The development of innovative learning material integrated with environmental activities to improve student learning outcomes on electrolyte and nonelectrolyte solution

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Abstract. The aim of this research was to develop an innovative learning module electrolyte and non-electrolyte Solution and student environmental awareness. The population of the research is students grade X SMA Negeri 5 Medan, SMA Negeri 1 Percut Sei Tuan, SMA Swasta Santo Thomas 1 Medan, chemistry lecturer, chemistry teacher, and chemistry book. Trial for the module has done by giving questionnaire for standardization that assesses by the lecturer (3.72), by the teacher is (3.67), by students (3.52) all are categorized as a good module. Total average is (3.67). Total average Pretest of student achievement in High Group (HG) for an experimental class is 38.33±3.92, while in control class is 36.83±4.07. For Low Group (LG) total average of students achievement in experimental class is 25.67±6.16, while in control class is 24.83±5.29. And the average students achievement (posttest-I) in High Group (HG) using module (experiment class) 86.17±4.78 is higher than using book (control class) 82.33±2.99, while in Low Group (LG) using module 79.33±4.46 less than using book 72.17±3.42 have teaching and learning activities by using module as media (in experiment class)

1. Introduction
Chemistry is one of the very difficult subjects for students, so the teacher must be creative so that students easily accept the lessons made by the teacher. As long as this teacher only explains the lesson directly from the book without using appropriate support tools to explain certain topics in chemistry learning. In addition to the books used also do not support the application of these lessons in everyday life. So students need to learn chemistry very busy and monotonous. In the current era of development, the quality of education depends on teacher quality, curriculum development, facility development, and school management development [1].

It needs to apply chemical learning and apply it in discussions about the participation of students more interested in chemical research.

So that the teaching and learning process in the classroom can be done with the resources needed to study as support designed and used by the teacher, including one of them is teaching material [2]. Teaching materials arranged systematically are used to help teachers in the learning process in the chemicals delivered, for example, textbooks, modules, worksheets, interactive teaching materials. Referring to the curriculum used to achieve basic competency and competency standards [3].

Successfully in the chemistry textbook, what must be done is the development of modules to meet the quality and environmentally friendly chemical books. In addition, the modules developed must also have criteria that encourage chemical learning to be complete, systematic, sociable, interesting, interesting, motivating students to learn independent and equipped with applications in life provided and help students to think critically [4].
The textbook that will be developed will also help students who care about the environment and applications that apply materials in teaching and learning activities as teaching aids in the classroom [5]. At present, the learning process is student-centered rather than the teacher because the teacher only acts as a facilitator. Related to the development of teaching materials to be carried out will also be easy for students to do. The research and development methods carried out were adapted from ADDIE which consisted of 5 agreed stages, Analysis, Design, Development, implementation and evaluation [6].

In addition to being an innovative module, this module will also be equipped with a record of awareness of the surrounding environment caused by the experimental waste results in schools, so that this module is equipped with mini project question sheets relating to the effect of practicum waste on human health and environment [7–9]. The use of learning resources from the internet is also included in the book as a site address that directs students to explore more information related to module topics that they will learn because the media is very much needed and has a positive influence on the development of an increasingly advanced education world along with technology [8,10,11].

Teaching materials developed must be communicative so that the application of communication is carried out while using learning modules with students because basically there is a relationship between the language and cognitive development of the student [12]. Continuing education considers three main domains in its implementation, namely the environment, economy, and society of society [13,14]. Innovation in learning material in education should follow trend of industry revolution 4.0 in using of ICT is very important to help the student find more information about the topic and explore much information that can open their mindset knowledge in the world, so they will be able to compete with people in the education field [15–17].

2. Methods

2.1. Research Types

The types of this research are Research and Development (R &D). Where published are 4 types of bilingual chemical books used by public and private high schools in North Sumatra.

2.2. Research Instrument

The instrument of this study is multiple-choice. Evaluation of learning in the form of pretest and posttest. Before the instrument is used, the researchers first tested the instrument 40 questions of the students of class XII IPA to determine the validity, reliability, level of difficulty of the test.

2.3. Questionnaire

The questionnaire prepared to validate the innovative learning module. The module validated by lecturer and teacher by giving Checklist in the column.

