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Practicality and Effectiveness of Biological *Liveworksheets* in Measuring High School Students' Critical Thinking Skills

Muhammad Zaini[1], Sri Amintarti[1], Lalu Anang Ilmy[2], Deby Rahmadayanti[2], Qathrin Nada[2], Nadya Hilmia[2], Rabiatul Adawiyah[2], Rizqa Mardhatilah[2]
[1]Lecturer of the Biology Education Study Program, FKIP ULM, Indonesia
[2]Student of the Biology Education Study Program, FKIP ULM, Indonesia

Abstract. This development research aims at explaining the practicality and effectiveness of biological *liveworksheets* in measuring students' critical thinking skills. The study used Tessmer's model, expert tests, individual tests, small group tests, and field tests. Critical thinking skills are acquired through small tests and field tests. The research was conducted for six months (July-December 2021) at Sma Negeri 1 Sungai Tabuk Banjar Regency. The study subjects tested a small group of four students and one partner teacher, a field test research subject of 18 students and three partner teachers. Research instruments use problem items when working on *liveworksheets*. The results of the study concluded 1) *liveworksheets* have been used based on student responses when using this book, namely a) ease of learning the contents of the book, b) clarity of commands given, c) availability of time, d) how to teach and learn resources, and e) interest in subject matter. 2) be able to measure critical thinking skills and excellent results i.e. a) interpretation, b) analysis, c) evaluation, d) inference, e) explanation, and f) self-regulation. The results of this study were also consistent when field tests were conducted. Based on the results of research, *liveworksheets* prototypes can be used in class X high school.

Keywords: development research, critical thinking skills, *liveworksheets*

Introduction

The results of the 2007 National Research Council (NRC) workshop revealed three 21st century skills, namely 1) critical thinking skills (non-routine problem solving, critical thinking, systems thinking), 2) interpersonal skills (complex communication, social skills, teamwork), team, cultural sensitivity, diversity), 3) intrapersonal skills (self-management, time management, self-development, self-regulation, adaptability, and executive function). The important thing that needs to be done immediately is how to design learning and conduct assessments that can stimulate increased scientific literacy. Observing conditions like this, it is time for teachers to leave the rules of teaching (to teach) to be teaching (to learn), both concepts (standard content) and processes (working scientifically) (Ridwan, 2010).

According to the OECD PISA (2015) cognitive tests aimed at measuring scientific literacy are presented in two groups, namely 1) standard units, which consist of statistical material including text, graphs, tables, and graphs and related questions, and 2) interactive units, which include interactive stimulus material and related questions. The standard unit demands learning through scientific work and the interactive unit demands technological literacy students. These two abilities must be encouraged so that students have scientific and technological literacy. One way that might help improve scientific and technological literacy is to carry out learning using wetland-based worksheets.

Volk and Cheak (2003) explain that environmental education is used to measure critical thinking skills. He uses the Critical Thinking Test of Environmental Education (CTTEE) by drawing conclusions, making inferences and identifying biases. If the acquisition of knowledge and skills is designed to teach wetland ecosystems, thinking skills can be accommodated. Both critical thinking skills, creative thinking skills, and higher order thinking skills, all three are means to improve students' thinking skills.

Researches on the development of teaching materials (modules, lesson plans, books, worksheets, learning media) have been reported. The results of the study were in the form of a fish diversity module in the mangrove area (Abdunor, 2014). Mangrove plants have the potential as food ingredients (Ripani, 2014). Diversity of birds in the mangrove forest (Hesty, 2014). Conservation of mangroves (Febrina, 2014), and the development of ecotourism modules (Zaini & Dian, 2016).

Another research aimed at developing the potential of human resources was initiated through a preliminary study of environmental education in elementary schools (Zaini et al., 2010), followed by other research through the development of learning tools oriented to mangrove forests (Zaini & Asnida, 2015).

Liveworksheets that contain critical thinking skills are absolutely necessary, so that students have cognitive skills in dealing with everyday life. One way that can be done is to carry out development research to produce quality worksheets, one indicator of the quality of this product is the critical thinking skills of students. The stages of development research are expert test, individual test, small group test and field test (Tessmer, 1993).

