

Development of Scientific Approach Based on Discovery Learning Module

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Abstract: Scientific Approach is a learning process, designed to make the students actively construct their own knowledge through stages of scientific method. The scientific approach in learning process can be done by using learning modules. One of the learning model is discovery based learning. Discovery learning is a learning model for the valuable things in learning through various activities, such as observation, experience, and reasoning. In fact, the students' activity to construct their own knowledge were not optimal. It's because the available learning modules were not in line with the scientific approach. The purpose of this study was to develop a scientific approach discovery based learning module on Acid Based, also on electrolyte and non-electrolyte solution. The developing process of this chemistry modules use the Plomp Model with three main stages. The stages are preliminary research, prototyping stage, and the assessment stage. The subject of this research was the 10th and 11th Grade of Senior High School students (SMAN 2 Padang). Validation were tested by the experts of Chemistry lecturers and teachers. Practicality of these modules had been tested through questionnaire. The effectiveness had been tested through experimental procedure by comparing student achievement between experiment and control groups. Based on the findings, it can be concluded that the developed scientific approach discovery based learning module significantly improve the students' learning in Acid-based and Electrolyte solution. The result of the data analysis indicated that the chemistry module was valid in content, construct, and presentation. Chemistry module also has a good practicality level and also accordance with the available time. This chemistry module was also effective, because it can help the students to understand the content of the learning material. That's proved by the result of learning student. Based on the result can conclude that chemistry module based on discovery learning and scientific approach in electrolyte and non-electrolyte solution and Acid Based for the 10th and 11th grade of senior high school students were valid, practice, and effective.

1. Introduction

Learning is a condition deliberately designed to create an atmosphere of learning that provides an opportunity for students to build their own knowledge. Currently the Curriculum is the 2013 curriculum, which has a basic view where students are subjects who have the ability to actively seek, process, construct, and use their knowledge. The implementation of the 2013 Curriculum in the learning process is using a scientific approach. Scientific approach is more highlight the dimensions of observation, reasoning, invention, validation, and explanation of a truth, which means students are required to be actively involved in the learning process.



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Chemistry is the study of the structure of matter, and the changes experienced by matter [1]. Chemistry is closely related to the scientific approach, because chemistry is inseparable from the scientific process that underlies the emergence of a scientific approach. This is in accordance with the opinion of The College Board which states that scientific shortcuts will support the direct involvement of students with chemical phenomena, which means that in studying chemistry is needed a scientific approach that includes the process of solving problems and critical thinking so that students really understand the chemical phenomena [2].

The process of applying the scientific approach in chemistry learning can be realized by using the discovery learning model. This model emphasizes the importance of understanding structures or important ideas to a discipline, through active student involvement in learning. Several international studies show that discovery learning is worthy of use in the chemistry learning process. Among others, by Ali GunayBalim and Olufunmilayo I [3].

The information summaries from questionnaires which was distributed to some high school students show that learning in school has started smoothly. Students learn by using the learning package and students' activity sheet (LKS) which contains learning materials that are verbal, so that in the learning process students tend to memorize. This resulted in a lack of student interest in the learning process, and it can be said that the direct involvement of students in the concept discovery has not been maximized. This is certainly a bit contrary to the demands of learning 2013, which essentially, requires students to be able to find their own concepts through the direction and guidance of the teacher.

Discovery as a learning model has certain syntax, namely (1) stimulation to stimulate students to explore relevant materials, (2) identify problems to find out what problems are faced through observation, questioning, etc., (3) data collection to interpret the data obtained, (4) verify data to verify data, and (5) summarize concepts, and principles on the material being studied. The learning steps of this discovery learning model require students to be actively involved in discovering the concepts of the material being studied. It is expected to help the students to improve their ability in understanding learning materials [4].

Results of research conducted by Mahmoud [5] show that the effect of learning using Discovery Learning Strategy can improve the metacognitive ability of children. The scientific approach in the learning process also consists of certain steps, namely (1) Observing, (2) Questioning, (3) Collecting information (Experimenting), (4) Associating, and (5) Communicating. The combination of these steps is actualized in the developed module. The modules as teaching materials have components such as Teachers and Students Manuals, Worksheets, Work answer-sheet, Test Sheets and Test answer- Sheet.

Based on the above descriptions, it has been carried out development research to produce a product in the form of chemical module based on discovery learning with scientific approach on the material of electrolyte and non-electrolyte solution, also for acid and base solution. The quality of the product of development is determined by three categories namely the validity, practicality, and effectiveness of the product.

