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Science Environmental Technology and Society-based Module Development on Petroleum Chemistry to Enhance Student Learning Achievement

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***Abstract* – This study aims to develop and comprehend the feasibility of STES-based module on petroleum chemistry, including student achievement and their responses to the learning activity. It used one group pretest and posttest design accompanied with research and development (R & D) method which is arranged by model of analysis, design, development, implementation, and evaluation (ADDIE). The sample was 69 students of class XI IPA 2 in MAN Banda Aceh elected by purposive sampling technique. Data were collected using module feasibility assessment, pretest, posttest and questionnaire. Generally, the assessment indicated the developing module got a very good category. The result was supported by N-gain value of 55.51 with moderate category, and $t_{count} > t_{table}$ which is 12.24 > 1.67. The statistical data presented that there is a significant enhancement on student learning achievement both before and after SETS module was applied. Students gave answer "Yes" with percentage of 89.92. According to the results, it can concluded that the developing SETS-based module is feasible to be learning resource and it proved that the module is successful to improve student achievement supporting with their positive responses to the module in learning petroleum chemistry.**

***Keywords* – Module Development, Science Environmental Technology and Society, Student Learning Achievement.**

I. INTRODUCTION

Curriculum 2013 creates students with quality to be able and proactive in responding for whole challenges in dynamic period. It is in accordance with Minister of Education and Culture number 69 of 2013 that the objectives of the curriculum include preparing students to have abilities which are faithful, creative, and innovative, and able to achieve optimal learning outcomes (Kemendikbud, 2013).The process of learning is related to the achievement of learning outcomes, lack of optimal or low learning outcomes is closely related to the ability of students to absorb and understand the concept of the material being taught (Cavus & Alhih, 2014; Babadogan et al., 2010).

One way for helping students in which comprehend the conceptual learning, achieve the optimal results is using module as learning resource (Novaliyosi et al., 2018). Module is one of learning resources designed completely and systematically, and provided by sufficient topics and materials which coach students to mastery the specific learning objectives (Kildan et al., 2015; Lee & Osman, 2012). The usual modules that are frequently used in several schools including in chemistry learning, but they were not integrated with complementary sciences (Prayitno et al., 2016). Thus, the usual modules were not interesting for students because they do not have a specific direction during learning process, and then caused the low of student outcomes (Alias & Siraj, 2012; Lee & Osman, 2012).

The mentioned problems were reflected to the result of national examination (UN). During last five years, data of UN shows the reduction on chemistry either value or category. From academic year of 2013/2014 until 2017/2018, the decline was represented by the percentages of 50.35; 72.41; 44.45; 41.52 and 40.78, and had increased for 2014/2015. So, it is the problems that should be finished. When we look for special topic of petroleum chemistry, MAN 1 Banda Aceh has 45.45% for academic year of 2017/2018, whereas MAN 3 Banda Aceh only got 33.33% for the same topic. Two results showed that the achievement of student in UN on petroleum chemistry is low (Puspendik, 2017).

During observation in MAN 3 Banda Aceh, the learning is still adapted to teacher center, so the students were look like not interest to the teaching learning process. In addition, they felt bored because they could not apply what they have been learned to the real environment. Besides that, according to interviews with teacher also revealed that the teaching materials used were less linked between the concepts of chemistry (science) and environment, so students did not yet know that the chemical material studied as in petroleum material had a meaning that was closely related to their life.The observation of these problems was also obtained in accordance with Rahmah et al. (2017) that students' responses to the material were not interesting, monotonous, and did not contain learning values with life around them, so this condition caused students to feel bored which ultimately had an impact on learning outcomes.