2.4. Data Analysis

Data analysis techniques used researchers in answering the first problem formulation is by way of descriptive analysis. While the data analysis techniques used by researchers in the second answer to the problem formulation was solved descriptively quantitative by using the percentage obtained based on Calculation of Likert scale scores[18] are as follows:

| Criteria          | Score |
|-------------------|-------|
| Very good         | 4     |
| Good              | 3     |
| Not good          | 2     |
| Not so good       | 1     |

\[ K = \frac{F}{N \times 1 \times R} \times 100 \% \]

Where:
\[ K = \text{Percentage of eligibility criteria} \]
\[ F = \text{Total answer of respondents} \]
N = Highest Score in the review sheet  
I = Number of questions in the review sheet  
R = Number of respondents

3. Research Procedure

The research that will be done was combining with the development of learning material become innovated learning material for conducting the teaching method based on curriculum 2013. This study is a combination of descriptive and experimental for teaching activities in research. This study is a descriptive use of the traditional document as an object. The object of this study is chemistry book of that use bilingual language in X grade, where used as references book for Senior High School students in the location of research conducted at academic year, teacher of SHS that selected and also a lecturer in chemistry department which categorized as expert in chemistry to standardize the learning module. The experiment was conducted in this research are by using innovated learning module on the teaching of electrolyte and non-electrolyte solution for high school students. The procedure that has been conducted in the research is explained as follows. Analysis and evaluation of chemistry textbook or module in senior high school or Madrasah Aliyah that using bilingual teaching that discusses electrolyte and non-electrolyte solution.

The analysis and evaluation of the chemistry textbook has the aim to know the existence of the content of chemistry textbook or module with topic is electrolyte and non-electrolyte solution, the suitability of the extension, the suitability of the depth and design, and bad or good the chemistry textbook have appropriated with the basic competence based on curriculum 2013.

![Flow chart of the research procedure](image)

4. Result and discussion

Survey of chemistry textbook for grade X, odd semester have done in some book store and some school that gets predicate ex RSBI. Based on the survey in some book store, obtain that there are four books that mostly used by ex RSBI students those are, chemistry textbook which are published by Esis, Tiga Serangkai, Yudhistira, and Yrama Widya. Based on survey in three school, get the data, (1) SMAN 5 MEDAN used bilingual chemistry textbook that is published by Yrama Widya, (2) SMAN 1 Percut Sei Tuan used bilingual chemistry textbook that is published by Yudhisithira and (3) SMA ST THOMAST -1 MEDAN used chemistry textbook that published by Esis and their chemistry teacher also used textbook from other published that is Tiga Serangkai.

Based on the result of description analysis in the table 4.2 below shown and could be known that the comparison of percentage suitability for all target textbooks., it could be seen that good textbook that has analyzed was the textbook code B1(75%) then followed the textbook code B2(55%).
B3 (50%) and textbook code B4 (35%). It means that the textbook code B1 was better than textbook code B2 and it better than textbook B4 and B1 Electrolyte and nonelectrolyte Solution. Among the chemistry textbook, three of the book is appropriate as a good enough to use as a reference for student’s or teacher to use but one of them still need to be revised to make easy to understand and make it more interactive because categorized as a bad textbook.

**Table 2.** Percentage Average of Suitability of the Textbooks

| Criteria          | Textbook Code |
|-------------------|---------------|
|                   | B1 | B2 | B3 | B4 |
|                   | %   | %  | %  | %  |
| Content           | 3   | 3  | 75 | 75 | 2  | 50 | 2  | 50 |
| Extension         | 3   | 75 | 1  | 25 | 2  | 50 | 1  | 25 |
| Depth             | 3   | 75 | 2  | 50 | 2  | 50 | 2  | 50 |
| Design            | 3   | 75 | 2  | 50 | 2  | 50 | 2  | 50 |
| Language          | 3   | 75 | 3  | 75 | 2  | 50 | 1  | 25 |
| Average (%)       | 75  | 55 | 50 | 25 |

**Table 3.** Average and Standard Deviation of Student’s Achievement in Pretest

| School Name                  | Group | Pretest |
|------------------------------|-------|---------|
|                              |       | Experiment | Control |
| SMAN 5 Medan                 | HG    | 38.00±3.49 | 37.00 ± 4.21 |
|                              | LG    | 27.50 ±5.40 | 26.00 ±4.59 |
| Average                      |       | 32.75±4.45 | 31.50±4.40 |
| SMA Santo Thomas 1 Medan     | HG    | 40.00±5.77 | 36.00 ±3.16 |
|                              | LG    | 26.50 ±5.29 | 22.50 ±6.70 |
| Average                      |       | 33.25±5.53 | 29.25±4.93 |
| SMAN 1 Percut Sei Tuan       | HG    | 37.00 ±2.50 | 37.50±4.85 |
|                              | LG    | 23.00±7.80 | 26.00±4.59 |
| Average                      |       | 30.00±5.15 | 31.75±4.72 |
| Total Average                | HG    | 38.33±3.92 | 36.83±4.07 |
|                              | LG    | 25.67±6.16 | 24.83±5.29 |
After conducted the teaching treatment then to measure the student mastery level of chemistry topic of electrolyte and nonelectrolyte solution, the students were done the posttest. The result of posttest 1 has a relationship with the student’s achievement after conducted the teaching treatment. Using the innovative learning module based on curriculum 2013.