2. Methods

This type of research is a developmental study using the Plomp model, ranging from the preliminary research phase, the prototyping stage development phase, and the assessment stage [6]. To obtain discovery learning based learning module with valid scientific approach done preliminary research. Based on the results of the analysis in the preliminary research phase, the learning module is designed based on discovery learning with scientific approach.

The preliminary research phase consists of needs analysis, curriculum analysis, student analysis and concept analysis. In the development or prototype phase the module based discovery learning was designed with scientific approach. In the prototyping stage, a formative evaluation was performed. The prototyping stage consists of prototype 1: self-evaluation; prototype 2: expert validation and one-to-one evaluation; prototype 3: namely small group evaluation, and prototype 4 is field test. Discovery

based learning module with scientific approach that has been designed followed by self-evaluation, and in revision validated by experts (expert judgement). Module validation was carried out by three chemistry lecturers and high school chemistry teachers. To find-out the practicality and effectiveness, the module performed at SMA N 2 Padang in X class MIA₅ and X MIA₆ for electrolyte and non-electrolyte solution modules and XI class MIA₁ and XI MIA₂ for Acid-Base modules. The research data was collected through validation sheet, teacher and student response questionnaire, interview sheet, and student test result in the experimental class and control class which then tested the hypothesis by using t test.

3. Results and Discussion

3.1. Initial Investigation Phase

Activities in the initial investigative phase begin with needs analysis, curriculum analysis, student analysis and concept analysis.

3.1.1. Needs Analysis. At this stage the collection of information about the problems contained in the learning chemistry. Needs analysis is done by interviewing high school teachers, and obtained information that the school has implemented the 2013 curriculum. The learning process is done as much as possible so that students can understand the concept through discussion, question and answer and lecture method by using textbooks from publishers and LKS. This resulted in the lack of involvement of students to find and build their own knowledge, so the tendency of students in learning is memorizing, which resulted in low understanding of the material learned. Student activity during the learning process has not been fully able to make students to be active and perform the learning steps it is recommended by the 2013 curriculum that is a scientific approach. This is because the commonly used teaching materials have not yet presented the learning steps required by the 2013 curriculum clearly.

3.1.2. Curriculum Analysis. The curriculum analysis is Core Competence and Basic Competence. This analysis aims to formulate the concepts of learning on the material of Electrolyte and Non Electrolyte Solutions and Acid Bases class X and XI SMA. After analysis followed by state of indicators, then proceed to determine the concepts to be studied. Based on the results of the analysis and then identified problems that are found to then need to develop teaching materials in the form of discovery learning-based module with a scientific approach.

3.1.3. Student Analysis. Student analysis is conducted to examine the character of students who become the target users of developed products. Students who were targeted in this research were X and XI grade high school students, who were on average aged 15-16 years. According to Piaget, at the age of more than 11 years, a person is at a formal stage of operation, where the student has the ability to think abstract, which is characterized by the ability to think deductively.

3.1.4. Concept Analysis. Concept analysis is conducted to identify, detail and systematically arrange the necessary concepts and be used as a reference in developing discovery learning module with scientific approach. Based on the indicators that have been formulated from KD, the next stage of concept analysis. The results of the analysis at this early stage of investigation is the basis for the authors to develop a discovery learning-based chemical module with a scientific approach. The modules developed are tailored to the demands of the curriculum and needs in the field.

3.2. Development Phase (Prototyping)

Phase 1 prototype is the stage of design or compilation of discovery based learning module with a scientific approach on the material of electrolyte and non electrolyte solution and acid base material. The preparation of this module is based on the results of the initial investigations that have been analyzed. There are three aspects that need to be considered in the design of the module is the

interface, content and support (language and legibility). The contents design, display, and language that has been designed in the module is followed by self evaluation before discussed with the experts. In addition, the researchers also checked the suitability of the content of learning material modules that must exist in accordance with KD, indicators, and learning objectives. After the self-evaluation is done then the improvement. The results of these improvements resulted in prototype 2.

The result of self evaluation which has been done is continued with module validity activity by expert on module which has been designed at prototype stage 1. The module validated by chemistry lecturer and chemistry teacher of SMA. Aspects observed in the validation are components of content, constructs, language and graphics. During the validation process there are several revisions suggested by the validator. This recommendation becomes the basis for further product design revisions once revised, the validator gives an assessment of the draft. The values given by the validator, processed using the moment kappa. The result of data analysis of validity can be seen in Table 1. Table 1 shows that the developed chemical module is valid, it is seen from the total kappa moment value is 0.89 and 0.907.