The solution for this problem is by developing chemistry learning modules that are integrated with various sciences, including science, environment, technology, and society (SETS) (Wulandari et al., 2015). The SETS isa learning approach that links science, environment, technology and society as a whole with a variety of real problems in daily life (Aysan, 2015).SETS-based modules play a positive role in the relationship between learning and the real world, which encourages students to be more active and creative in learning (Vaino et al., 2015).SETS-based modules can also provide understanding to students that the interrelationship between knowledge at this time involves the four elements of SETS and the interrelationships that affect each other (Samsudin et al., 2012; Trnova & Trna, 2015).This SETS-based module development was adopted from the research of Fitriyani (2016) who developed a SETS-based chemical enrichment book. However, the development research developed in the form of enrichment books still needs to be innovated into a SETS-based module for chemistry.Therefore, it is necessary to develop a SETS-based module on petroleum chemistry, because the material is closely related to life. One proof of its relevance is the sustainability of society with technology after oil has been processed can be used as fuel.It is important to develop module so that the learning process runs well, encourages students to be involved in active learning to achieve learning goals, and triggers an increase in the value of UN on chemistry and student learning outcomes (Watson et al., 2016; Arlitasari et al., 2013).

There are several results on the development and use of SETS-based modules that have been carried out showed a positive influence. The research conducted by Nugraheni et al. (2013) exhibited that SETS-based learning 90% of students obtained values above the minimum completeness criteria (KKM) in petroleum chemistry.In addition, activities and student responses to SETS-based modules were also high, which were 90 and 92.44%, respectively (Tamimiya et al., 2017). Research conducted by Wasiso and Hartono (2013) shows that SETS-based learning can improve students' ability to solve problems.Other results obtained from Oktaviani et al. (2017) provide results that SETS-based learning has a positive impact on student learning participation. In addition, the results of the study by Sari et al. (2016) students are also more motivated so that they are expected to improve student learning

outcomes in learning activities developed through science, technology, environment and society, so that they can link chemical materials with their environment.

Based on the mentioned problems above, so it is a need to conduct a study concerned to SETS-based module. It improved student achievement during learning process developed through science, environment, technology and society, therefore it is possible to create correlation between various chemistry topics and life environment.

II. Research Method

Research and development (R & D) method with model ADDIE is used to develop SETS-based module on petroleum chemistry learning. It was conducted using one group pretest and posttest as research design. Population was students of class XI MAN Banda Aceh, odd semester for academic year of 2018/2019. Sample was elected by purposive sampling technique according to the score percentage of UN for chemistry concerned on petroleum chemistry indicator, and the sample was students of class XI in MAN 1 and MAN 3 Banda Aceh. The determination for classes was done random sampling, thus it selected 38 students of class XI IPA 2 in MAN 1 Banda Aceh and 31 students of class XI IPA 2 in MAN 3 Banda Aceh.

Data were collected using assessment sheet for module feasibility, pretest and posttest, and questionnaires. Then, the data were analyzed using the percentage values for module and questionnaire, N-gain and t-test for learning achievement.

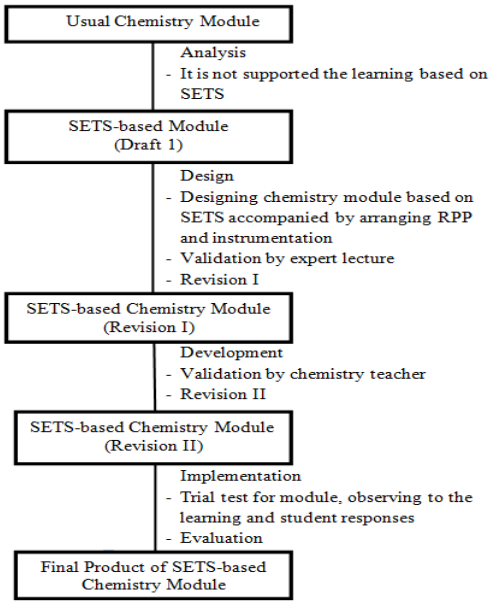

Fig. 1. Flow chart for research on SETS-based module development.

III. Findings and Discussion

A. *SETS-based Module Development*

The development for SETS-based module used ADDIE model and the results as the follows:

1) *Analysis*

The analysis was conducted with field studies to find information about learning in schools so far. At this stage an analysis of the availability of learning resources in schools is based on preliminary studies, namely in MAN 1 and MAN 3 Banda Aceh.Needs analysis is done by observing and interviewing teachers and students, and the

results of field study analysis, namely (1) in the learning process teachers do not often use teaching materials in the form of modules and often explain through lecture methods not with certain teaching materials except through textbooks, (2) the availability of teaching materials in learning only uses textbooks contained in the library and teaching materials in the form of integrated modules can increase students' interest and creativity still lacking.

