The Development of Scientific Literacy-Based Biology Textbook for High School Students

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Abstract: Scientific Literacy-Based Biology Textbook can be used to improve the literacy of science of senior high school students. This research aims to provide a qualified scientific literacy-based biology textbook. The research consists of the stages of analysis, design, and development. This book was developed based on the analysis of question items of the PISA 2006 and 2015 as well as linkages with the basic competency of curriculum 2013. The stage of analysis, design, development, internal validation and test I carried out in the biology laboratory of FKIP Universitas Riau. The external validation and testing II implemented in SMA Negeri 1 Pekanbaru. The analysis of question items of the PISA 2006 and 2015 produce four topics which are developed; Methods, biodiversity, evolution, and biotechnology. This book was validated based on three aspects of scientific literacy: aspects of the format of the book and the graphic, aspect of content eligibility and scientific literacy. The contents eligibility includes the technique of presentation and scientific literacy includes science as the torso, science as a way of investigating, science as a way of thinking, and scientific as interaction between the science technology and society. The third aspect is the aspect of language. Scientific literacy-based biology textbook that is produced in this research is at a very valid category and very good so it is appropriate to be used as a source of autodidact learning in developing scientific literacy ability.

Keywords: BiologyTextbook, ScientificLiteracy

1. Introduction

The 21st century is the era that full of tough competition. To face such competition, every individual need to have life skills). Science education has a great potential in preparing human resources who have the life skills. This potential can be realized if science education is able to create students become proficient in their field; have logical thinking, creative thinking, problem solving skills, critical thinking; to master the technology and adaptive to the changes and developments of the times. One way to achieve this potential is by increasing the scientific literacy skill. The National Science Teacher Association (2003) suggests that a scientific literacy person who has a basic knowledge about facts, concepts, network concepts and process skills that allows to continue to learn and think logically. Proficiency and integrated skills in scientific literacy can be observed and measured. The measurement is done as an evaluation for improvement efforts the literacy skills of science in the future.

Scientific literacy cannot be presented in a short time, but it takes quite long time for its formation. One of the steps to establish the ability of science is through education, specifically science learning. One of the institutions dedicated to the importance of science literacy in the life is The Organization for Economic Co-operation and Development (OECD), which

established The Programfor International Student Assessment (PISA) to provide information about the achievements of scientific literacy of participating country students. The results score of Indonesian students for scientific literacy in PISA 2000, 2003, 2006, 2009, 2012 and 2015 consecutive was 393, 395, 375, 383, 393 and 401 with average of participating countries is 500 which is indicating that the scientific literacy of Indonesian students is still low.

Researches which find out the achievement of scientific literacy of students in Indonesia have already done a lot. Ginna Sophia (2013), do some research to see the profile of the achievements of the scientific literacy of senior high school in Garut based on the framework of PISA on the content knowledge of biology, the results of the study showed the scientific literacy of students is relatively low with a mean score of 26,58 or equal to 29,53%. MarianiNatalina., et al (2017), conducted a similar study to analyze the scientific literacy of first grade students of senior high school in academic year 2017/2018 in Pekanbaru. Based on the results of the research showed that from 845 participants, the students obtained a mean score of 40.23, which is categorized low, with the acquisition of the average score 42.14 on the aspects of identifying the scientific problems, 43.58 on the aspects of explaining the scientific phenomena and 34.98 on the aspects of the use of scientific evidence.

According to MochamadIsyan Password (2013), one factor that leads to low science literacy is the text book used is not showing the balance of the category of science literacy. Research on analysis of textbook-based learning of scientific literacy has a lot to do with the books used by students in Indonesia.

Ranti An-Nisaa., et al (2015), conducted research of analysis of first grade biology textbook based on the charge of scientific literacy obtained results that the aspect of knowledge is the most dominates aspect that is 68.8% of the whole chapter of the book. This indicates that the balance of the category scientific literacy is not contained in the textbook. According To Chiappetta., et al (1991), there are four categories in the learning textbook of science, namely science as the torso, science as a way of thinking, science as way of investigating, and the interaction between science technology and society.

