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*Original Research Article*

# The Development of Microbiology Textbook to Enhance Scientific Literacy of Biology Students

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## ABSTRACT

This study aimed to find out: (1) the advisability level of scientific literacy-based microbiology textbook according to material experts; (2) the advisability level of scientific literacy-based microbiology textbook according to design experts; (3) the advisability level of scientific literacy-based microbiology textbook according to lecturers; (4) the advisability level of scientific literacy-based microbiology textbook according to college students; (5) The advisability level of scientific literacy-based microbiology textbook applied in the learning process of microbiology. This model comprised six main steps, namely; (1) preliminary studies implementation; (2) product planning; (3) material collection; (4) initial product development; (5) product validation and (6) revision and trial. Trial subjects consisted of the team of material experts, design experts, 2 lecturers of microbiology, 3 students of Biology Education Program at Universitas Negeri Medan (State University of Medan) on the individual trials, 9 students on the small group and 40 others on the limited field group trials as well. The data of the product quality in this study was collected by using questionairres and subsequently was analyzed by the quantitative and qualitative descriptive techniques. The results showed that: (1) the advisability level of scientific literacy-based microbiology textbook according to material experts was categorized to be "very good" (84.48%); (2) the advisability level of scientific literacy-based microbiology textbook according to design experts was categorized to be "very good" (86.44%); (3) the advisability level of scientific literacy-based microbiology textbook according to lecturers was categorized to be "very good" (89.13%); (4) the advisability level of scientific literacy-based microbiology textbook according to college students was categorized to be "very good" (81.75%). It could be concluded that the product of a scientific literacy-based microbiology textbook that has been developed was advisable and eligible to be applied as one of the additional sources for students in the course of microbiology. This study was just conducted until the limited field trial ended, then to find out its effectiveness of the textbook required other studies in the near future.

***Keywords:*** *Research and Development, Textbook, Scientific Literacy, Microbiology*

## 1. INTRODUCTION

In the world of education, a book is one of the most important parts to encourage people's success in education. Due to a book, the implementation of teaching and learning activities become more effective and efficient. Teachers or lecturers can perform their duties optimally with the aids of books. Similarly, student's knowledge is obtained to be more meaningful by combining science from books and also from teachers or lecturers.

However it is undoubtedly that there are a lot of textbooks that still contain some basic erroneous mistakes (Directorate of School Education, Ministry of Religion Affairs, 2007). The textbooks that are widely distributed furthermore are too

materialistic, shallow, and emotionally ineffective to students. Eventhough it is cognitively oriented, yet it can not intellectually mobilize the critical power and curiosity of its readers. A textbook will determine the success of students' education in the learning process at school, a book will also serve as a connector of the learning resources (Hedge, 2008). Therefore, either a good and quality textbook that becomes a source of knowledge that can support the students' success in learning, it can also guide and direct the teaching and learning process in the classroom towards a quality learning process as well, in addition practical books can be used inside and outside of the classroom (Oshborne & Dillon, 2010).

The quality of Indonesia's education particularly on the students' scientific literacy skills in the international level is still very low, it is proven by the score of the Program for International Student Assessment (PISA) in 2015 in which it is at the 66th out of 72 countries. According to Jäppinen (2005) *in* Stacey (2011) the success of Finnish students in achieving the best achievement of PISA is a factor that comes from teachers. According to Udompong *et al*. (2014) suggested that the ability to master the materials and elements of scientific literacy is extremely required by teacher candidates to be able to apply other qualified and effective methods in developing scientific literacy in the learning process.

Many factors have influenced the students' low scientific literacy in this country, such as the difference in the demands of learning was not in line with the demands of PISA (Diana, 2016). In the opinion of science education experts summarized by Surpless *et al*. (2014), suggested that the decreasing level of scientific literacy was due to the learning patterns at school (including in Higher Education), which still emphasized the mastery of material content rather than through scientific processes. In addition, these factors would cause students' scientific literacy to be decreased simultaneously, especially for the students of Undergraduate Biology Education Program, State University of Medan. Based on the need analysis, the students of Undergraduate Biology Education did not have any textbooks containing the components of scientific literacy and most of the them (73%) were still difficult to understand the materials of Microbiology. This was also in line with the results of Hasruddin and Mahmud's previous study (2017) suggested that 93.45% of students required a Microbiology textbook.

