

Developing Ecology and Environment Learning Materials of Scientific Literacy Skills and Local Potencial for Indonesia Students

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Abstract: *Indonesian students' scientific literacy skill is still low. It caused by the availability of scientific literacy learning material and textbook are limited and also rare developed based on local potencial, especially for ecology and environment topics. The research aimed to develop a learning material on ecology and environment topics based on scientific literacy and local potencial of North Sumatera-Indonesia which is feasible empirically. The feasibility of learning material is obtained through the validation by scientific literacy-content experts, design expert, assessment from biology teacher and students responses. Borg and Gall model was used in this research. However, this study is solely limited to preliminary field testing. Data validation was analyzed descriptively qualitative. The research result showed that according to scientific literacy-content experts, the feasibility of learning material was very feasible, in which the feasibility based on science as a body of knowledge has an average score 93.75%, whereas science as a way of investigation 87.50%, science as a way of thinking 95.31% and for interaction of science technology and society (STS) 92.50%. The feasibility of learning material's design corresponded to the design expert was very feasible with 91.43% as well. Result of biology teacher assessment on learning material was 93.75% (very feasible). Students' response to the preliminary field individual testing was 80.35% (feasible), small group trial 84.52% (very feasible) and large scale group 91.38% (very feasible).*

Keywords: *Scientific literacy, ecology and environment learning material, local potencial, North Sumatera-Indonesia*

1. INTRODUCTION

The 21st century learning in science and technology sector, students need to be equipped with the 21st century skills to ensure their competitiveness in the globalization era. The skills of 21st century learnings which are: digital age literacy, inventive thinking, effective information, communication and high productivity (Greenstein, 2012). Scientific literacy is one of the skills required in digital age literacy. Miller (2002), who has been involved in assessing scientific literacy for over three decades, emphasizes the importance of "civic scientific literacy" in a modern society that relies heavily on technology. He believes that 21st century society requires a public with knowledge about scientific and technological issues for the democratic process to function properly. Scientific literacy plays an important role in human daily lives. Promotion of scientific literacy has been recognized as a major goal of science education in the world (BouJaoude, 2002; National Research Council [NRC], 1996; Zembylas, 2002). Educators agree that scientific literacy should be nurtured as early as possible (Barton, 1994; Bybee, 1997).

Indonesian students' scientific literacy based on PISA surveys in 2015 had taken 66th rank from 72 participants (OECD, 2016). The data showed that Indonesian students only achieve score about 400 constantly from year to year, which means students' scientific literacy still at the beginner level. In addition to the core of literacy, students also need to acquire research skills. Among other things, they need to know is how to access and find book through the library article, note taking and integrate secondary sources, determine the reliability of data, read maps and graphics, visual understanding of scientific, capturing the type of information conveyed by various system representations, distinguishing between fact and fiction, fact and opinion, construct argument and monitor evidence. Students also need to develop technical skills. They need to know how to log on, find information, using a variety of programs, focus on the camera, edit the recording, do the basic programming and so on (Jenkins, 2007).

The results of the observations conducted in North Sumatra Indonesia showed that biology learning of senior high school (SMA) on topics ecology and environment has not been developed of learning materials, and yet contained four components of scientific literacy. Another fact was the biology text book has not based on local potential in North Sumatra and students had not got learning materials which available today contain issues that close to students' daily lives and learning biology in schools should not be linked to the real environment around them. Whereas in biology textbook in Canada, Texas, Mexico and Thailand (Feedman, 2009; Miller & Levine, 1998; Veeravatanond *et al.*, 2001) have highlight the example of real environment that known by students and bring a very positive impact on students' scientific capabilities in interpret information, solve problems, create appropriate decisions, accommodate change, and achieve new understandings.

Students are able to make connections between what they learn in classroom and what they see in daily life (Chamnay *et al.*, 2008). Furthermore, Adisenjaya (2008) and Ariska (2015) had reported that most of biology textbook in high school in Indonesia nowadays are not completely developed based on scientific literacy aspects. Chiapetta *et al.* (1991a&b) suggested that there were four components to developed scientific literacy, such as: science as a body of knowledge, science as a way of investigating, science as a way of thinking, and interaction of science, technology and society (STS). Keller & Suzuki (2004) stated that students' attention could be emerged by using various learning strategies, media, and materials. It is also necessary for learners to perceive the instructional requirements to be consistent with their goals, compatible with their learning styles and connected to their past experiences. It could help students to get relevance for their learning (Driscoll, 1994, Keller & Suzuki, 2004, and Hodges, 2004).