One effort that can be done to improve the scientific literacy of students is by providing scientific literacy-based biology textbook developed based on the concept, the activities of science, information and the application of science in everyday life and also exercises that promote the scientific literacy of students, as well as have a balance category of scientific literacy. Based on this background so scientific literacy-based biology textbook is developed.

2. Methodology

This research was conducted in Biology Education, Mathematics and Natural Science Education Department (PMIPA), Faculty of Teacher training and Education faculty (FKIP), Universitas Riau for the analysis, design, development and validation by lecturers as well as test I and Validation by the teacher and test II was conducted in SMA Negeri 1 Pekanbaru. The time of the research is in November 2017 to June 2018. This research is the development research, where the research is used to design and develop a scientific literacy-based biology textbook. The model that is used in this research is ADDIE. This model consists of 5 (five) stages; Analysis, Design, Development, Implementation, and Evaluation. This research was conducted up to stage 3 (three), the development stage. This book was developed based on the essential indicators based on the results of the analysis of the question items about scientific literacy developed by PISA 2006 and 2015 as well as linkages with Basic Competence in Curriculum

2013. The following steps of the development of scientific literacy-based biology textbook to produce the product:

2.1 Analysis

This study was begun with the analysis stage, that is by analyzing needs and question items of PISA 2006 and 2015 and analysis of the curriculum2013. Furthermore, analyze PISA 2006 and 2015 to make the essential indicator on the knowledge of biology. The indicator has been elaborated based on PISA that is analyzed by looking at the repeatability of the emergence of questions with the same theme in different years.

2.2 Design

This stage is the stage of making the framework of the scientific literacy-based biology textbook. The developed book is a modification of Education Ministry (2016). This book consists of 4 chapter; chapter I: the scientific method, chapter II: biodiversity, chapter III: evolution and chapter IV: biotechnology.

2.3 Development

The book that has been developed was validated by the validator. And then the result of the validation was revised by the researcher and test I was conducted. Test I was conducted on 10 second semester students of biology education. After that, revising based on the results of the test, the suggestion and recommendation of the scientific literacy-based biology textbook. Next, the test II was conducted on first grade students of SMA N 1 Pekanbaru. Then, the result of test II was revised so it produce scientific literacy-based biology textbook.

3. Result and Discussion

Scientific literacy-based biology textbook was developed from a competency based on the result of the repeatability of the emergence of questions with the same theme in different years. Based on the analysis that is got from 4 topics; scientific method, biodiversity, evolution, and biotechnology. The sequence of the chapter on scientific literacy-based biology textbook was adjusted with the level and basic competency on curriculum 2013; scientific method, biodiversity, evolution, and biotechnology. The developed biology textbook format is arranged by using this following format:

The format of scientific literacy-based biology textbook format

Cover
Acknowledgement
Table of content
Scientific literacy-based biology textbook description
The goals and uses of scientific literacy-based biology textbook
Instruction of the use of scientific literacy-based biology textbook
The material chapter that consists of:

- Title
- Core Competency, basic competency, the essential indicator of PISA
- Concept map
- Material description
    - Exercises
    - Bio concept
- Material mastery
- Bio web
- Summary
- Formatif test
- Bibliography
- Answer key
- Supporting references
- Glossary

Picture 1. The format of Scientific literacy-based biology textbook

The book framework was then developed into a book draft which was validated and revised then tested. Validation in this study consisted of 3 aspects assessed by the validator namely, aspects of book format and graphics, aspects of content eligibility and scientific literacy. Content eligibility includes scientific presentation and literacy techniques includes science as the torso, science as a way of investigating, science as a way of thinking, and the science of interaction between science technology and society. The third aspect is the aspect of language. The validation results of the validator on biology textbooks based on scientific literacy in the format and graphics aspects can be seen in table 1 below.