Table 1. Results of validity of the electrolyte non-electrolyte solution and acid-base solution.

No	Measurement aspect	electrolite	Level of validity	Acid & Base	Level of validity
1	Content component	0,89	Very high	0.87	Very high
2	Construct component	0,91	Very high	0.80	High
3	Language component	0,80	high	0.96	Very high
4	Graffiti component	0.93	Very high	1.00	Very high
Total Validity		0,89	Very high	0.907	Very high

The validity of the content component is to see the compatibility of chemical modules with the curriculum, the suitability of the learning steps with the discovery learning model, and the accuracy of the material content presented in the module. Validation data shows that from the aspect of content component is in very high and high category. This validation result shows that the chemistry module developed in accordance with the predefined curriculum, and the steps of learning activity on the module is very appropriate with the discovery learning step. In addition, the material presented in the module is appropriate and appropriate.

The aspects of the construct component assessed in the chemical module validation process are the module systematics, and the interrelationship between the concepts and the problems presented. Validation data for both electrolyte and non-solvent modules are in very high category, while for acid-base modules in the high category. Thus it can be said that the developed chemical module is very systematic, and has interrelationships between concepts with the problems presented. This is because the module developed consists of discovery learning steps that guide the students to find the concept of the material they are learning.

Validation of language components aims to reveal the suitability of the language used in the module with the Indonesian rule. Validation also reveals whether the language used is easy to understand and can develop students' thinking skills. The linguistic component of the developed chemical module is in the category of high validity level. This is because the language used in the discovery learning-based chemical module in accordance with the demands of Indonesian rules. In addition, the language used is a simple language that is easy to understand and can improve students' thinking ability.

Validation to see the clarity of the drawings and illustrations ,in addition, this validation also aims to see the variations in the use of the size and typeface, lay out, and colors used in the module. Based on the data of the research, the level of component validity is very high. Based on this, it can be said that the pictures or models contained in the chemical module are very clear.. The layout of each component in the module is good and the colors used make the module more interesting.

The design of the valid module then goes to the one-to-one evaluation stage. Individual evaluation aims to see the clarity of the instructions and sentences contained in the module, whether understood or not by students. Individual evaluations were conducted on three student on Xth and XIth grade from the cluster category, moderate and low group. In this activity the researchers met directly with the students and conducted informal interviews to request their response to the developed chemical module. The interview result shows that there are some sentences that are still unclear and questioned by the students. This is the subject of further product revisions. The revised product design is called prototype 3.

Activity after prototype 3 is done by doing small group evaluation. This small group evaluation aims to see the practical level of modules when used on a small scale and the suitability of time allocations with time available. This evaluation was conducted on each of 6 students of class X and XI who have high ability level, medium and low. The process of conducting this evaluation is done like a regular learning process, students are led to find the concept of the material by filling out the activity sheet on the module. During the learning process, students look enthusiastic about the use of developed chemical modules, but there are some dubious parts for some students. This is then revised to become clearer and easier to understand. The product after this revision is called prototype 4.

The activity that is done after the learning process is done is to fill the questionnaire of practicality. This small group study was conducted 5 times meeting for acid base material, while the material of electrolyte and non electrolyte solution as much as two meetings. The researcher explains how to learning by using the module. The second, third, and fourth meetings of the learning process were smoother than previous meetings because students already had modular learning experiences at the first meeting. The questionnaire results show that the developed chemical modules are practical and can be used in accordance with the time available. This can be proved by the kappa moment value (K) of student data questionnaire that is 0.88 for electrolyte and non electrolyte solution. As for the acid-base solution, $K = 0.86$. This value is in the range of very high level of practice, meaning that the module produced is very practical. With the completion of prototype 4 then it can be tested more widely through experiment.

The next stage of this research is the assessment phase. The activities undertaken in this evaluation were to test the use of modules developed in the actual learning process. Evaluation of large groups (field test) in this study is still a limited test conducted in SMA Negeri 2 Padang for the two modules. This evaluation uses experimental research principle with Randomized Group Control Post-test Design. The population in this study is the students of class X SMA Negeri 2 Padang registered in the academic year 2016/2017 consisting of six classes X .. After the analysis, then get two classes of samples, class X MIPA5 and X MIPA6, where X MIPA5 set as the experimental class and X MIPA6 as the control class. The experimental class for XI grade is the XI MIPA 1 and the control class is XI MIPA 2. Experimental class, applied learning using discovery learning-based chemical module, while in control class applied learning without using module. Overall, large group evaluation is useful to determine the level of effectiveness and effectiveness of developed modules. This can be explained as follows.