Diana, *et al*. (2015) explained that in order the students' scientific literacy skills to be increasing quite well, the teachers were encouraged to start introducing and learning materials using various learning strategies that aspire to scientific literacy, among others, to teach the materials through experiments that stimulate high-level thinking and contextual aspects. Learning evaluation tools were also expected to demand the aspects of scientific literacy, not just to emphasize the concept by itself. The results of the relevant study conducted by Coil, *et al*. (2010) on the process of teaching science, demonstrated that scientific literacy skills at the beginning of the lesson can improve understanding of the science content. Based on the results of need analysis, it could be concluded that the needs to develop instructional media in the form of textbooks and also needed by lecturers and students in the learning process to enhance their learning outcomes.

## 2. RESEARCH METHOD

### 2.1 Location and Subject of the Study

This study was conducted at Universitas Negeri Medan (State University of Medan), located in Jl. Willem Iskandar, Medan Estate to the seventh semester students. This study was conducted in March to August 2017. The trial subjects were microbiology lecturers and the seventh semester students of Biology Education Program. There were 2 material experts, 2 design experts and 2 lecturers were

appointed to validate the textbook that has been already developed.

### 2.2 Method and Design of the Study

This study was a Research and Development (R & D) model adopted from Borg dan Gall, modified with the needs of research. This model consisted of six main steps, namely; (1) preliminary studies implementation; (2) product planning; (3) material collection; (4) initial product development; (5) product validation and (6) revision and trial. The product trials were conducted through two phases, that was the expert trials and focus group trials as well. All the data was collected by the lists of questionairres.

### 2.3 Technique of Data Analysis

The obtained data in this study was a quantitative data about the condition of scientific literacy-based microbiology textbook that has been developed where it was processed from the assessment/validation by the team of material experts, design experts and the list of questionairres that has been distributed to the entire students. There were four kinds of questionairres used to obtain the information and data collection on the development of scientific literacy-based microbiology textbook, that were questionairre A, B, C and D. Questionairre A was given to the material experts, intended to give suggestions or comments to the scientific literacy-based microbiology textbook, questionairre B was given to the design experts, questionairre C was filled up by the microbiology lecturers and questionairre D was filled up by students to figure out students' responses on the product that has been previously developed in the form of assessment questionairre scores by calculating the percentage of every answers. The pattern of the data analysis could be seen as follows:

Score percentage of scientific literacy-based textbook= $\frac{amount\ \ of\ indicator\ \ per\ category}{amount\ \ of\ indicator\ \ total\ \ category} \times 100\%$

(Adisendjadja, 2008)

***Table 2.3. Criteria of indicator percentage of scientific literacy-based microbiology textbook components that has been already developed***

| No | Interval of Percentage | Score |
|---|---|---|
| 1. | 81% ≤ X ≤ 100% | Very Good |
| 2. | 61% ≤ X ≤ 80% | Good |
| 3. | 41% ≤ X ≤ 60% | Less Good |
| 4. | 21% ≤ X ≤ 40% | Not Good |

(Sudjiono, 2007)

The technique of data analysis used in this study was a descriptive analysis and not testing the hypotheses.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

#### 1. The Data of Validation Results Based on Material Experts

The validation to the product was intended to find out the opinions of material experts about the advisability of material contents, presentation, and all the components of scientific literacy as an additional input for the improvement of the developed textbook. Based on the assessment of the material advisability by two material experts, suggested that the microbiology textbook that has been developed was "very good' with the total score of 85.18% where the result of validation from the first material experts obtained the score of 85.82% that was very good. Subsequently, the result of validation from the second material experts obtained the score of 84.56% was very good.