The use of local potential in learning process is useful to train student's ability in socialize and problem-solving skills (Ahmadi *et al.* 2012). In addition, the use of local potential in accordance with a curriculum and syllabus gives freedom to each school to consider the potential of school and the surrounding area in learning process (Sajidan, 2013).

North Sumatra has resources, biodiversity that are very important and potential. It has 181,860.65 km² of its total area, consist of 71680.68 km² land area and the 110,000.65 km² marine area (Badan Pusat Statistik, 2015). The geomorphology of North Sumatra is flat to undulating near the coast and rolling to mountains in the upland of Bukit Barisan Mountains. The geomorphology of these regions affects the rainfall pattern, leading to high local variation rainfall distribution (Pieter *et al.*, 2003). It is made this province rich of in ecosystem such as rice field, palm oil plantation, fruit and vegetable garden, lake ecosystem, marine ecosystem, mangrove ecosystem, *etc.* North Sumatera also rich of cultures and has some historical sites. These potential can be optimized through the availability of learning materials for ecology and environment topics based on North Sumatera ecosystem characteristic.

Based on the explanation above, it is necessary to conduct developed a learning material on ecology and environment topics based on scientific literacy and local potential of North Sumatera-Indonesia. According to Kemdikbud (2014), the existing activities on the learning material with a scientific literacy can encourage and inspire students to be able to understand, implement, and develop ways of thinking rationally. This study aim was to carry out with the objective of assessing the feasibility of scientific literacy ecology and environment learning material based on local potential of North Sumatera-Indonesia that has been developed according to scientific literacy -content experts, design expert, biology teacher and students in Senior High School. The process and product of this reserach are expected to learning material based local potential on North Sumatra – Indonesia had been feasible.

2. MATERIALS & METHODS

2.1. Research Design

This research and development used Borg and Gall modification model (Gall *et al.*, 2003) which comprised the step of (1) Identifying learning needs; (2) Product planning which include field survey and study in many ecosystem in North Sumatera (rice field, palm oil plantation, lake toba, vegetable and fruit garden, mangrove, *etc.*) in order to collect local potential of North Sumatera for learning material composition; (3) Designing preliminary product; (4) Preliminary product development; (5) Preliminary product field testing; (6) Main product revision; (7) Product main Field testing; (8)

Operational product revision; (9) Product operational field testing; and (10) Final product revision. However this study was limited simply for preliminary field testing. In order to reach this purpose, the learning material scientific literacy ecology and environment topics based on local potential of North Sumatera-Indonesia has been developed and validated by content and design experts, biology teachers review and students response or perception.

2.2. Study Samples

Product development was started on February 2016 and preliminary field testing was carried out on May 2016 to know the feasibility of product. The preliminary field testing was carried out in SMA Negeri 6 Binjai (State Senior High School) Jl. A. R. Hakim No. 66A, Sub-District of Binjai, North Sumatera. The sample preliminary field testing was used individual, small sample, and large sample.

2.3. Instruments

Research data was collected by using questionnaire instrument. Instrument for content expert review consist of 56 questions related to scientific literacy aspect and local potential availability on this product, instrument for design expert consist of 27 questions related to product design and presentation, whereas instrument for biology teacher review consist of 16 questions and 14 question for students response through this product feasibility.

The data primary was collected used a point 4 Likert scale. The responses to each statement of a four scale that was 1 (bad/ not feasible) ; 2(not good/less feasible); 3 (good/feasible); 4 (excellent/very feasible). The respondents will give a number of each item on questionnaire based on the established criteria. Data validation from the questionnaire response from teachers and students were analyzed descriptively qualitative.

The feasibility of learning material was obtained through validation by scientific literacy-content experts to assess feasibility of content based on *science as a body of knowledge*, *science as a way of investigation*, *science as a way of thinking*, *interaction of STS*, design expert to assess feasibility of learning material design, assessment of biology teacher and students' responses to learning material developed.

3. RESULTS & DISCUSSION

3.1. Results

The results of research and development had which comprised the step of :

1. Collect Information about Learning needs

It is used by a questionnaire instruments consist of learning needs problem on school, learning material, local potential on North Sumatra, scientific literacy. The results of these activities showed that related to ecology and environment's learning has not been developed, and yet contained four components of scientific literacy.

