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ECOLOGY TEXTBOOK BASED ON SCIENCE, TECHNOLOGY, ENVIRONMENT, SOCIETY-LITERACY (STESL) STRATEGY TO TRAIN STUDENT'S CRITICAL THINKING SKILLS

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Abstract

To achieve Basic Competencies in learning Ecology, students need critical thinking skills that integrate science, technology, environment, society to science literacy. The aims of this research was to produce textbook based on Science Technology Environment Society-Literacy (STESL) on Ecology material to trained students' critical thinking skill, and to describe the validity and practicality of textbook. The research used the ADDIE design, with the implementation phase was limited to 16 of X-1 grade of science students SMAN 1 Menganti. Validity was reviewed based on validation by education expert and biologist used validation sheet. Practicality was reviewed based on readability using the Fry diagram sheet and student response using student quessionare response sheets. The data of textbook validity, readability of textbook and student response was analyzed descriptively quantitatively. The developed textbook was declared valid based on the average score of validity was 3.6 with very valid category. The developed textbook was considered practice based on the readability of the Fry diagram at level X and the average score of student response was 99.61% with very positive category. The result showed that the book developed can be used to train student's critical thinking skills.

Keywords: Science Technology Environment Society-Literacy (STESL), critical thinking skills, Ecology.

INTRODUCTION

The 21st century is an era of changes in every aspect of life, like economy, social, culture, education, science and technology. The capabilities possessed in this era include technological capabilities through digital literacy, critical and creative thinking skills, good personalities and social skills (Arsad, 2011). One of the common skills needed in the 21st century is critical thinking skills (Rahma, 2012). Through critical thinking skills, students obtain some opportunity to get more complete understanding, be able to make decisions and solve problems wisely in life (Dwyer, 2014). However, currently the students' critical thinking skills are still low, indicated by the Program for International Student Assessment 2015 (PISA 2015) record, the institute reporting the results of education in the world that Indonesia Science is ranked 64th out of 65 countries (OECD, 2013). Another international organization has also corroborated by reporting that the HDI (Human Development Index) or Indonesian human resource quality was placed at 110 in 2014 on the latest Human Development Index (HDI), released by the United Nation Development Programme (UNDP, 2015).

To achieve the competence of critical thinking, people must have knowledge about the material being learned. The knowledge can be obtained through scientific literacy. Through science literacy, people can use their knowledge and information to understand, communicate and apply what they know, that they have high attitude and sensitivity to theirselves and their environment in making decisions. Critical thinking skills and science literacy have a one-way relationship. If students critical thinking skill is high, the students science literacy will be high too (Rahayuni, 2016).

In addition, integrating science to the environment, technology, and society is needed to relate the knowledge with the phenomena occuring in life. Science,

Technology, Environment, Society (STES) is a strategy that integrates components of science, technology, environment and society to learning process to form a multidimensional framework for achieving science literacy (Zoller, 2013). Science, Technology, Environment, Societey-Literacy (STESL) integrates a concept with knowledge of science, technology, environment, society and science literacy (Maesyaroh et al., 2013). Millah, *et., al.,* (2012) and Zoller (2013) argued that in STESL requires high cognitive skills that can help students to achieve critical thinking skills in accordance with 21st century competencies.

Ecology textbook based on Science, Technology, Environment, Society-Literacy (STESL) is a textbook that integrates a concept with science, technology, environment, society and science literacy. This textbook contains the competencies: to analyze natural phenomena and technologies that occur in the environment scientifically, to evaluate and design scientific inquiry by observing the aspects of science, technology and environment, and interprete data or scientific facts. The STESL indicators are related to critical thinking indicators. So by developing Ecology textbook based on STESL can be used to train students critical thinking skills.

Based on research conducted by Nugraha, et., al., (2013) who developed teaching materials, using SETS strategy was significantly able to improve critical thinking ability. Other research conducted by Rahayuni (2016) model of Science, Technology and Society (STS) was able to improve critical thinking skills and science literacy. This was supported by Zoller (2013) with the results of his research stating that Science, Technology, Environment, Society-Literacy (STESL) was able to improve critical thinking skills to solve problems and make decisions. Based on the explanation, it was necessary to conduct research aimed to produce a valid and practice Ecology textbook based on STESL to train student's critical thinking skills.