Table 1. Results of validation on format and graphic aspects

No.	Statement	Average	Category
1.	Cover page related to the contents of biology books	3,25	SV
2.	Biology books are arranged in a systematic and clear format	3,12	V
3.	Biology book formats and templates have an appeal for readers	3,25	SV
4.	Room arrangement or layout of biology books is neatly arranged	3,50	SV
5.	The type and size of the letters in the book are appropriate and clear	3,25	SV
6.	Systematic consistency of servings in chapters	3,62	SV
7.	Suitability and accuracy of illustration with material	3,25	SV
8.	Concept map at the beginning of each chapter and summary at the end of each chapter	3,62	SV
9.	There are concept emphasis exercises	3,50	SV
10.	Examples of practice questions in each chapter	3,37	SV
11.	Key answers to practice questions at the end of the book	3,50	SV
Average	3,39	SV	

Description: V = Valid, SV = Very Valid

Table 1 shows that the format and graphic aspect validation results are used to measure the quality of biology books that have been developed in terms of appearance including cover page designs, formats and templates, numbering systems, space settings or layouts, and types and sizes of letters. This aspect also measures the support of presenting material such as illustrations, concept maps, exercises, and answer keys. Biology books developed have systematic consistency in each chapter and have concept maps at the beginning of each chapter and summaries at the end of each chapter. Development of biology books contains material or discussion that is in line from beginning to end and has the same components in each chapter making it easier to use biology books.

The presentation of concepts also relates to concept maps presented at the beginning of the material, presented in a series of ways ranging from easy to difficult, from concrete to abstract and from simple to complex. It coupled with the summary at each end of the material that presents a brief discussion of the material. This is in line with the opinion of I NyomanSudanaDegeng (2016) which explains that there are three principles in making a book, namely the principle of relevance, means that the material of the book is relevant to the achievement of student competence; the principle of consistency which contains teaching materials that are in line from the beginning to the end; and the principles adequacy that explains matters related to competencies or sub-competencies selected. The results of validation by the validator on the eligibility of content and scientific literacy can be seen in the following tables 2, 3, 4, 5 and 6.

Table 2. Results of validation of the presentation technique indicators

No.	Statement	Average	Category
1.	Description of biology books in accordance with the contents of the book	3,37	SV
2.	Instructions for using books direct the reader to understand the contents of the book	3,62	SV
3.	Biology books have material titles to facilitate learning the concepts to be studied	3,75	SV
4.	Biology books display core competencies, basic competencies and essential indicators that are in line with the PISA literacy items	3,75	SV
5.	Biology books have concept maps that direct the scope of the material to be studied	3,75	SV
6.	The description of the material in the biology book is presented clearly and systematically	3,37	SV
Average		3,60	SV

Description: SV = Very Valid

Table 2 shows that the results of this aspect validation function to measure presentation techniques and the eligibilty of scientific literacy in biology books. The biology book that was developed in the presentation technique in each chapter has different material titles according to the results of the analysis that has been done before, the title presented in the biology book is made concisely and clearly aims to facilitate the learning of concepts. The title in the biology book consists of the main title on the cover page, the title in each chapter, and the title of each sub-chapter. Typing the titles is different, such as using capital letters, thickened and using a larger size with the aim to attract the reader focus on the material being discussed.

The next description of the title is KI, KD (core and basic competency) and essential indicators displayed sequentially from general to specific aiming to become acquainted in understanding the material to be achieved. The purpose of displaying KI, KD, and essential indicators in biology books is the readers can find out the extent of the material described in the chapter. According to Nana SyaodihSukmadinata (2002) as for the benefits of displaying indicators one of which is to facilitate in communicating the purpose of learning activities to be achieved, so that students can learn independently.