**Table 1. The Result of Assessment from Material Experts**

| Assessment | Validator 1 | Validator 2 | Average | Criteria |
|---|---|---|---|---|
| Advisability of content | 88.65 | 83.33 | 85.99 | Very Good |
| Advisability of presentation | 87.47 | 83.38 | 85.42 | Very Good |
| Components of Scientific Literacy | 82.55 | 81.25 | 82.02 | Very Good |
| Total Average | | | 84.48 | Very Good |

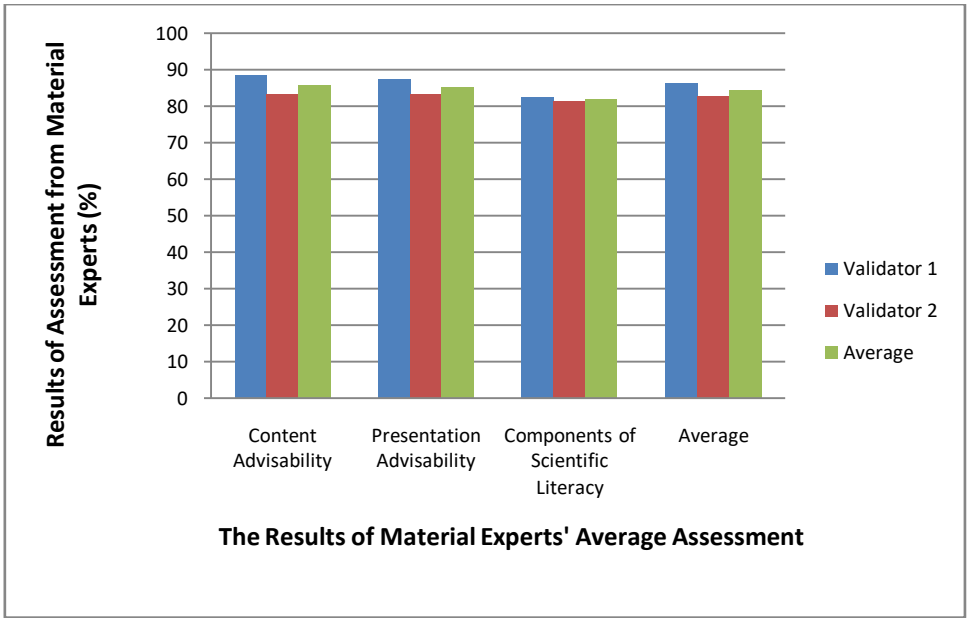


**Figure 1. Total Average of Assessment Results from Material Experts**

## 2. Data of Assessment Results from Design Experts

**Table 2. Results of Assessment from Design Experts**

| Assessment | Validator 1 | Validator 2 | Average | Criteria |
|---|---|---|---|---|
| Book Size | 87.5 | 100 | 93.75 | Very Good |
| Cover Layout | 81.25 | 87.5 | 84.37 | Very Good |
| Cover Typography | 87.5 | 93.75 | 90.62 | Very Good |
| Cover Illustration | 87.5 | 75 | 81.25 | Very Good |
| Layout | 82.14 | 89.28 | 85.71 | Very Good |
| Typography | 85 | 85 | 85 | Very Good |
| Illustration | 81.25 | 87.5 | 84.37 | Very Good |
| Total Average | | | 86.44 | Very Good |