METHOD

The developmental research used ADDIE (Analysis, Design, Development, Implementation, Evaluation) model (Sink, 2008). The research was conducted in Biology Department, The Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya and SMAN 1 Menganti in September 2016-March 2017. The object of this research is Ecology textbook based on STESL (Science, Technology, Environment, Society-Literacy) strategy. The subjects of this research were 16 students of grade X Science-1 SMAN 1 Menganti.

The validity was based on the validation of educational expert and biologist by using validation sheet. The data was collected by employing validation method and analyzed based on the validation score. The Ecology textbooks based STESL strategy was valid and able to be used, if the score ≥ 2.51 (Sugiyono, 2015).

The practicality was based on textbook readability and students response. The readability of textbooks was the level of student's reading ability using Fry's formula. Then it was analyzed descriptively by the author. The readability method in the Fry graph was obtained by taking samples from a hundred words in the Ecology textbook based on STESL strategy. Readability of the textbook is appropriate if the point between the vertical line and the horizontal line located at level 10.

Students response was obtained from the questionnaire given to the students. Questionnaire was the students response after using the Ecology textbook based on STESL. The questionnaire contains questions, then the students give a check mark (√) among "Yes" or "No" answer options. Students response to Ecology textbook based on STESL was positive, if the students response score was > 71% (Sugiyono, 2015). In this research, data obtained from the validation, readability level and students response will be analyzed descriptively.

RESULTS

Basic Competencies Ecology material to be achieved by students are 3.10 Analyze information or data from various sources about the ecosystem and all interactions taking place in it and 4.10 Simulate the interaction between components within an ecosystem. To achieve these Basic Competencies, requires integrative skills between science, technology, environment, society and science literacy in learning process. Therefore Ecology material could be taught by using STES (Maesyaroh *et.,al*., 2013).

In the analysis phase, researcher analyzed the curriculum, the student, the task, concept/material, determined indicators and learning objectives. Then in the design phase researcher made the textbook design such as the outline textbooks, references, book content and completeness of textbook features.

In development phase, produced a valid and practice Ecology textbook based on STESL strategy for grade X of senior high school to train student's critical thinking skills. This textbook contained four subchapters included abiotic and biotic components in ecosystems, interactions in ecosystems, energy flows and biogeochemical cycles.

1. **The Validity of Ecology Textbook based on STESL Strategy**

The result Ecology textbook based on STESL strategy validation was presented on Table 1.

Table 1. Recapitulation of Data Validation Result Ecology textbook based on STESL strategy

No.	Assessment	Score	Category
1.	**Content**		
	Conformity of the material in textbooks with Core Competence (KI) and Basic Competence (KD)	3.67	Very valid
	Material coverage and accuracy	3.44	Very valid
	Recency	3.33	Very valid
	Develop skills and stimulate curiosity	3.78	Very valid
	Recency features	3.67	Very valid
	Presents concrete examples from the local / national / regional / international	3.78	Very valid
	Textbook activity	3.67	Very valid
	Criteria of Ecology textbook based on STESL	3.67	Very valid
	Refferences	3.22	Valid
	Average of content	**3.64**	**Very valid**
2.	**Presentation**		
	Presentation techniques	3.67	Very valid
	Supporting material presentation	3.67	Very valid
	The physical form of textbooks	3.78	Very valid
	The font and size used in textbooks	3.78	Very valid
	Average of presentation	**3.72**	**Very valid**
3.	**Linguistic**		
	Language used	3.33	Very valid
	Language structure	3.22	Valid
	Use of symbols, terms and words	3.44	Very valid
	Average of language	**3.33**	**Very valid**
	Overall average	**3.56**	**Very valid**

2. Practicality Result of Ecology Textbook Based on STESL Strategy

The practicality of Ecology textbook based on STESL was determined based on the readability of textbooks and students response. Following was the results of the textbook reading level in Figure 1, Figure 2, and Figure 3.