**Table 4. Student achievement in posttest**

| School Name               | Group | Posttest | Experiment | Control |
|---------------------------|-------|----------|------------|---------|
|                           | HG    |          | 86.50±4.11 | 83.00±3.49 |
|                           | LG    |          | 80.50±3.68 | 72.50±3.53 |
| SMAN 5 Medan              |       |          | 83.50±3.90 | 77.75±3.56 |
|                           | HG    |          | 85.50±5.90 | 81.00±2.10 |
| SMA Santo Thomas 1 Medan  | LG    |          | 80.50±3.68 | 71.50±4.70 |
|                           |       |          | 83.00±4.79 | 75.75±3.40 |
| SMAN 1 Percut Sei Tuan    | HG    |          | 85.50±5.50 | 83.00±3.40 |
|                           | LG    |          | 78.00±4.21 | 72.50±3.53 |
|                           |       |          | 81.75±4.86 | 77.75±3.47 |
| Total Average             | HG    |          | 86.17±4.78 | 82.33±2.99 |
|                           | LG    |          | 79.33±4.46 | 72.17±3.42 |

**Table 5. The performance of textbook judged by the lecturer, teacher, and students**

| The Standard | Description                                      | Point | Average |
|--------------|--------------------------------------------------|-------|---------|
| Content      | Description                                      | L     | T       | S       |         |
|              | the completeness of content                      | 3.67  | 3.67    | 3.2     | 3.51    |
|              | the accurate of content                         | 3.67  | 3.67    | 3.6     | 3.65    |
|              | presented the extension of material              | 3.33  | 3.33    | 3.53    | 3.39    |
|              | clear the derived of material                    | 4     | 3.65    | 3.47    | 3.38    |
|              | the material presented starting from the         | 3.67  | 3.67    | 3.6     | 3.65    |
|              | introduction of the concept to interaction with  |       |         |         |         |
|              | the suitable between design layout with material |       |         |         |         |
|              | application of concept with example              | 3.33  | 3.33    | 3.33    | 3.33    |
|              | the suitable between design layout with material | 3.67  | 3.67    | 3.53    | 3.62    |
| Design       | presentation of table with image                 | 3.33  | 3.33    | 3.6     | 3.42    |
|              | involving learners (interactive)                 | 3.33  | 3.33    | 3.93    | 3.53    |
|              | in accordance with development of learner        | 4     | 3.67    | 3.8     | 3.82    |
| Language     | Communicative                                    | 3.33  | 3.33    | 3.2     | 3.28    |
|              | straight forward (the accuracy of using the term| 3.67  | 3.67    | 3.53    | 3.62    |
|              | language and symbol )                            |       |         |         |         |
| Average      |                                                  | 3.72  | 3.67    | 3.52    | 3.67    |

Note: (L) means valued by chemistry lecturer, (T) means valued by a chemistry teacher, (S) valued by students that using chemistry
5. Conclusion

Standardization that was conducted by chemistry lecturer as an expert in the chemistry topic in-state university of Medan and also chemistry teacher in each school who active in teaching using bilingual in the teaching process. Both of lecturer give value is good in criteria of the module that is 3.72 and for the teacher 3.67. means that the sequence of chemical materials in the module in order the topic of electrolyte and nonelectrolyte solution is easy to learn and it meets the curriculum education unit can be arranged. The analysis of chemistry textbook for SMA/MA grade X for bilingual class especially on the topic of electrolyte and non electrolyte solution not fully meet the core competency, basic competency feasibility of content, design presentation, and feasibility of language analysis for chemistry textbook code B1 is 75%, code B2 is 55%, code B3 is 50% and code B4 is 35%. It caused by the book doesn’t complete all the materials in the textbook and also for design is not suitable with background and also for language ts not good enough.

The learning module is effective to improve student’s achievement in the high group. It can be seen from the average value of posttest by using innovated chemistry learning module than the textbook. HG in experiment 86.17±4.78 is higher than in control class 82.33±2.99 and for LG in experimental class 79.33±4.46 is higher than in control class that is 72.17±3.42. The innovated chemistry learning module will apply the teaching process from teacher center learning into student’s center learning. And teacher also must be used innovated chemistry textbook to increase student’s achievement.

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