Liveworksheets developed to support the learning process of biology in this century. Through live worksheets, finding out skills are obtained from students' answers in doing the assignment. Explore critical thinking skills through worksheets based on constructivism learning theory. Dwiyogo (2018) explains constructivism theory discussing how the process of human knowledge is formed. According to this theory, the formation of knowledge occurs as a result of human construction (knowledge) of the reality it faces, so that it becomes the forerunner to gaining new knowledge.

Critical thinking means thinking deeply about problems or phenomena described in learning (Glaser, 1980; Fisher, 2012). In the era of globalization, various information can be obtained and accessed through the media. Various information can contain positive and negative things, directly or indirectly, but have an effect on students (Anindyta & Suwarjo, 2014). Susanto (2013) explains that students must have life skills, behave and behave adaptively in facing challenges effectively.

Critical thinking is the development of students' cognitive skills (Schafersman, 1991). When students work on assignments from the worksheets, they have developed critical thinking skills, while the message stored in students' memory is critical thinking skills that can be collected through tests.

Oser and Biedermann (2019) stated that critical thinking is considered as an authentic competency that is oriented to everyday life and is comprehensive, exceeding the pure intelligence possessed by students. Vieira et al. (2011) explains that critical thinking is an important dimension in promoting various competencies whose direction is very important to achieve the goal of increasing scientific literacy for all people.

The development of the ability to think critically requires the teacher's expertise in managing learning. Biology learning is rich with discovery and investigation. If biological concepts are used in compiling worksheets, this determines the success of developing students' critical thinking skills. Therefore, the learning process in schools should train students to explore their abilities and skills in finding, processing and critically assessing various information. An effective way to develop critical thinking skills is to include them as part of every lesson. Teaching critical thinking is an ongoing process. This cannot be limited to classroom sessions, but must be incorporated through a variety of questions, lessons, and activities that focus on higher levels of thinking skills (Reddington, 2012).

Facione (1998) explains that there are several skills that can be categorized as part of the KBK. These skills are expertise in interpretation, analysis, inference, evaluation, explanation, and self-assessment. If the student has mastered one of these skills, then he has led to the ability to think critically even though he has not fulfilled all the skills.

Learning the concepts of wetland ecosystems using liveworksheets is not something out of the ordinary. But it becomes unusual if it is done online. Moreover, the demands are to improve students' critical thinking skills. Therefore, the independence of students is highly emphasized to carry out learning well during this pandemic.

Wetlands are areas where the soil is saturated with water, either permanently or seasonally. Wetlands are areas that are inundated with water, whether natural or artificial, permanent or temporary, flowing or inundated, fresh, salty or brackish, including marine areas with a depth of < 6 m at the lowest low tide. Wetlands in South Kalimantan Province are easy to find, such as rivers, rice fields, and other parts, either submerged monotonously or periodically. Some low-level and high-level vegetation are also easily found complete with diversity.

Students can interact with the natural environment, or use the environment as a source of learning biology. The world of plants, animals, their ecosystems and their changes can be studied by utilizing wetlands such as rice fields and surrounding ecosystems. Students carry out contextual learning, because they live in wetlands and the diversity of their environment.

Research on the development of worksheets has been reported, as well as the development of other teaching materials. Although different objects, there is a common focus of research, namely critical thinking skills. Zaini and Jumirah (2016) reported that the learning tools were at least valid. Practical to use because the implementation of the lesson plan is very good and students show a positive response to learning. Effective based on 1) learning outcomes have been completed, 2) the learning process is very good, 3) students' critical thinking is also good, 4) social skills (collaborating and contributing ideas) are very good, 5) student activities are good, and 6) teacher activities are very good

Angkowati et al. (2018) reported 1) students' cognitive learning outcomes have been completed, 2) KBK results are very good, 3) student attitudes (caring and responding) are very good, 4) social skills (collaborating and contributing ideas are very good, and 5) student responses classified as good. Zaini (2019) reports that worksheets are effective because students' critical thinking skills are categorized as good based on defining problems, making hypotheses, collecting data, analyzing data, and drawing conclusions.