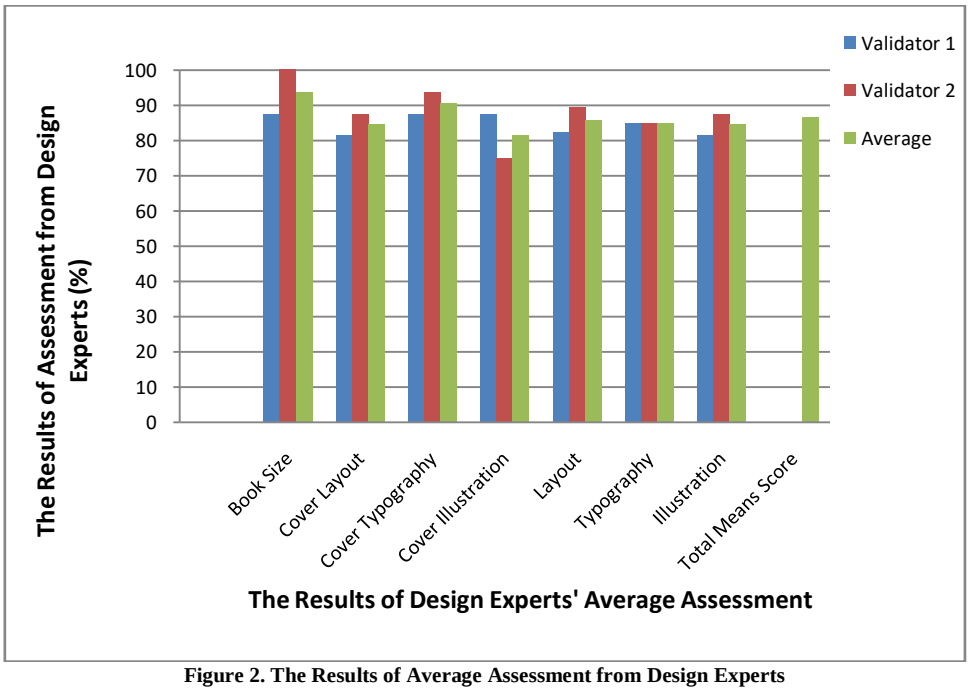


**Figure 2. The Results of Average Assessment from Design Experts**

## 3. The Data of Validation Results from Lecturers

The assessment of microbiology textbook from lecturers was conducted to obtain information that would be used to enhance the quality of developed textbook. The components that would be assessed by lecturers were science as the body of

knowledge, science as the way of investigating, science as the way of thinking, and the interaction of science, environment, technology and society. From the results of assessment from the lecturers could be concluded that the scientific literacy-based microbiology textbook was very good with the mean percentage score of 89.13%.

**4. The Results of Assessment for Scientific Literacy-Based Microbiology Textbook from the Students of Biology Education Program**

The assessment of microbiology textbook from the students was conducted to obtain information that would be used to enhance the quality of developed textbook. The components that were assessed by students were book designs, concept mastery, learning motivation, information acquisition, and all the components of scientific literacy.

### 4.1 The Results of Validation of Microbiology Textbook from the Individual Trials

**Table 3. An Analysis of Students' Perception from Individual Trials**

| Respondent | Total Score | Mean Score | Percentage | Criteria |
|---|---|---|---|---|
| 1 | 82 | 3.15 | 78.85 | Good |
| 2 | 90 | 3.46 | 86.54 | Very Good |
| 3 | 85 | 3.27 | 81.73 | Good |
| Average | 85.66 | 3.29 | 82.37 | Very Good |

The data of individual trial was conducted at State University of Medan to the seventh semester students of Undergraduate Biology Education. The trial was conducted to all three students with high, moderate, and low abilities, to identify the product shortages and students' initial perception on the developed product was very good with the mean percentage score of 82.37%.

### 4.2 The Results of Validation of Microbiology Textbook from Small Group Trials

**Table 4. An Analysis of Students' Perception from Small Group Trials**

| Respondent | Total Score | Mean Score | Percentage | Criteria |
|---|---|---|---|---|
| 1 | 90 | 3.46 | 86.54 | Very Good |
| 2 | 85 | 3.27 | 81.73 | Very Good |
| 3 | 92 | 3.54 | 88.46 | Very Good |
| 4 | 86 | 3.31 | 82.69 | Very Good |
| 5 | 86 | 3.31 | 82.69 | Very Good |
| 6 | 87 | 3.35 | 83.65 | Very Good |
| 7 | 87 | 3.35 | 83.65 | Very Good |
| 8 | 82 | 3.15 | 78.85 | Good |
| 9 | 85 | 3.27 | 81.73 | Very Good |
| Average | 86.66 | 3.33 | 83.33 | Very Good |

Small group trial was conducted to all nine students with high, moderate, and high abilities that was applied to the students of Undergraduate Biology Education. The data of small group could be concluded that the scientific literacy-based microbiology textbook was very good with the mean percentage score of 83.33%.

### 4.3 The Results of Validation of Microbiology Textbook from Limited Field Group

The limited field group trial was conducted at State University of Medan to the seventh semester students of Undergraduate Biology Education consisted of 40 students by grading five components of assessment with twenty six indicators of assessment. From the results of students' perception questionairres in the limited field group could be concluded that the scientific literacy-based microbiology textbook was very good with the mean percentage score of 81.75%.

