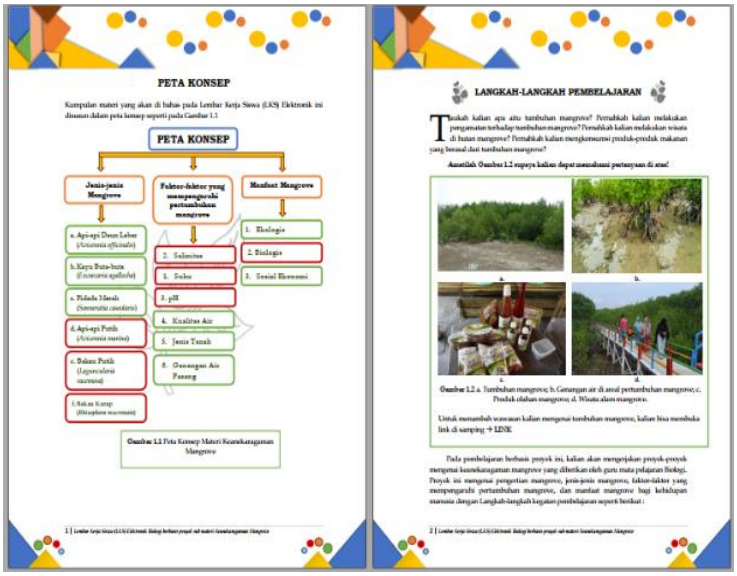

Figure 5. Concept Map and Project-based Learning Steps

The concept map contains a large overview of the material contained in the electronic student worksheets, namely about mangroves from mangrove species, factors that affect mangrove growth, and the use of mangroves themselves. Each part of the concept map can lead students to material found on the internet that has been hyperlinked to each shape.

Figure 6. Learning steps and learning alternatives

The learning stages on this electronic student worksheet refer to the project-based learning stages such as determining basic questions, preparing project plans, arranging schedules, monitoring project progress, conducting assessments, evaluating experiences. Then the alternative part of project completion contains clues for working on projects to facilitate students in the project work process.

Figure 7. Bibliography and Back cover

The bibliography section contains references in the form of books, journals, and other articles used in designing electronic student worksheets.

Development Stage

The development stage is carried out to test the quality of the resulting product in terms of material or content, graphics, systematics, and language. However, at this stage of development, it is only carried out until the stage of assessing the validity of the product. Aspects of practicality and effectiveness of electronic student worksheets have not been tested or assessed. The reason for choosing a biology subject teacher and a biologist is because the validator understands the condition of students when learning in class, what methods are good to use, suitable media to use and the most important thing is that the teacher knows the needs that students need in learning. This validity test was conducted to determine the validity of the electronic biology student worksheets on biodiversity material, especially mangrove diversity. Validation test results from various aspects such as material, systematics, graphics, and language can be seen in Table 2 below.

Table 2. Validation test results from various aspects such as material, systematics, graphics, and language

No	Indicator	Validator score			Average	Criteria
		Validator I (scientist)	Validator II (teacher 1)	Validator III (teacher 2)		
1.	Content criteria	77,8	77,8	83,3	79,6	Valid
2.	Systematic Criteria	82,1	85,7	96,4	88,1	Very valid
3.	Graphic criteria	95	100	100	98,3	Very valid
4.	Language criteria	75	81,2	93,8	83,3	valid
Average Percentage Criteria Score					**87,3**	Very valid

Based on Table The validity aspect developed on the Electronic Student Worksheet has reached the target of 87.3% which means it is very valid but this product is not yet feasible to use because it has not reached the aspects of effectiveness and practicality. This is in line with Lukmanul Labib's research (Labib, 2018) which states that the development product is declared valid if the value is above 70%. The average value of validity based on the achievement of content or material aspects is 79.6%, which means it is valid. This shows that the contents of the Electronic Student Worksheet are under the Core Competencies, Basic Competencies, learning indicators, and learning objectives in line with Yasinta Dwi Aprillia's research "Validity Of Project Based Learning Oriented Student Worksheets On Biodiversity Materials For Class X"(Aprillia, 2014). The material in this Electronic Student Worksheet can be accessed via the internet by clicking on each column on the concept map so that students can hone their technology use skills (Rahayu & Munadhiroh, 2020; Ratnasari et al., 2014; Yusri et al., 2019). As we know that 21st-century education requires students to be proficient with technology (Martín & García-valc, 2017; Mutakinati & Anwari, 2018; Razzaq et al., 2018).

The average value of validity based on the achievement of the systematic aspect is 88.1%, which means it is very valid. These results indicate that the Electronic Student Worksheet is under the title, namely the Electronic Student Worksheet based on the Mangrove Diversity Sub-Material Project, used for class X in the odd semester, the objectives, the learning steps are under the project-based learning steps and the project structure is coherent under sub-material of mangrove diversity discussed in the Electronic Student Worksheet (Barlenti, 2017). The steps in project-based learning must be written systematically and coherently so that students can easily carry out learning, especially Project-based Electronic Student Worksheets are still rarely used in the daily learning process at school (Rahim et al., 2019). The use of the project learning model as an update in the Electronic Student Worksheet can help students develop their abilities in various aspects such as critical and creative thinking skills as well as other cognitive and metacognitive abilities (Bettayeb et al., 2020; Ismirawati et al., 2020; Mahanal et al., 2019; Umar, 2017).

The average value of validity based on the achievement of the graphic aspect is 98.3%, which means it is very valid from the results of the expert validator's assessment. The assessment of the graphic aspect is closely related to the selection of images, the design of the product itself, as well as the selection of colors and other supporting things related to beauty. The selection of attractive colors and images can trigger students' interest in reading the developed Electronic Student Worksheets (Lismidarni & Yohandri, 2020; Tsai, 2013). In addition, the font design used and the font size in the Electronic Student Worksheet must also be arranged in such a way as to beautify the appearance of the Electronic Student Worksheet itself (Melania et al., 2021; Sari et al., 2021).

The average value of validity based on the achievement of the language aspect is 83.3%, which means that it is valid from the results of the expert validator's assessment. The use of communicative and uncomplicated language will make it easier for students to understand the material and projects to be worked on (Jamaliyah, 2014). The choice of a simple language will help students to more easily understand the contents of the Electronic Student Worksheet (Afannudin, 2019).

Conclusion

Based on the results of the research that has been carried out, the electronic worksheet based on the mangrove diversity material project has been declared valid by the validator in terms of material, language, graphics, and systematics. Thus the development of learning media for electronic student worksheets based on mangrove diversity material projects to improve students' critical thinking skills can be declared valid but still cannot be declared feasible to be used in learning because practical and effective trials have not been carried out. Suggestions for further research are the need to conduct trials regarding the effectiveness and practicality of the product so that in the future this product can be declared feasible to use and can be an alternative learning media that can be used for learning in the classroom and observation outside the classroom.

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