Zaini (2018) reports 1) student learning outcomes (products and processes) are good, 2) student performance skills are very good, 3) character behavior (discipline and responsiveness) is very good, 4) social skills (collaboration and contribute ideas) are very good, and 5) students' critical thinking skills are good. Sari et al. (2018) reported that learning tools were valid and practical to use because partner teachers were able to carry out learning and students responded well.

Maslyni et al. (2018) reported that the science module with environmental insight into the concept of pollution and solid waste was assessed as effective based on 1) average critical thinking skills in the good category, 2) average student learning outcomes were also good, 3) cognitive learning outcomes with a high N-Gain category. Rezeki et al. (2017) reported that 1) inquiry-based learning has an effect on product cognitive learning outcomes, 2) has an effect on process cognitive learning outcomes, 3) has an effect on analyzing ability, 4) has an effect on evaluating ability, and 5) does not affect the ability to apply.

Zaini et al. (2018) reported that students' attitudes during the learning process were in good condition, seen from the character's behavior parameters (cooperation and appreciation to friends). The social skills of students are also included in the good category seen from the questions asked by the indicators.

Zaini et al. (2018) reported that the effective learning implementation plan instrument was used based on good student cognitive learning outcomes, very good critical thinking skills, good category assessment results of behavior and social skills, as well as student activities.

Based on previous research, there are still gaps that research must be carried out, namely students' critical thinking skills through wetland-based worksheets. On this basis, a research question is raised about how critical thinking skills of high school students in learning biology are using live worksheets.

Method

The development research uses the Tessmer Model, consisting of four micro-cycles namely expert test, individual test, small group test, and field test. The research focused on small group testing, and field testing. Small group test to determine the practicality of expectations and the effectiveness of expectations, field tests to determine the actual practicality and actual effectiveness. The concepts of wetland ecosystem are presented in Table 1.

Table 1. Wetland ecosystem concepts tested through formative evaluation

No.	Wetland Ecosystem Concepts	Number of worksheets (pieces)
1	Plantae	4
2	Animalia (sub-concept of vertebrates)	5
3	Ecosystem	3
4	Environmental changes	4
	Total	16

The research was carried out for six months (July-December 2021) at SMA Negeri 1 Sungai Tabuk, Banjar Regency. The research subjects are presented in Table 2.

Table 2. Research subjects for each micro-cycle

Micro-cycles	Aim	Student (person)	STeacher Partner (person)
Small group test	The practicality of hope and the effectiveness of hope	4	1
Field test	Actual practicality and actual effectiveness	18	3

The instrument for evaluating the practicality of expectations and actual practicality is in the form of a questionnaire containing input and opinions when using liveworksheets with a range of 1-100, and the final decision using the very good (76-100%), good (51-75%), adequate (26-50) categories. %), not good (< 25%). Expected effectiveness and actual effectiveness and critical thinking skills using the average scores of students and teachers, with categories very good (76-100%), good (51-75%), moderate (26-50%), poor (< 25 %).

Results and Discussion

Research Results

The practicality of expectations and the effectiveness of expectations through small group testing to produce liveworksheets. Liveworksheets are constantly being improved through formative evaluation. A summary of the practical results of expectations through small group testing regarding the ease of use of liveworksheets is presented in Table 3. Table 3 explains that liveworksheets are stated to be very good, meaning (easy to use). This decision is based on student responses when using live worksheets based on five aspects of practicality of expectations.

The practicality of the expectations obtained is one of the recommendations for producing revised liveworksheets. Furthermore, the determination of the effectiveness of expectations is also carried out through a small group test. A summary of the results of the effectiveness of expectations is presented in Table 4. Table 4 describes the results of the effectiveness of expectations very well, this is one of the recommendations to produce liveworksheets of the next revision. The next step is to determine the actual practicality and actual effectiveness to produce prototype liveworksheets. Here it is reaffirmed that the instrument used to determine the actual practicality and actual effectiveness uses the instrument to determine the practicality of expectations and the effectiveness of expectations.