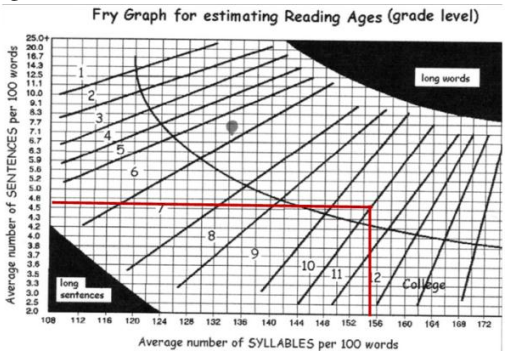

Figure 1. Readability of the first sample in first paragraph page 12

Based on the readability level by using Formula Fry, known that level readability of Ecology textbook based on STESL was 10, either the second (Figure 2) or third sample (Figure 3).

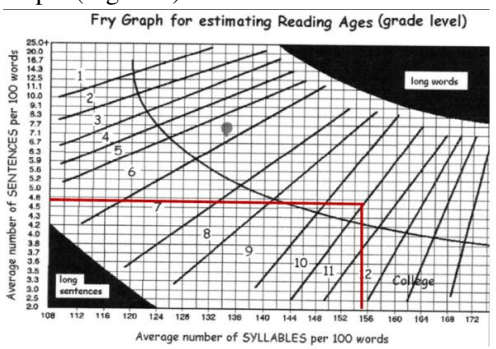

Figure 2. Readability of the second sample in first paragraph page 55

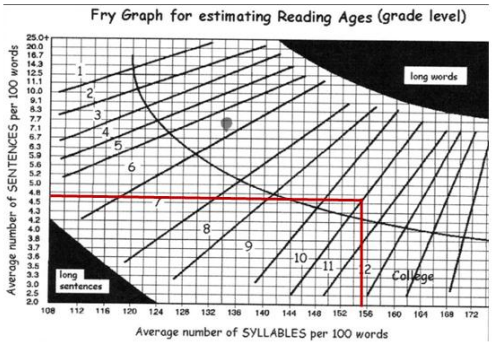

Figure 3. Readability of the third sample in third paragraph page 79

After the textbook has valid category and appropriate readability for grade X, the textbook would be implementated limited to 16 students grade X Science 1 of SMAN 1 Menganti (Implementation phase). Practicality of the Ecology textbook based on STESL strategy not only based on readability, but also students response after used the the textbook. The students response was presented on Table 2.

Table 2. Results of recapitulation of students response to Ecology textbook based on STESL

No.	Aspect	Percentage (%)	Category
1.	Content	100%	Very positive
2.	Presentation	100%	Verypositive
3.	Linguistic	98.44 %	Very positive
4.	Criteria of Ecology textbook based on STESL	100%	Very positive
	Overall everage	**99.61%**	**Very positive**

DISCUSSION

The developed textbook based on STESL obtained very valid category, because it can use to train students

critical thinking skill. Ecology textbook based on STESL integrates a concept with science, technology, environment, society and science literacy. This textbook contains the competencies: to analyze natural phenomena and technologies that occur in the environment scientifically, to evaluate and design scientific inquiry by observing the aspects of science, technology and environment, and interprete data or scientific facts. The STESL indicators are related to critical thinking indicators. So by developing Ecology textbook based on STESL can be used to train students' critical thinking skills.

The first indicator of STESL was analyzing natural phenomena and technologies that occur in the environment scientifically. In this indicator, student was given a feature that encourage critical thinking was based on the Basic Competence 3.10 Analyze information/data from various sources about the ecosystem and all interactions taking place in it, on page 66 the "What Will Happen?". In this feature, students were asked to read and predict after observing a graphic of producers, herbivores and carnivores in an ecosystem. Then followed by questions "What happening if the number of first consument population is decrease? What is the impact to the environment if the number of first consument population is decrease? What should we do to overcome the population decreases?" By periodically presenting some questions based on the STESL and critical thinking indicators include: identifying natural phenomena and technologies occurring in the environment, making predictions, hypothesizing and designing problem-solving, so students are motivated to explore more information that students will be trained to think critically. It was accorded by Paul & Elder (2005) that one indicator of critical thinking is exploring relevant information.

