

**Development of STEM-Based Module With Integrated Chemo-Entrepreneurship to Enhance Students' Conservation Characters and Entrepreneurship****Tria Ruliyanti<sup>1</sup>✉, Sudarmin<sup>2</sup>, Nanik Wijayati<sup>3</sup>**<sup>1</sup>. SMK Askhabul Kahfi, Semarang, Indonesia<sup>2,3</sup>. Department of Chemistry, FMIPA, Universitas Negeri Semarang, Indonesia**Article Info***History Articles:*

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**Keywords:**STEM, Chemo-  
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This research was done due to the limited learning resources that can be used by students independently. The purpose of this research was to develop a module based on Science, Technology, Engineering and Mathematics integrated with Chemo-entrepreneurship to develop students' conservation character and entrepreneurship. This study used a research and development design (R&D). The data were obtained and analyzed by using descriptive percentage. The results of the module feasibility test done by the experts obtained an average of 84.8% with very feasible category for use. The students and teachers responses from Askhabul Kahfi and Lemuria Vocational High Schools showed 94% and 91% results with very good category. Based on the analysis of the cognitive learning outcomes of Askhabul Kafi and Lemuria students, it showed that students achieve an average completeness that exceeds 75, achieve classical completeness of more than 75% and experience an increase from the pretest and posttest scores. In addition, based on the observation of conservation character has increased with N-Gain 0.64 in the medium category and 0.73 with the high category. While the distribution of student entrepreneurial interest questionnaires has increased with an N-Gain of 0.68 in the moderate category and 0.79 with the high category. So these results suggest that the developed modules are effective to enhance the students' conservation character and entrepreneurial interest.

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## INTRODUCTION

Waste is trash production containing materials that can cause pollution and can damage health. Trash is not something that must be thrown away unnecessarily, because with proper processing and utilization, it will become a more useful item than before. Trash that is disposed directly without any treatment can cause pollution. Generally, some people say that waste is useless and cannot be reused, it must be disposed immediately. If the disposal is carried out continuously and not processed immediately, it will cause disease and pollution. Trash will be increasingly mounting and piling up in landfills. Some of the “green land” or fields which turned into housing will reduce the beauty. This results cause a densely populated environment which will impact on the heat of air circulation due to the reduction of trees. One of the solutions to this environmental change is by using STEM (Science, Technology, Engineering and Mathematics) (Aninda, 2019).

STEM is a four-aspect approach to solve real problems and also problem-based learning. This approach is able to create an active learning atmosphere because these four aspects are very much needed in solving problems (Apri, 2015). The four aspects of STEM that have been described by Torlakson (2014), namely: (a) Science, means the science of nature which represents natural laws related to physics, chemistry, biology and treatment or application of facts, principles, concepts and convection related to disciplines. (b) Technology, is a skill or a system that is used in managing society, organization, knowledge or it can be defined as a product of the essence of science and technique. (c) Engineering, is engineering knowledge by utilizing concepts from science and mathematics as well as technological tools to solve a problem. (d) Mathematic is knowledge that connects quantities, spaces, and numbers which requires logical arguments. These four fields of knowledge can make knowledge become more meaningful when integrated to the learning process.

The integration of STEM can also be inserted with chemo-entrepreneurship (CEP) where previously students had difficulty in developing their entrepreneurship due to the lack of material linkages with daily life applications (Rohayati, 2015). CEP in general is still rarely found in schools (Prayitno, 2016). Therefore it becomes a need for STEM-based module with integrated CEP. The CEP approach is one of a

teaching method that connects objects in everyday life, this equips students' knowledge and skills in turning raw materials into creative products (Wijayati, & Rengga, 2016; Sudarmin, 2017). The application of the CEP approach is also very much needed in Vocational High School learning. Vocational High School as an educational institution is also expected to be able to produce productive young people who have great quality to face their own challenges. They are not only a generation who capable in knowledge, but also a generation that has strong skills (Yahya, 2015).

In Indonesia, 71% of students who graduated from Vocational High School do not continue to Higher Education (University Level) and return to society with less life skills (soft skills). Soft skills have an important role in shaping the personality of an individual, so it is important to provide students with adequate skills beyond academic and technical skills (Carnawi, 2017). These skills will make students have more value which will help them in facing the competitive work world. Due to this situation, entrepreneurship training in chemistry (chemo-entrepreneurship) is expected to provide inspiration and open new jobs for students (Adlim, 2015).