A summary of the actual practicality results through field tests with consistent use of liveworksheets is presented in Table 5. Table 5 describes liveworksheets well stated, meaning (easy to use). This decision is based on student responses when using this book based on five aspects of practicality expectations.

A summary of the results of actual effectiveness through field tests by collecting the results of critical thinking skills is presented in Table 6. Table 6 describes live worksheets capable of measuring critical thinking skills, and is similar to the expected effectiveness results. So liveworksheets through revision is a prototype.

Table 3. Summary of expectation practicality test results (in %)

No	Aspect	Plantae				Animalia					Ecosystem			Environmental Change				Average flat	Category
		P1	P2	P3	P4	A1	A2	A3	A4	A5	E1	E2	E3	L1	L2	L3	L4		
1	Content is easy to learn and understand.	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent
2	The command given to acquire skills (such as observing, experimenting, etc.) can be understood.	100	100	100	100	100	100	100	100	100	100	75	100	100	75	100	50	93,37	Excellent
3	Time to learn is available	100	100	100	100	100	100	100	100	100	100	100	75	75	100	100	100	96,87	Excellent
4	a) Contents relating to (equipment, manner, source of materials) are already known before.	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent
	b) How to align (such as commands / tasks) has been done before.	100	75	75	75	75	100	100	100	100	75	75	75	75	75	50	100	85,93	Excellent
	c) Fun learning resources	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent
5	Interesting learning materials to learn	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent

Note:
Category 85.00- 100.00% (excellent), 70.00 - < 85.00% (good), 50.00 -< 70.00% (less good), 00.00 - < 50.00 (not good)
P1 (Moss Plants); P2 (NailPlant); P3 (OpenSeed Plant); P4 (Closed Seed Plants).
A1 (Pisces); A2 (Amphibia); A3 (Reptiles); A4 (Aves); A5 (Mammals).
E1 (Ecosystem Component); E2 (Energy Flow); E3 (Biogeochemical Cycle).
L1 (Air Pollution); L2 (Soil Pollution); L3 (Water Pollution); L4 (Waste Recycling).

Table 4. Summary of expectation effectiveness test results (in %)

Critical thinking skills	Score	Plantae				Animalia					Ecosystem			Environmental Change				Category
		P1	P2	P3	P4	A1	A2	A3	A4	A5	E1	E2	E3	L1	L2	L3	L4	
Interpretation	14	100	100	95	91	86	86	86	86	86	98	79	-	90	90	95	96	Excellent
Analysis	10	80	90	97	100	100	100	100	100	100	100	-	98	100	80	95	100	Excellent
Evaluation	20	100	100	94	75	90	90	90	90	90	90	90	90	95	95	100	100	Excellent
Inference	24	99	92	96	92	95	95	95	95	95	89	78	91	89	86	91	84	Excellent
Explanatory	20	94	93	100	80	92	92	92	92	92	75	80	92	100	100	100	100	Excellent
Self-regulation	12	100	100	87	96	81	81	81	81	81	96	87	100	100	100	100	100	Excellent

Note:
Category 85.00- 100.00% (excellent), 70.00 - < 85.00% (good), 50.00 -< 70.00% (less good), 00.00 - < 50.00 (not good)
P1 (Moss Plants); P2 (Nail Plant); P3 (Open Seed Plant); P4 (Closed Seed Plants).
A1 (Pisces); A2 (Amphibia); A3 (Reptiles); A4 (Aves); A5 (Mammals).
E1 (Ecosystem Component); E2 (Energy Flow); E3 (Biogeochemical Cycle).
L1 (Air Pollution); L2 (Soil Pollution); L3 (Water Pollution); L4 (Waste Recycling).