The results of the data obtained through observations and interviews are that the teacher needs teaching materials, namely modules that can increase student interest and learning achievement.So far, the learning of petroleum chemistry has not used modules and the material has not been linked to science, environment, technology and society. The results of these observations will then be applied by developing SETS-based modules that can be used as one of the integrated learning. Based on literature review, it also found that the SETS approach can be associated with learning which is implemented as one way to attract teaching and learning processes and enhance students' creativity (Sugiarto & Djukri, 2015; Bettencourt et al., 2011).

2) *Design*

The next draft is to develop a SETS-based module, this module is designed to aim to improve student learning outcomes, starting from covers, preface, table of contents, module concept maps, objectives, learning material, student worksheets, questions and their solutions.Modules are designed using Microsoft Word applications, A4 paper size, varied fonts and font size 12.Designed modules with varied colors and equipped with images that match the learning material to attract students' attention in learning. In addition, the modules that have been designed will be validated by experts, namely expert lecturers and chemistry instructors to be asked for suggestions so that the modules will improve.

3) *Development*

At this stage, the first validator is conducted by expert validators on the SETS-based modules that have been designed. Expert validator consists of three experts, module quality assessment based on the contents, appearance, completeness, readability, and others.During the validation process, there are parts that must be revised. The results of the SETS-based module validation by the expert validator as a whole can be seen in Figure 2.

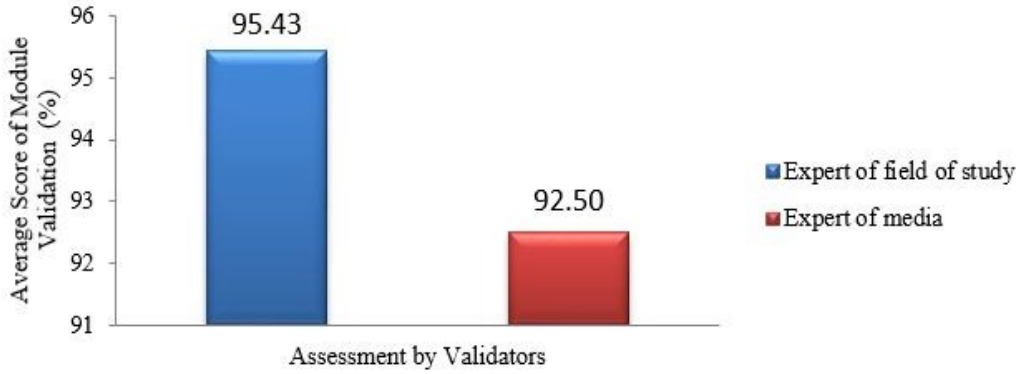

Fig. 2. The result for module validation conducted by experts.

As shown in Figure 2, the percentage of the average material quality is 95.43 with excellent categories according to the module's assessment criteria. Then the material contained in the module is feasible to be tested and can be applied in the learning process.Furthermore, the results of module appraisal by two media experts showed that the percentage of the average rating was 92.50 with a very good category, so that the aspects in it could be used as a form of student interest in SETS-based modules.

The second stage, after being validated by expert validators and has been revised. Then the second validation was carried out by four chemistry teachers in two schools namely MAN 1 and 2 Banda Aceh. The developed module is given to the teacher for further review or validation.

The results of the validation by the teacher show overall that the SETS-based modules that have been developed are very good, which is 90.55% and can be tested on improving student learning achievement on petroleum chemistry. This module applies five SETS elements in a material and is a solution for students to understand learning material and help students improve their creativity (Amrullah et al., 2017; Zhang et al., 2017). In 2015, Maryono also found that there was an increase in student grades and a spirit of learning by using these modules, thus giving a good influence on student interest and understanding of the material being studied. This was also proven in the research of Shofiyah et al. (2014) that the modules in the appropriate category are very good criteria.