Concept maps are presented before the description of the material in each chapter. Concept maps that are presented contain concepts compiled from general concepts to specific concepts that aim to direct the reader into the scope of the material to be studied. This is in line with the opinion of DedySetyawan (2016) which states that concept maps are used as an aid to see the relationship between concepts and to assess understanding, conceptual development and to know the misconceptions of the material. Concept maps have the characteristics of crosslinks that connect one concept to another so that it forms proportions.

Table 3. Results of validation of aspects of science as the knowledge torso

No.	Statement	Average	Category
1.	Presenting facts	3,62	SV
2.	Presenting concepts	3,50	SV
3.	Presenting principles	3,37	SV
4.	Presenting theories	3,50	SV
5.	Presenting illustrations	3,75	SV
Average		3,50	SV

Description: SV = Very Valid

Table 3 shows that the results of this aspect of validation serve to assess information on content that contains various kinds of knowledge as a result of scientific research. The biology book developed shows that illustrations and pictures of enrichment books that are considered to provide visual stimulation. Illustrations that are presented is in a clear format and quality so that they can help in understanding the material. A good illustration in the form of pictures, graphics, tables serve to increase the appearance of enrichment book material and help explain the concept to be simpler so that it is easy to understand. This is in line with the opinion of AniCahyani and Hartono (2015), that the illustrations and images contained in the textbook must be relevant to the concept given theoretically.

Table 4. Results of validation of aspects of science as a way of investigating

No.	Statement	Average	Category
1.	Require students to answer questions based on available material	3,62	SV
2.	Require students to answer questions through the use of charts	3,37	SV
3.	Require students to provide explanations regarding the answers given	3,50	SV
4.	Involve students in experiments or thinking activities	3,50	SV
Average		3,50	SV

Description: SV = Very Valid

Table 4 shows that the results of this aspect of validation serve to assess general science description and reflect the aspects of student activity in inquiry learning, which relate students to scientific methods and processes. The biology book developed shows that there are questions that require students to answer questions based on available material; this is because the questions contained in the enrichment book are presented in the form of multiplechoice questions and essay questions.

There is also a practice question at the end of the sub-chapter that aims to emphasize the concept and requires students to provide answers based on the material described earlier. Questions contained in the biology book provide reinforcement and add to the experience of students in working on scientific literacy-based exercises. The researcher chooses multiple choice questions and a brief description because some PISA questions are presented in the PISA question, such as multiple choice, description, and Yes / No. Various forms of questions aim to train students in working on various forms of questions.

Each question form has its own strengths and weaknesses, such as a description of a problem that one cannot guess the answer as in a multiple choice question, so it must master the whole material to answer the question. This is in line with Ridwan Abdullah Sani (2015), which states that essay questions can be used to measure a person's ability in depth because it requires someone to give answers that are described freely, organize their thoughts, express their opinions, and express ideas with their own sentences .

Table 5. Results of validation of aspects of science as a way of thinking

No.	Statement	Average	Category
1.	Describes how a scientist conducts experiments	3,37	SV
2.	Shows the history of the development of ideas	3,63	SV
3.	Emphasizes the objectivity of science	3,37	SV
4.	Presenting the use of assumptions about questions	3,25	SV
Average		3,40	SV

Description: SV = Very Valid

Table 5 shows that the results of this aspect of validation serve to assess the description in conducting an investigation. This indicator gives a general and special description of science and a description of scientists in conducting investigations about natural phenomena. The biology book developed shows that there is a section that shows the history of the development of ideas; this can show that the biology book that was developed has provided the basis for the development of ideas from the material discussed. The history of the development of ideas needs to be known to see how a scientist thinks objectively and is full of a sense of confidence, curiosity, imagination, thought and shows a causal relationship in the world. This is in line with the opinion of YayahSitiMaryah (2014) who said that the work of scientists related to reason, describes human curiosity to understand nature. This fundamental understanding helps students to learn science.