Table 5. Summary of actual practicality test results (in %)

No	Aspect	Plantae				Animalia					Ecosystem			Environmental				Average	Category
		P1	P2	P3	P4	A1	A2	A3	A4	A5	E1	E2	E3	L1	L2	L3	L4		
1	Content is easy to learn and understand.	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent
2	The command given to acquire skills (such as observing, experimenting, etc.) can be understood.	100	100	100	100	100	100	100	100	100	100	90	90	100	90	90	100	97,50	Excellent
3	There is enough time to study available.	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Excellent
4	a) Content related to (equipment, method, source of material) is known beforehand.	90	100	90	90	100	100	100	100	100	100	100	100	100	100	80	90	96,25	Excellent
	b) How to teach (such as orders/tasks) has been carried out before.	70	100	100	100	75	100	100	100	100	100	100	100	100	100	100	100	96,56	Excellent
	c) Fun learning resources	100	100	100	100	100	100	100	100	100	100	100	100	90	100	100	100	99,37	Excellent
5	Interesting learning materials to learn	90	100	100	100	100	100	100	100	100	100	100	100	90	90	100	100	98,12	Excellent

Note:
Category 85.00- 100.00% (excellent), 70.00 - < 85.00% (good), 50.00 -< 70.00% (less good), 00.00 - < 50.00 (not good)
P1 (Moss Plant); P2 (Ferns); P3 (Open Seed Plant); P4 (Closed Seed plant).
A1 (Pisces); A2 (Amphibia); A3 (Reptilia); A4 (Aves); A5 (Mammals).
E1 (Ecosystem Components); E2 (Energy Flow); E3 (Biogeochemical Cycle).
L1 (Air pollution); L2 (Soil Pollution); L3 (Water pollution); L4 (Waste Recycling).

Table 6. Summary of actual effectiveness test results (in %)

Critical thinking skills	Score	Plantae				Animalia					Ecosystem			Environmental change				Category
		P1	P2	P3	P4	A1	A2	A3	A4	A5	E1	E2	E3	L1	L2	L3	L4	
Interpretation	14	88	88	78	77	100	85	90	84	86	93	79	-	89	82	82	81	Excellent
Analysis	10	85	79	83	92	97	100	95	100	100	100	-	93	80	84	96	100	Excellent
Evaluation	20	62	71	88	55	94	-	-	-	-	92	92	91	94	92	93	95	Excellent
Inference	24	85	85	87	84	91	94	89	93	93	90	87	90	89	86	91	83	Excellent
Explanatory	20	77	81	94	85	95	97	99	100	96	81	80	90	93	95	94	94	Excellent
Self-regulation	12	80	82	87	96	98	94	92	95	95	94	95	96	95	93	88	90	Excellent

Note:
Category 85.00- 100.00% (excellent), 70.00 - < 85.00% (good), 50.00 -< 70.00% (less good), 00.00 - < 50.00 (not good)
P1 (Moss Plant); P2 (Ferns); P3 (Open Seed Plant); P4 (Closed Seed plant).
A1 (Pisces); A2 (Amphibia); A3 (Reptilia); A4 (Aves); A5 (Mammals).
E1 (Ecosystem Components); E2 (Energy Flow); E3 (Biogeochemical Cycle).
L1 (Air pollution); L2 (Soil Pollution); L3 (Water pollution); L4 (Waste Recycling).

Based on the results of research put forward inference 1) has been used based on student responses when using this book, namely a) ease of learning the contents of the book, b) clarity of the commands given, c) availability of time, d) how to align and learn resources, and e) interest in lesson materials. 2) be able to measure critical thinking skills and excellent results i.e. a) interpretation, b) analysis, c) evaluation, d) inference, e) explanation, and f) self-regulation. The results of this study were also consistent when field tests were conducted. Based on the results of research, *liveworksheets prototypes* can be used in class X high school.

Discussion

Ease of Use of Liveworksheets

Liveworksheets have been used based on student responses when using it in learning, namely a) ease of learning the contents of the book, b) clarity of commands given, c) availability of time, d) how to teach and learn resources, and e) interest in lesson materials. *Liveworksheets* have appeal and are easy to use, these findings are in line with previous research (Widiyani *et al*., 2021; Muhiddin, 2021; Putri *et al*., 2021; Erina *et al*., 2021; Fitriani *et al*., 2021; Amalia *et al*., 2021; Sari *et al*., 2018). Attractiveness can be interpreted as the practicality of content because it relates to one of the micro cycles used in development research (Erina *et al*., 2021; Fitriani *et al*., 2021). Attractiveness is also interpreted as feasibility (Widiyani *et al*., 2021; Marzuki & Muhiddin, 2021; Princess *et al*., 2021).