4) *Implementation*

Modules that have been validated by experts are then implemented for students. The implementation of this study was carried out in a limited manner which was piloted in two schools namely MAN 1 and 3 Banda Aceh.Implementation in both schools was conducted in October 2018, each of which consisted of two meetings. Implementation in MAN 1 Banda Aceh was carried out to 38 students of class XI IPA 2 (29 women, 9 men), while MAN 3 Banda Aceh implementation was carried out to31 students of class XI IPA 2 (18 women, 13 men).

The implementation is carried out to see the extent to which learning outcomes are increasing and students' responses regarding SETS-based modules have been developed.Before being tested, the module was pretested first, at the end of the learning the students answered the posttest questions, while the questions that were designed in advance were tested to see the quality of the questions developed. Based on these results, there were 20 accepted questions from the developing 40 questions.

During implementation, there are several activities such as: (1) distribution of SETS-based modules to groups that have been distributed, (2) students discuss material and fill in their respective LKPD contained in the module, (3) students present the results of the discussion and frequently asked questions group.Learning by using SETS-based modules is expected to get student knowledge and can understand the material more deeply that is linked in the scope of science, environment, technology, and society. The following is a picture of student activity.

Fig. 3. Student activities during learning usingSETS-based modules.

5) *Evaluation*

The evaluation phase is the final part of the ADDIE development model. This stage is carried out to evaluate the entire series of teaching and learning processes that have been carried out by giving values to SETS-based modules. Data obtained from the results such as the validity analysis of modules from expert experts, teachers and

also evaluations carried out by analyzing student responses and seeing learning outcomes using SETS-based modules.To find out the feasibility of the module used data from validation results, and student response questionnaire data aims to determine the response to the module that has been developed, while the data pretest and posttest to obtain student learning achievement.

Giving a response to the quality of the SETS-based module is also important in the success or failure in applying the module during learning. Student responses after the learning process there are those that respond positively and negatively.Students respond and provide a positive response to the use of SETS-based modules that learning is interesting and applicable. Another thing, students responding to negative responses assume that the module being tested must be revised quality. Details of student responses are shown in Figure 4.

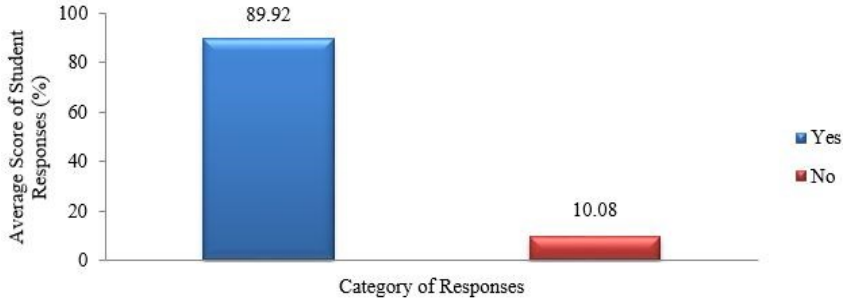

Fig. 4. Questionnaire representation for student responses.

Based on Figure 4 the percentage of the average response of students who choose the Yes option is 89.92 while those who choose the option No is 10.08 so it is included in the excellent category. This suggests that more students like SETS-based modules in learning than previous study.This is also supported by Martini et al. (2018) that overall student responses to SETS-based modules get a score of 85.09% which indicates that the module developed provides positive responses to students.Furthermore, it can be seen also in the first and seventh questions obtained values of 89.85 and 95.65% with positive answer choices that the SETS-based module is able to provide an increase in the spirit of learning and students' understanding of the material being taught. Then, it is in accordance with the research of Syahroni et al. (2016) that the module can improve student understanding so that it has a positive impact on learning outcomes. Furthermore, previous research provided by Rusilowati et al. (2015) also told that students also like learning in the SETS approach so they are motivated in learning it.It was also proven Riastuti in 2015, the student activity in applying it responded positively so that students were enthusiastic in learning.

Overall, it can be seen that students' responses to SETS-based modules with positive criteria are higher than negative. Therefore, it can be concluded that the SETS-based module that has been tested gets a positive response and students are interested in using the module in the learning process especially in petroleum chemistry.