The second indicator of STESL was evaluating and designing scientific inquiry by observing the aspects of science, technology and environment. The example of this indicator, student was given an article about the influence of abiotic component to biotic component, that is acid rain problem (degree acidity of water) that influence fish life. After reading the article, students were guided to identify the abiotic components and biotic components involved in the reading. Then students were asked to identify problems by formulating problems based on article, then students was guided to identify the factors occurrence of acid rain problems, continued by questions that guide students to identify the resulting consequences and steps to solve the problem. In this section, studenst also presented article 2 about papaya plants that can be used to neutralize the degree of acidity of fish pond, then students was guided to link between the problems on first and second article to science, technology, environment and its role in society. These questions were based on the STESL indicator that can be used to train critical thinking skills. It was accorded by Paul & Elder (2005), the indicators of critical thinking skills used are analyzing problems based on data obtained to solve problems. According to the research resulted by Nugraha, *et., al.,* (2013) who developed teaching materials with vision of SETS, can significantly improve the ability of critical thinking. Another research conducted by Rahayuni (2016) model of Science, Technology and Society (STM) can improve critical thinking skills and students science literacy. This is supported by Zoller (2013) with the results of his research stating that Science, Technology, Environment, Society-Literacy (STESL) can improve the ability to think critically to solve problems and make decisions.

The third indicator of STESL was interpreting data or scientific facts. In this indicator, student was given questions presented in the technological aspects of "Make a chart of how to utilize papaya plants to neutralize degree acidity of water". After reading the text students make a sceme of utilizing papaya plants to neutralize degree acidity of water based on the text provided. So, it is mean that the textbook developed was consisted of the indicator of STESL that can be used to train students critical thinking skills (Zoller, 2013; Nugraha, *et., al.,* 2013). It was accorded by Paul & Elder (2005) that one indicator of critical thinking are analyzing and modifying data to make a conclussion.

The practicality of the textbook developed was obtained from the readability and students response. A good textbook has the conformity based on the validity standard set by BSNP, so the textbook will appropriate to the readability of students, so that students easily understand what they are reading (Hernawan, *et. al*., 2008). The level of readability was what a passage easy to read and understand (Beaglehole, 2010; Zamanian & Heydari, 2012). Based on the readability level by using Formula Fry, known that level readability of Ecology textbook based on STESL tested to 16 students of grade X Science 1 of SMA Negeri 1 Menganti is 10, either the second or third sample. So, the readability of the textbook was accordance with the grade level of the students of grade X.

The practicality was also obtained by using the student response that obtained from the questionnaire given to them. Students give very positive response to the textbook developed. It caused by the Ecology textbook based on STESL presents phenomena in the daily life, integrates a concept with science, technology, environment, society and science literacy. This textbook also contained indicators of critical thinking such as to

analyze natural phenomena and technologies that occur in the daily scientifically, to evaluate and design scientific inquiry by observing the aspects of science, technology and environment, and interprete data or scientific facts, makes predictions and hypotheses, guides to determine questions or problems that can be answered, designs to solve problems, and evaluates the problem solving design by caring the aspects of science, technology and environment, guides students to change data into various forms, analyzes data and differentiates between arguments. Enthusiastic students using Ecology textbooks based on STESL is also supported by the student suggestions for developing textbooks based on STESL on other materials. So students give very positive response to the criteria of Ecology textbook based on STESL aspect. The high student response affects the effectiveness of the learning process (Murray & Rockowitz, 2017).

CONCLUSSION

Based on the results of the research, the Ecology textbook based on STESL (Science, Technology, Environment, Society-Literacy) was stated very valid with the average score of 3.6 and it was declared practical with the suitability of the textbook readability level for grade X and the average score of student response was 99.61% with very positive category.

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