2. Product Planning

The result of these activities showed that the formatted of learning materials, the presentation component of learning material, and teaching material content.

3. Product Design

The results of these activities showed that format of learning material designed was started from determining paper size, layout, colour, selecting font and font size.

4. Preliminary Product Development

The result of the product development stages was the realization of planning stage. The Draft of finishing product then validated to the expert and reviewers will gain ratings and feedback for improvements. The results of validation will help to make revision of draft product.

5. Preliminary Field Testing

3.1.1. Draft Assessment Based on Scientific Literacy-Content Expert

The results of research and development that content expert based on scientific literacy can be seen at figure 1.

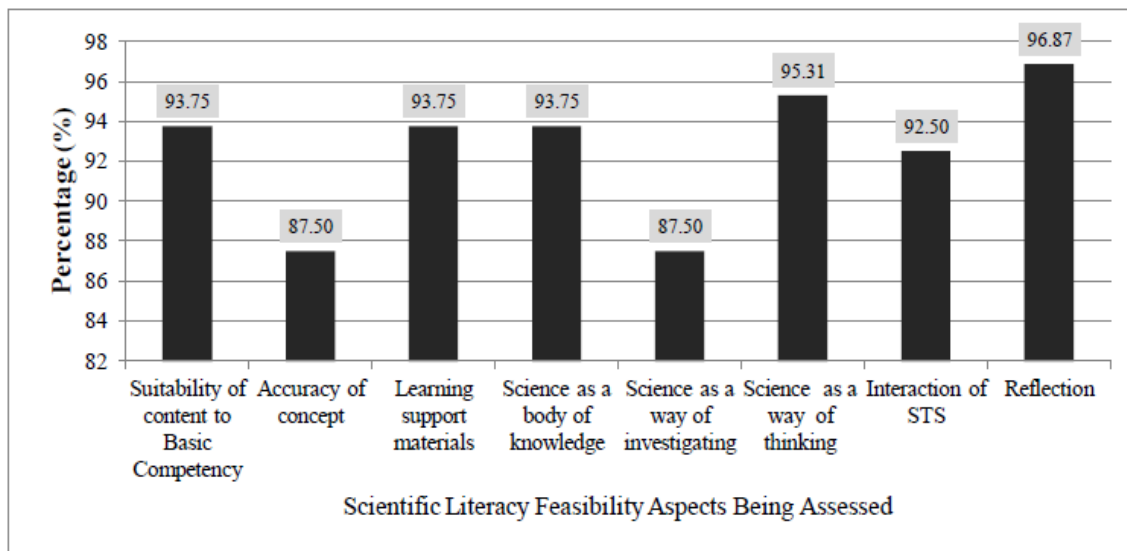


Figure1. The graph result of Percentage Content Experts Assessment for Scientific Literacy Ecology and Environment Learning Material

Figure 1 shows that the value of percentage content experts indicators was, namely: science as a body of knowledge has 93.75% (very feasible), science as a way of investigating has 87.50% (very feasible), science as a way of thinking has 95.31% (very feasible), interaction of STS has 92.50% (very feasible), sustainability of content to basic competency has 93.75% (very feasible), accuracy of concept has 87.50% (very feasible), learning support material reached has 93.75% (very feasible) and reflection has 96.87% (very feasible).

The results feasibility of product's presentation can be seen at figure 2. There are four sub-component as very feasible: presentation techniques, presentation of learning, completeness of presentation and presentation of North Sumatera's local potential that are the hallmarks of learning materials-developed. Learning materials presentation techniques included in the criteria of "very good" (91.07-100%). This shows that the product has been written in the appropriate sequence and interconnected, and assisted with the use of good language.