Table 6. Results of validation of aspects of interaction between science, technology and society

No.	Statement	Average	Category
1.	Describes the use of science and technology for society	3,50	SV
2.	Discuss social issues related to science or technology	3,50	SV
Average		3,50	SV

Description: SV = Very Valid

Table 6 shows that the results of this aspect of validation serve to illustrate the influence or impact of science on society. This indicator alludes to the application of science and how technology helps or even disturbs humans. The biology book that was developed has illustrated the usefulness of science and discussed scientific problems for the community. Social problems related to technology and society is closely related to the use of science and technology for society. According to Tri RetnaniAriningrum (2013), the interaction between science technology and society also touches on social and career issues. The book material included in this indicator must describe the positive and negative impacts of science and technology for the

community, as well as mentioning careers and jobs in the field of science and technology.The results of validation by validators on biology books based on language science literacy can be seen in table 7 below.

Table 7. Results of language aspect validation

No.	Statement	Average	Category
1.	The grammar of the book in accordance with the rules of the Indonesian language is good and right	3,62	SV
2.	The writing and language used in the book are in accordance with EYD rules	3,25	SV
3.	The writing and language used in biology books are clear and easy to understand	3,25	SV
4.	The language used in biology books encourages reading interest	3,25	SV
5.	The language used in biology books is communicative	3,25	SV
Average		3,33	SV

Description: SV = Very Valid

Table 7 shows that the results of this aspect validation function to see the quality of the language used in the biology book in accordance with the good and correct Indonesian language rules. Biology books that have been developed using standard language and have fulfilled the rules of Indonesian language that are good and true. The use of language in biology books is also clear and easy to understand and in accordance with EYD rules. The use of language that is good and right can make it easier for users to understand the contents of biology books, such as the contents of the description of the material, the purpose of practice questions, formative tests, and others. This is supported by IsmaRusanFahrani (2015), stating that scientific writing must be based on the correct writing following the improved spelling rules that have been set and appointed. In line with the opinion of Mohammad Ridwan (2016), states that the aspect that is very important for books is the language used. Accuracy in using word choices, language styles, and sentences used in books is tailored to the reader, easy to understand and the relationship between sentences must be clear. The language of a book affects the readability of a book.

The book of biology based on scientific literacy that has been validated based on suggestions and recommendation of the validator is then carried out a limited trial to see the readability and suitability of the book. The trial was carried out in two stages: the first trial was carried out on 10 second semester students of biology education FKIP University of Riau and trial II of 20 students of class X SMA Negeri 1 Pekanbaru. The response questionnaire which was filled by respondents consisted of 15 questions that assessed aspects of content, language, and graphics.

Respondent in trial I and trial II gave a positive response to biology books based on scientific literacy. This is because this book was developed systematically, clearly and easily understood and has an appeal to the reader. This interest is a sign of students' interest in studying this book. The illustrations presented in this book are relevant to the material presented, it aims to assist the reader in understanding the material described. The images presented in the form of functional images, namely images to eliminate a complicated one that is impossible to be presented verbally and expressive images, which are images that are useful for influencing the reader's attitudes and feelings.

Based on the results of the trial illustrates that the scientific literacy-based biology books that have been developed can be used as one of the additional learning resources of students in training scientific literacy and as additional references to textbooks. This is in line with the Ministry of National Education (2016) which states that the characteristics of books that are

good in content aspects are in accordance with KI and KD, have material accuracy (accuracy in the selection of discourses, concepts, theories, examples, and exercises) and have presentation support material, namely conformity with the development of science, the material presented is always the latest, and in accordance with the development of science.

4. Conclusion

From the results of the research it can be concluded that: (1) The results of the biology book evaluation based on three aspects, namely the format and graphic aspects, content eligibility and scientific literacy and aspects of language are in a very valid category, (2) The results of trial I and the results of trial II on high school students are in the very good category, (3) Biology books based on scientific literacy for high school students have been developed in very good categories and can be used as learning resources to develop scientific literacy skills.

For further researchers, it is recommended to continue the next stage of development research, implementation and evaluation.

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