The level of practicality is determined from the results of the questionnaire of student responses and teacher responses to the application of module usage in learning. Data obtained, processed by using kappa cohen analysis. The result of questionnaire analysis of student response as a whole can be seen in Table 2.

Table 2. Practicality Results on Field Test

No	Measurement aspect	K-electrolyte	Practicality level	K-acid base	Practicality level
1	Attraction	0,91	Very high	0.84	Very high
2	The Use Process	0,88	Very high	0.83	Very high
3	Evaluation	0.85	Very high	0.81	Very high
Total practicality		0,88	Very high	0.826	Very High

Table 2 shows that the module developed has a very high degree of practicality of the three assessed components. The first component is the aspect of attraction with a kappa moment value of 0.91 and 0.84. The module attraction aspect relates to the overall appearance of the module, the colour composition, the font size and the clarity of the usage instructions. This is in accordance with Haryono's opinion if students can focus fully on learning, this is proven to improve learning outcomes [7].

The second component is the aspect of the use process with the kappa moment value of 0.88 and 0.83. Evaluation of the practicality of the aspect of the use process is in very high category, in means the module can help students to find the concept of learning materials independently. This is because the discovery learning steps are arranged systematically and can lead students in the discovery of the concept. This statement is in accordance with one of the advantages of discovery learning model that encourages active student involvement and training self-learning students [2].

The third component is the evaluation aspect with the K= 0.85 and 0.81. The result of the analysis of practicality shows that the evaluation aspect is in the category of high level of practicability. Based on this it can be concluded that discovery learning-based chemistry module can help students improve understanding of learning materials well through the exercises contained in the module.

The overall kappa moment value is 0.88 and 0.826 is in very high category. Chemical modules developed have high practicality, because the module is a unit of learning activities are arranged in the form of a particular package unit. The developed chemical module can be said to be a complete package that contains learning activities to find concepts, and worksheets to establish understanding of student concepts.

The effectiveness of modules developed is seen from two indicators, namely student learning outcomes and student activities. Determination of the effectiveness of chemical modules through student learning outcomes is by comparing the students' learning outcomes of the experimental class and the control class. In the experimental class applied the learning by using discovery learning-based chemical module, while the control class applied as usual learning without using module. The results of the learning process seen from the results of student learning in the experimental class and control classes are given test results of learning (final test) in the form of written tests in the form of multiple choices. To see whether the use of the module can affect student learning outcomes, hypothesis testing is performed.

The predefined hypothesis, i. e learning outcomes of students who are learning by using discovery learning-based chemical module significantly higher than the learning outcomes of students who learn without using the module.

Table 3. Hypothesis Test Results for electrolyte and non electrolyte solution module

Class	N	$\bar{x}$	S	S^2	t_{hitung}	t_{tabel}
Experiment	35	85.83	8.08	65.23	4.15	
Control	35	77.49	8.66	75.05		1.67

Table 4. Hypothesis Test Results for acid-base solutions modules

Kelas	N	$\bar{x}$	S	S^2	t_{cal}	t_{tab}
Experiment	36	85.11	10.3696	107.5032	3.83	
Control	36	76.11	10.8385	117.4731		1.67

The test result for the two modules shows the $t_{calc} > t_{table}$, meaning the hypothesis in this study is accepted, where there is a significant difference between the learning result of the students of the experimental class and the control class. Based on this it can be concluded that students' learning outcomes by using chemical modules are significantly higher than student learning outcomes without

using modules. This result was in accordance with Balim's research results ^[8] which states that Discovery Learning can improve academic achievement, inquire scores and student retention scores.

4. Conclusion

From the process and the results of this study, it can be concluded that discovery learning-based chemical module with scientific approach on the material of electrolyte and non-electrolyte solution for X Grade and on Acid base Solution for XI grade can be categorized as valid, practical and effective. This chemical module can be used in a learning process without significant obstacles.

Acknowledgements

The authors thank's to LP2M Universitas Negeri Padang, Chemistry teacher and students of tenth and eleventh grade of SMAN 2 Padang, as well as those who have assisted in the completion of the research and preparation on this article.

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