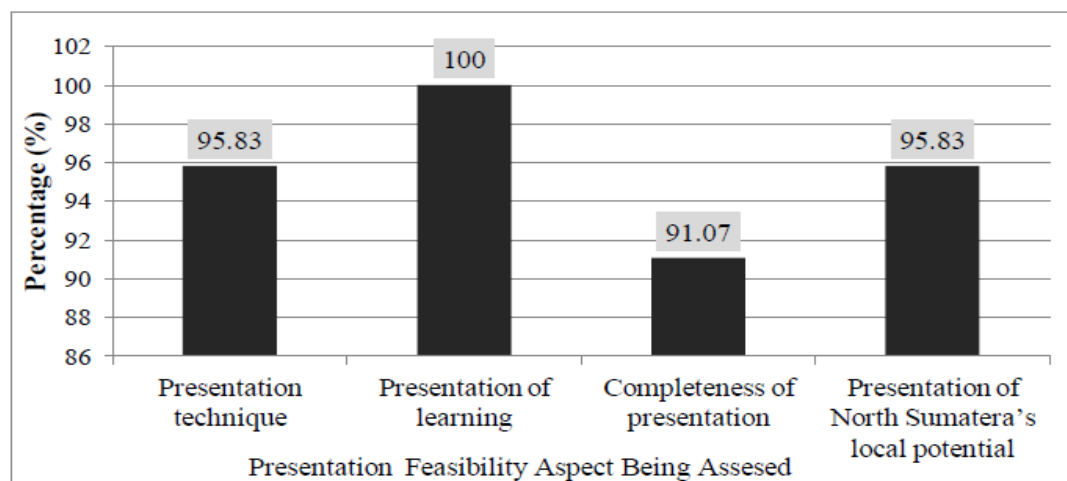


Figure2. The graph Percentation of Scientific Literacy Learning Material on Ecology and Environment Topics Based on North Sumatera-Indonesia Presentation

3.1.2. Draft Assessment Based on Design Experts

The results of draft Assessment based on design expert can be seen in Table 1 and at Figure 3. Table 1 shows that the average score was 91.43% and it categorized as very feasible.

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Table1. Feasibility assesment of design expert to learning materials scientific literacy on ecology and environment topics based local potential of North Sumatera- Indonesia

Component	Sub-component	The number of item	Design Validator	Total Score	%	Criteria
Book's format	Size	3	11	11	91.67	Very Feasibe
Cover's design	Cover layout	3	10	10	83.33	Very Feasibe
	Cover typography	4	14	14	87.50	Very Feasibe
	Cover ilustration	3	10	10	83.33	Very Feasibe
Book's Content design	Arrangement/ content layout	6	20	20	83,33	Very Feasibe
	Typography	5	20	20	100	Very Feasibe
	Content ilustration	3	11	11	91.67	Very Feasibe
Total/ Average		27	96	96	91.43	Very Feasible

Figure 3 shows that the assesment of design aspect feasibility in book's format, namely: learning material format has 91.67% (very feasible), cover design has 86.54% (very feasible) and content design has 91.07% (very feasible).

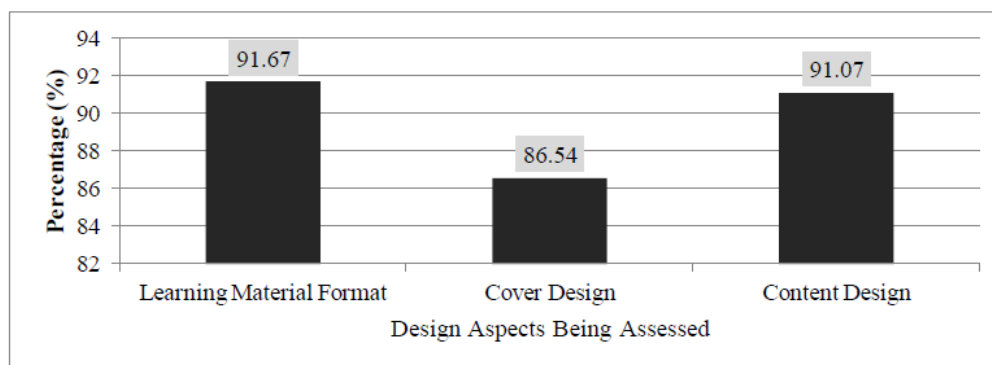


Figure3. The graph of Percentage of Design Experts Assessment for scientific literacy ecology and environment learning material.

3.1.3. Draft Assessment Based on Biology Teachers Assesment and Students Response

The results of draft assessment based on biology teachers assesment and students response can be seen in Table 2 and at Figure 4. Table 2 shows that the average score was 94.27% and it categorized as very feasible.