B. *Description for Enhancement of Student Learning Achievement*

Assessment for the development of SETS-based module can also be seen from the learning achievement by doing a pretest before the first and posttest meeting learning begins after the final meeting has been conducted, which previously tested the instrument.To obtain answers from the application of SETS-based modules, it is necessary to analyze the research data. Data on student learning achievement of petroleum chemistry in this study were seen from the values of pretest, posttest and N-gain, namely low, medium and high. The enhancement on student learning achievement can be seen in Figure 5.

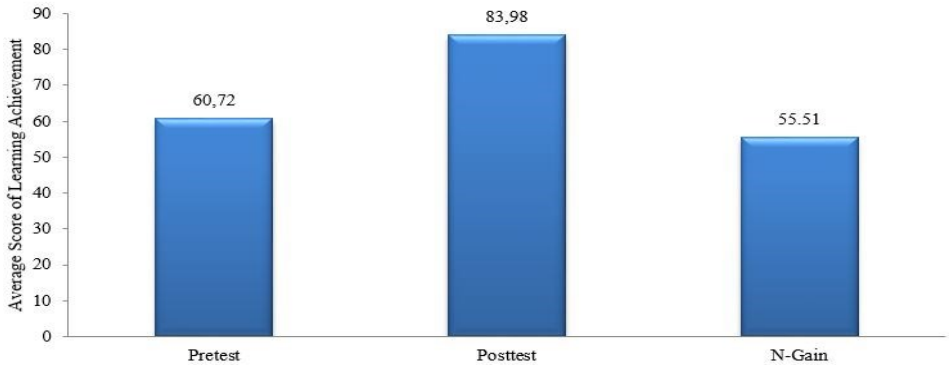

Fig. 5. Average values of pretest, posttest and N-gainconducted in MAN Banda Aceh.

Based on Figure 5, the learning achievement is generally increased. The results of the pretest values were obtained at an average of 60.72, while the posttest increased by 83.98 with the average N-Gain acquisition of students at 55.51.

The results of pretest and posttest data after normal distribution, the next step is to conduct a statistical test to determine the increase in student learning outcomes before and after using the SETS-based module using the correlated t-test, because the data are normally distributed (Sugiyono, 2014).

Based on the provisions of hypothesis testing if $t_{count} > t_{table}$ then H_o is rejected and H_a is accepted, so there is a significant increase in student learning outcomes before and after learning. Conversely, if $t_{count} < t_{table}$ then H_o is accepted and H_a is rejected, so there is no increase in student learning outcomes.The test results on the t-test found that the t-value at a significant level ($\alpha = 0.05$) and the degree of freedom symbolized as df = 69-1 = 68 was 1.67 (seen in the t-test table). Therefore, the results obtained by $t_{count} > t_{table}$ are $12.24 > 1.67$, then the hypothesis H_o is rejected that there is a significant increase in student learning outcomes before and after the SETS-based module is applied.

Based on the results, the learning activities used SETS-based modules have different influences on students' enthusiasm in learning. The first assessment was obtained from the initial meeting before learning by distributing 20 pretest questions and then conducting group discussions using the SETS-based module.Activities in discussion groups are chosen on the basis of combining 4-5 students randomly, by carrying out activities together. At the beginning of learning activities when applying modules, students do not yet know the shape of the module.The teacher explains each step for using the module. Then after the module is known by students then they read the instructions from the module and start discussing. The presentation of the contents of the LKPD contained in the module in the discussion activities starting from explaining the process and the results of the separation of petroleum in the needs of the community, so that students find concepts related to the processing process to gain an understanding of the material. In the trial, the role of teacher as a companion and guiding students, the teacher does not explain the material as thoroughly as previous learning. Thus, with the module it is expected that students can find and understand the concept itself. The answers to the results of the discussion of the activities of the student work are explained again by the teacher at the end of the lesson.