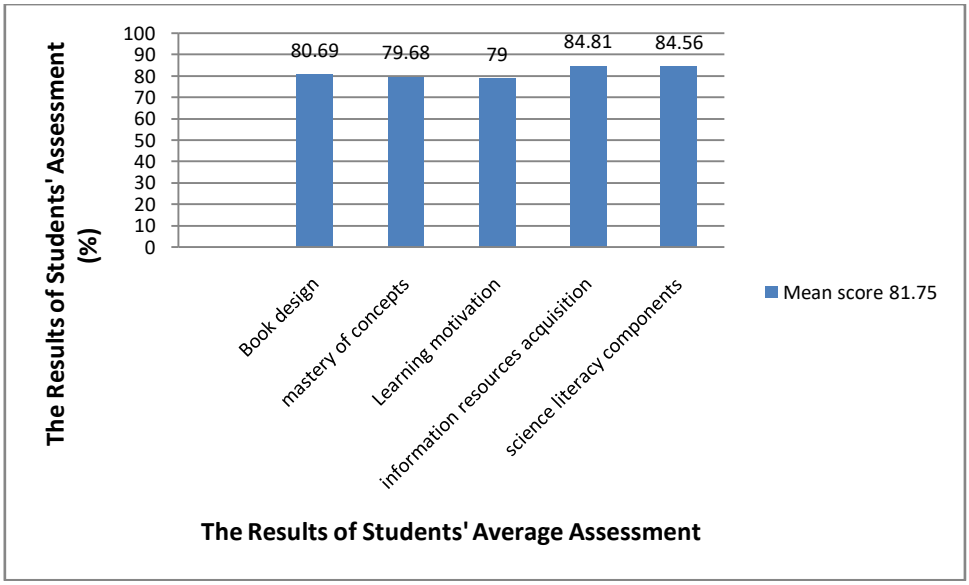


**Figure 3. The Average of Validation of Microbiology Textbook from the Limited Field Group Trials**

### 3.1 Discussion

This developed textbook was assessed from several aspects of material course, components of scientific literacy and book design. The advisability of the material content of this textbook was very good consisting of three aspects of the assessment that focus on the content advisability of material in accordance with competence standard and basic competence, the accuracy of the material, and learning support materials were very good with the mean percentage score of 89.06%. As Mudjiono (2000) pointed out, the focus of content validation is to measure the constructs/components of the conceptual accuracy including factual truth, principles of terms and definitions. The developed textbooks met these aspects. Presentation advisability consisted of three components of presentation techniques, presentation of learning and completeness of presentation, all these aspects were excellent with the mean percentage score of 84.72%.

The aspects of scientific literacy have been validated by experts and overall the book was very good with the mean percentage score of 81.77%, however the component of science as a way of investigating was good. These results were in line with the study of Chiapeta, *et al* (1991), suggested that "*A Quantum Analysis of Physic Textbooks for Scientific Literacy Themes"*, explained that scientific literacy-based textbooks should have four components of scientific literacy, namely science as the body of science, science as the way of thinking, science as the way of investigating and interaction of science, environment, technology and society as well.

The aspects pf instructional design were assessed by the learning design experts. Several components assessed that were the book size was very good with the mean percentage score of 93.75%, cover layout was very good with the mean percentage score of 84.37%, cover typography was very good with the mean percentage score of 90.62%, cover illustration was very good with the mean percentage score was 81.25%, layout was very good with the mean percentage score of 85.71%, typography was very good with the mean percentage score of 85%, and last but not least the illustration was very good with the mean percentage score of 84.37%. It could be suggested that the assessment of design assessment was very good with mean percentage score of 86.44%. Product presentation as well as design need to be considered to show the physical quality of interest, therefore can support the learning process (Mudjono, 2000). The results of design experts assessment on the aspects of product design from the developed textbook

was very good. The appraisal includes several aspects: book size, cover layout, cover typography, cover illustration, layout, typography, and the content illustration, each and every aspect was very good.

The results of assessment or validation from microbiology lecturers suggested that the components of scientific literacy were very good with the mean percentage score of 89.13%, by any additional improvements noted. This was in line with the results Gagne's previous study in 1979 showed that the best textbooks in the world will not fulfill their functions and roles if those books are not favored by teachers.

Textbook assessment from the students of Undergraduate Biology Education was either on individual, small groups and limited field group trials that have assessed 26 indicators clearly showed the evidence that the book was very good with the mean percentage score of 81.75%. These results were in line with the Directorate of Education (2004), suggested that material resources can help enrich other information and certain competencies.