Table2. Percentage of Biology Teachers Assesment to learning material

No	Indicators	Biology Teachers			(%)	Category
		1	2	3		
1	Learning objective	4	3	4	91.67	Very Feasible
2	Appropriate to students' development level	4	4	4	100	Very Feasible
3	The use of term and image/picture	4	3	3	83.33	Very Feasible
4	Presentation of teaching materials	4	4	4	100	Very Feasible
5	Provide benefits for teachers and students	4	4	4	100	Very Feasible
6	Opportunity for independent learning and group	3	4	4	91,67	Very Feasible
7	Motivate students to communicate, interact and collaborate	4	3	3	83.33	Very Feasible
8	Invite students to think holistically & analitically	4	3	4	91.67	Very Feasible
9	Stimulate students to think critically	3	4	4	91.67	Very Feasible
10	Easily understood language	4	4	3	91.67	Very Feasible
11	The material in accordance with ecologists principle	4	3	4	91.67	Very Feasible
12	Presenting concrete examples	4	4	4	100	Very Feasible
13	Be based on scientific literacy	4	4	4	100	Very Feasible
14	Suitable example to the daily life	4	4	4	100	Very Feasible
15	Presents case/ phenomena in surrounding environment of North Sumatra	4	4	4	100	Very Feasible
16	Facilitate self-learning students	3	4	4	91.67	Very Feasible
Total Score/ Average		61	59	61	94.27	Very Feasible

Figure 4 shows that the Students response to learning material, namely: personal/individual has 80.35%, small group has 84.52%, and large scale group has 91.38%. Student response showed the learning material categorized very feasible.

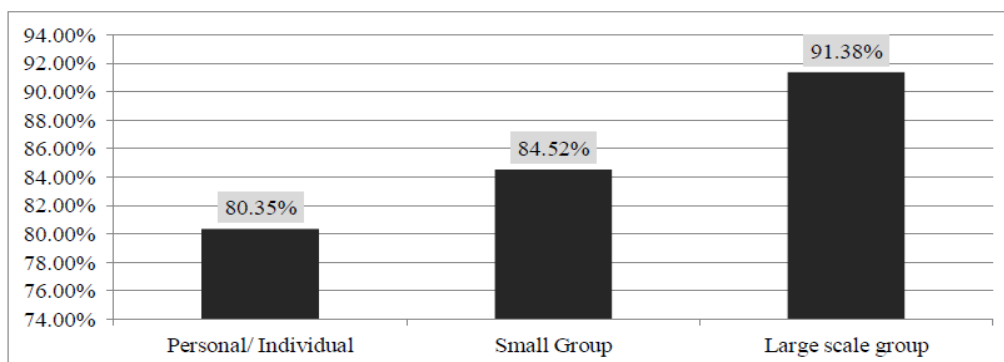


Figure4. *The Graph of Students response to learning material*

3.2. Discussion

Based on the above findings showed that feasibility of learning material was very feasible. The results of this research is in line with the statement of Trianto (2010) and Nisak & Susantini (2013) which stated a good learning material should be has didactic (content) and construction (linguistic), whereas the secondary requisite is techniques (writing, picture and performance)

All sub-component of scientific literacy-content involved the suitability of content to core and basic competence; the accuracy of concept; the learning support materials based on local potential of North Sumatra; science as a body of knowledge; science as a way of investigating; science as a way of thinking; interaction of STS and reflection have fulfilled the criteria “very good” or “excellent”. This is because in the preparation of product developing refers to the learning objectives and a description of the material that has been in accordance with core competencies and basic competence in Indonesian curriculum (Kemendikbud, 2013), as well as the requirements for the preparation of learning resources are good. According to Kariem *et al.*, (2013), preparing or designing the learning resource must be considered with the curriculum.

The learning materials development was arranged by fulfilled all the requirement for a good standard learning material based on Kemdikbud (2013) standards. In this case, it begins by analyzing the curriculum, drawing up a map of the needs of learning material, specifying the topic and title of learning material which will be developed, and then set to write draft of learning materials.

The learning material product has fulfilled four components of scientific literacy in accordance with Chiapetta *et al* (1991), such as: (1) *science as a body of knowledge*; by describing and explaining the truth of facts, concepts, principles and procedures, based on the concepts and theories applicable thus the content can be justified scientifically on ecology and environment topics in biology course at grade X SMA, (2) *science as a way of investigating* by answering questions about ecology using graph, table, calculating and critical thinking in solving problems related to ecology and environment. It was available in bio-review and mini-lab on product, (3) *science as away of thinking*; by giving illustration, diagram to find out the relationship, interaction also cause-effect of phenomenon related to ecology and environment in North Sumatera (as rice field, palm oil plantation, fruit and vegetable gardens, river and lake ecosystems, marine and mangrove ecosystems), (4) *interaction of STS*; by providing information related to topics of science technology and society, updated issues which displayed on *connecting biology and daily life* also *bio-link* on this product and it has *reflection* questioning which could help students to reflect their knowledge into a better life. Furthermore, theories and concepts of material and activities in the product were acquired from several textbooks, empirical research obtained from various journals and news on the web site. Therefore, the feasibility of material content in these developed products could be used as learning materials on ecology and environment topics in biology course at grade X SMA in North Sumatera.