Easy to use (has the practicality of expectations) means *liveworksheets* can be used in learning, even if done by developers. These findings are in light of previous research reports (Marzuki & Muhiddin, 2021; Erina *et al*., 2021; Amalia *et al*., 2021). The findings of development research are a quality guarantee, because this model does not allow continuing to the next stage when results are found under the agreed provisions in the research rubric. So remedial is always open on every micro cycle.

Ability to Measure Critical Thinking Skills

Able to measure critical thinking skills and excellent results i.e. a) interpretation, b) analysis, c) evaluation, d) inference, e) explanation, and f) self-regulation. The results of this

study were also consistent when field tests were conducted. Based on the results of research, liveworksheets prototypes can be used in class X high school. These findings are supported by several previous research reports (Erina *et al*., 2021; Amalia *et al*., 2021; Zaini & Jumirah, 2016; Angkowati *et al*., 2018; Zaini *et al*. 2018, Quitadamo & Kurtz, 2007).

Erina *et al*. (2021) finds aspects of interpretation gaining good categories. Other aspects include excellent analysis, inference, explanation and self-regulation of categories. Facione (2010) puts the aspect of interpretation simpler than other aspects. Unlike other studies (Amalia *et al*. (2021) reports excellent critical thinking skills based on six aspects of students' critical thinking skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Analytical and inference skills improved significantly in the treatment (writing) group. Students in the treatment group also showed improvements in evaluating skills, but were not significant (Quitadamo & Kurtz, 2007).

Research aimed at proving (prove) also supports these findings, as previously reported (Ristanto *et al*., 2020; Mahanal *et al*., 2019; Siburian *et al*., 2019). Students who are taught with Cirsa learning have higher biological critical thinking skills compared to conventional learning (Ristanto, *et al*., 2020). A difference between critical thinking skills of students whose learning is facilitated with RICOSRE and critical thinking skills of students who follow conventional learning (Mahanal *et al*., 2019). A significant relationship between critical thinking skills and creative thinking skills to cognitive learning outcomes (Siburian *et al*., 2019).

This study measured critical thinking skills based on six aspects, in contrast to other research reports that took on average all aspects despite excellent categories (Zaini & Jumirah, 2016; Angkowati *et al*., 2018; Zaini *et al*. Aspects of students' critical thinking skills can also be measured from defining problems, hypothesizing, collecting data, analyzing data, and drawing conclusions. (Angkowati *et al*., 2018; Zaini, 2019).

Learning is carried out in the environment where students live using *liveworksheets* with application. Zaini & Asnida (2015) suggests learning in a natural environment using environmental attachment plays an important role in learning biological concepts because it can motivate students, and thinking skills. Nur (2011) explained that learning process skills is not limited to school in whole classes, but can be done in small groups, or individually. Students can start working individually in class or at home, then discuss their strategies and results in small groups or throughout the class.

The use of biology *worksheets* allows students to perform real activities with learned objects and problems (Windari & Suryadharma, 2019). For teachers worksheets facilitate students carrying out the scientific process. The use of *liveworksheets* is in line with other studies (Rambitan, 2015; Kopniak, 2018). Pfrills with smartphones affect students' critical thinking skills in learning biodiversity concepts (Rambitan, 2015). The use of *Interactive Multimedia Worksheets* (IMWS) is effective in achieving the formative evaluation of high school students (Kopniak, 2018).

Conclusion

Based on the results of the study, it can be concluded that live worksheets are easy to use based on student responses when using this book, namely a) ease of learning the contents of the book, b) clarity of instructions given, c) availability of time, d) teaching methods and learning resources, and e) interest in material, lesson. 2) able to measure critical thinking skills and the results are very good, namely a) interpretation, b) analysis, c) evaluation, d) inference, e) explanation, and f) self-regulation. The results of this study were also consistent when field tests were carried out. Based on the research results, the prototype live worksheets can be used in class X SMA.

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