## 4. CONCLUSION

Based on the results of the study, all the aspects of material contents such as advisability of presentation and feasibility of scientific literacy-based microbiology textbook that has been previously developed were very good, therefore it was acceptable and feasible to be used in the learning process. The result of instructional validation from design experts was very good and fascinating, hence the book was acceptable and effective to be applied in the learning process. Questionnaires from lecturers about the feasibility of scientific literacy-based textbook showed an excellent quality to be applied for course teaching. According to student responses on individual, small and field group trials suggested that scientific literacy-based microbiology textbooks was very good. Therefore, this textbook was suitable to be used as a textbook for students. It could be concluded that this developed textbook was excellent for students in their learning activities, in which this book has contained the four aspects of scientific literacy as well.

## REFERENCES


- Adisendjaja, Y.H. (2008). Analisis Buku Ajar Sains Berdasarkan Literasi Ilmiah sebagai dasar untuk memilih buku ajar sains (Biologi). Bandung: Pendidikan Biologi FMIPA UPI.
- Borg, W. R. & Gall, M.D. 1983. Educational Research: An Introduction, Fifth Edition. New York: Longman.
- Chiappetta, E.L, Filman, D.A, dan Sethna, G.H.(1991)."A Quantitative Analysis of High School Chemistry Textbooks for scientific Literacy Themes and Expository Learning Aids". Journal of Research in Science Teaching. 28(10):939-951.
- Coil, D., Wenderoth, MP., Cunningham, M. (2010). Teaching the Process of Science: Faculty Perceptions and an Effective Methodology. CBE-Life Sciences Education. 3(9): 524-532.
- Direktorat Pendidikan Madrasah Departemen Pendidikan Agama. (2007). Tor Lomba Penulisan Buku Pelajaran "Mipa". [Online]. Tersedia: www.depag.go.id.
- Direktorat Pendidikan Menengah Umum. 2004. Pedoman Umum Pengembangan Bahan Ajar. Jakarta: Departemen Pendidikan Nasional.
- Diana, S. (2016). Penerapan Strategi Peer Assisted Learning (PAL) untuk Meningkatkan Kemampuan Literasi Sains Mahasiswa Dalam Perkuliahan Fisiologi Tumbuhan. Laporan Penelitian Pendidikan Biologi Departemen Pendidikan Biologi UPI. Bandung.
- Diana, S., Rachmatulah, A., Rahmawati, E. (2015). Pengaruh Penerapan Strategi Peer Assisted Learning (PAL) Terhadap Kemampuan Literasi Sains Mahasiswa Dalam Perkuliahan Morfologi Tumbuhan. Jurnal Pengajaran MIPA, 21(1): 82-91, April 2016.
- Hasruddin, Mahmud (2017). Analisis Kebutuhan Pengembangan Buku Ajar Mikrobiologi Berbasis Literasi Sains, disampaikan pada Semirata Bidang Mipa BKS-PTN Barat.

- Hedge, R. 2008. Resource Books for Teachers Writing Second Edition. New York: Oxford University Press.
- Mudjiono. 2000. Proses Belajar Mengajar. Bandung: PT. Remaja Rosdakarya.
- Osborne, J. & Dillon, J. 2010. " How Science Work" dalam Osborne, J & Dillon, J. (Eds.), Good Practice in Science Teaching What Research has to Say. New York: Open University Press. Hlm. 20-45.
- Stacey, K. (2011). The PISA View of Mathematical Literacy in Indonesia. IndoMS. J.M.E, 2(2): 95-126.
- Sudjiono.(2007). Pengantar Evaluasi Pendidikan. Jakarta: PT. Raja Grafindo Persada.
- Surpless, B., Bushey, M., & Halx, M. (2014). Developing Scientific Literacy in Introductory Laboratory Courses: A Model for Course Design and Assessment. J. Geosci. Educ. 62, 244–263.
- Udompong, L., Traiwicitkhun, D. & Wongwanich, S. (2014). Causal model of research competency via scientific literacy of teacher and student. Procedia-Sosial and Behavioral Science, Vol. 116: 158-1586.


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