The systematic of writing on product rated as excellent because it presented coherence and systematically, the connection between sentences, paragraphs and concepts were very good. Besides, the learning materials were easier to understand since the language used was in accordance with the level of student’s development as well as the phrases which were clear and not ambiguous. Trianto

(2010) stated the language used in a learning materials should be clear, simple, and in accordance with students' abilities. This was consistent with student responses on preliminary field testing of product which stated that language used in learning materials was suitable to students education level and sentences structure were clear and simply to understand.

Learning materials were able to motivate learners to respond to the material. Yet it was encouraged students to think critically, and creatively, active, communicative, interactive and involved students to find out knowledge through activities. Supporting presentation included was very feasible. Title in product adapted to the material. This result is also line with Prastowo (2011) who stated the title should be in accordance with basic competency or subject matter that should be achieved by students.

According to design expert, the design and layout of learning materials considered as attractive and able to captive the interest for students because its design was looks nice and not overdone, involved updated issues about the local potential of North Sumatera that associated to learning materials that can attract the attention of students. This was consistent with the responses given by the students during individual/personal, small and big group testing in which students expressed that the design of product was very interesting. In this case, Trianto (2010) stated appearance is very important in learning materials, because it was captive the interest of students at the beginning before straightforward to the contents.

Learning materials also provide student identity column and another main component as well as table of contents, instructions for use product for teachers and students, introduction, supporting information, mini-lab activities, closure, reference, glossary and the identity of the author. This is also in line with Prastowo (2011) and Kemdikbud (2014) stated that structure of learning materials is generally load titles, basic competencies to be achieved, the time required to complete, equipment or materials required to complete the task, a brief description, the work step, tasks to be performed, references and glossary.

The feasibility of learning materials design included in the criteria of very feasible. This was obtained from front type, size, easy to read, understand and printing in an appropriate size. Kemdikbud (2014) stated that in design a printed learning material very important to consider the stimulant/attractiveness and readability. It is strongly supported by the results of expert validation on design component and typography of cover and content which qualifies as very feasible.

This learning materials was packed with a good packaging, cover paper using *art paper* 260gr and laminated so it looks shiny and waterproof, paper of learning materials use A5 size with 80 gr paper that are not transparent when used back and forth. This is also supported by the results of expert validation of the format design of product that are included in the criteria of "very good".

In addition, the pictures quality used learning material was clear, interest, clarify the description, and representative to the concept. Komalasari (2011) stated a figure or photo-graph can give a real capture which shows the real object, give meaningful learning and learning accurately than lectures technique and it can stimulate students' thinking skills. Thus, this learning material will give a positive influence on learning activities, especially improve student motivation. This is also supported by the results of expert design validation to illustration on learning materials contents which categorized as "very feasible" category.

Based on the considering assessment from 40 students and 3 biology teachers, the feasibility of learning material were very feasible. It had been caused a good packaging, original image and the update issues. This result was line with Brown (2001) stated using the good image in learning material to increase students attention and interesting. Additionally, the learning materials was compiled based on scientific approach. Students' activities organized by the scientific approach, independently construct their understanding on biological material. A real learning experience will make students easy to remember concepts as stated by Komalasari (2011) that involves the students will make them remember the concept of 90% and reduce the occurrence of misconceptions.

4. CONCLUSION

It is concluded that learning material on ecology and environment topics based on scientific literacy and local potential of North Sumatera is very good of feasible to used in teaching ecology and environmental topics in grade X SMA. Where the feasibility of the content based on *science as a body*

of knowledge has an average score 93.75% (very good), whereas *science as a way of investigation* 87.50% (very good), *science as a way of thinking* 95.31% (very good), *interaction of science, technology and society* 92.50% (very good). Feasibility of learning material's design that has been developed based on design expert is also very good with a percentage score of 91.43%. Result of biology teacher assessment on learning material on ecology and environment topics based on scientific literacy was developed with 93.75% (very good). Students' response to the preliminary field testing individual testing was 80.35% (good), small group trial 84.52% (very good) and large scale group 91.38% (very good).

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