When the learning process used SETS-based modules, students were interested and motivated in completing worksheets contained in the module.This situation can be seen when students have difficulty in completing tasks, students ask directly to the teacher in order to complete the task in the form of LKPD in the module. Furthermore, after obtaining the results of the discussion students are required to present the results in front of the class.Students

from other groups are given the opportunity to respond to the results presented. At the end of learning, the teacher persuades students to create conclusion based on learning, then provides reinforcement to the conclusions on what have been learned.Continuing until the second meeting, the presentation of the contents of the LKPD in the module in the second activity began from identifying the images contained in the LKPD related to the quality of fuel oil fraction, as well as in the previous learning activities students were asked to be more active in discussions.It was proven in Magbana (2018) that LKPD can also improve students' conceptual abilities and be more focused in learning. Then at the end of this meeting, it was given 20 posttest questions by answering questions individually and independently, this was done to see the abilities and results of student learning after the learning took place and fill out student questionnaires on the SETS-based module.

The concept of the material presented in the module can be applied directly in daily life such as facilitating students in learning so that learning can be more meaningful than learning that prioritizes the concept.These results were obtained from students after using the SETS-based module, where the results obtained from the pretest and posttest mean values were 60.72 and 83.98. Based on the different test pretest and posttest, it also obtained from the average N-Gain value of 55.51 with the medium category.It shows a good influence on learning with modules designed by linking the five SETS elements. The results of hypothesis testing data, it can be concluded that there is an increase in student learning outcomes before and after the SETS-based module is applied.Based on the results, it is known that learning using the SETS-based module provides positive results, namely an increase in learning achievement, so that this SETS-based module can be declared appropriate and effective to use in learning to improve student learning achievement.

This was also evidenced in Atmojo et al. (2018) that effectiveness with SETS learning shows positive results that are able to support students more easily in understanding the material being taught. Learning using the SETS-based module is feasible and very well used for educators and students in the learning process that are expected to be able to give a high influence on knowledge (Setiawati & Senam, 2015; Mubarok et al., 2015).The SETS approach also increases students' ability to think about aspects of scientific literacy and make students more active. The use of SETS-based modules can increase student learning interest so that they are interested and comfortable during learning (Widiyanti et al., 2015). It was also proven in the study of Susilogati et al. (2014) that the module is feasible to be applied to students as a guideline in learning.In 2018, Shang et al. found that teaching materials can actively encourage students to participate in class activities. The results were also obtained from Rahma (2012) that the SETS approach associated with the module gave a positive response to the implementation of the module in learning and could improve learning outcomes.

C. *Student Responses to the SETS-based Module*

Learning using the SETS-based module also achieved a very good response, as seen in the questionnaire assessment. The results of the average student response were 89.92% responding positively, and 10.08% negative from the total 69 students.The questionnaire description indicators are listed to see participation in learning, mutual understanding, interaction and student interest in SETS-based modules. The questionnaire description indicator also proves effective or not the approach associated in the module and is more active and vibrant or not in learning. Based on the results obtained from the student response questionnaire, it shows that the number of students giving positive responses to learning using SETS-based modules is proven based on percentage criteria which are in excellent categories.

Also proven through the research conducted by Setiawan et al. (2017) learning with modules can provide a positive response of 87.5% in the excellent category. The results of Sulistyorini (2016) study show that SETS-based learning of students tends to actively explore new information and more focused learning on students.According to Safitri et al. (2015) the results in his research of SETS-based modules can enhance student activity and effectively the learning outcomes are achieved well. Furthermore, in the research of Syahroni et al. (2016) proved by the results that the response of students and teachers to positive modules in the category is very good or feasible to apply so that it can be concluded that students are easier to learn the material taught and can learn independently in developing science.So, SETS-based learning modules are very good as a solution to overcome learning problems and also be able to teach students to have capabilities that are integrated in science, environment, technology and society. The SETS approach can encourage students to learn science as a whole, use science into technological applications, and study its impact on the environment and society (Macleod, 2013; Usmeldi et al., 2017).

IV. Conclusion

According to the findings, it can conclude that the quality of SETS-based module was represented by average scores of validation test and students responses which are 93.96 and 89.92%, respectively. Besides that, using the developing module also enhance the students achievement on petroleum chemistry learning.

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