The concept of chemo-entrepreneurship (CEP) approach is a chemistry learning approach that is associated with real objects. Besides getting education, the CEP approach also allows students to learn the process of processing a material become useful and has high economic value product as well as fosters their entrepreneurial spirit (Supartono, 2009; Prayitno, 2017). For example, converting plastic waste into fuel, and making innovative aromatherapy wax products. Improving science process skills, developing conservation character and entrepreneurial interest in students requires a multidisciplinary and skill-oriented learning model in order to face the global challenges that students will face in the future.

The results of interviews and observations at Askhabul Kahfi Vocational High School Semarang indicated that the school had actually provided textbooks, but the material taught was not in accordance with the basic competencies of students, which is still dominant in cognitive aspects and less contextual. Furthermore, based on the results of interviews from the students themselves, the textbooks provided were not suitable for use because they were damaged and

several pages had been lost. As one of the efforts made by students was copying textbooks or taking notes, but not all students made these efforts.

Meanwhile, the results of interviews with the chemistry teacher in grade X Lemuria Vocational High School showed that: (a) students' motivation in learning chemistry was still low. This was indicated by the lack of student attention to chemistry lessons; (b) in learning the teacher has not introduced the term STEM to students nor has it applied it to learning so that learning was only delivered in accordance with the existing material; (c) chemistry practicum related to chemical products in everyday life has never been carried out; and (d) there were still many students who collect food waste in the class table drawers.

The results of data analysis from interviews in the two schools stated that there was still a lack of books that connected to STEM insights associated with CEP on chemistry. Due to the lack of chemistry textbooks that connect STEM insights associated with CEP on chemistry, especially independent textbooks (modules), it is necessary to develop a chemistry module. The module is expected to describe the relationship between the four aspects of STEM and the environment so that students are able to solve problems of environmental change around us (Firman, 2015). The purpose of this research was to develop an integrated STEM-based module with Integrated STEM and improve the students' conservation character and entrepreneurial interests.

## METHODS

The method used in this research is the modified RnD (Research and Development) of Thiagarajan. This research was conducted at Askhabul Kahfi and Lemuria Vocational High School. Research subjects at Askhabul Kahfi were 28 students and Lemuria were 23 students.

Sources and data collection methods included: documentation, questionnaires, tests, observations, and interviews. This research contained data analysis, namely: feasibility validation analysis, teacher and student response questionnaire analysis, and analysis of the effectiveness of cognitive learning outcomes, as well as analysis of the conservation character

questionnaire and student entrepreneurial interests.

## RESULT AND DISCUSSION

The STEM-based module with integrated CEP about petroleum materials in everyday life was intended to enhance the students' conservation character and entrepreneurial interest. The development process was carried out using word software. Before STEM-based module with integrated CEP was applied to learning, this module requires due diligence from experts. The instrument used was a validation sheet in the form of a questionnaire. The results of expert validation are presented in Table 4.1, which are as follows.

Table 1. Results of Expert Validation

| Assessment |              |            |               |
|------------|--------------|------------|---------------|
|            | Aspect       | Percentage | Criteria      |
| Expert 1   | Presentation | 83%        | Very Feasible |
|            | Content      | 87%        | Very Feasible |
|            | Language     | 92%        | Very Feasible |
| Expert 2   | Presentation | 83%        | Very Feasible |
|            | Content      | 81%        | Very Feasible |
|            | Language     | 83%        | Very Feasible |
| Expert 3   | Presentation | 92%        | Very Feasible |
|            | Content      | 87%        | Very Feasible |
|            | Language     | 75%        | Feasible      |
| Average    |              | 84,8%      | Very Feasible |

The expert validation assessment referred to Table 1 showed that the feasibility of STEM-based module with integrated CEP from each expert shows very feasible criteria even though expert 3 on the language aspect shows 75% results with feasible criteria. The average score of the validation experts was 84.8%, indicating that the STEM-based module with integrated CEP was very feasible for use in learning.

Revisions that have been done in the presentation component in the module were to adjust the layout of the material presented and the writing process needed to be added. Revisions made to the module material include: emphasizing STEM-based content and adding experiments to the module. So based on the acquisition of expert validation values, it could be said to be included in the very feasible criteria and can be used for implementation in learning. Students and teachers were given response questionnaires to STEM-based modules with CEP integrated.

The results of calculating the responses of class X students and teachers of Askhabul Kahfi and Lemuria Vocational High School showed good and excellent response results. This made the integrated STEM-based module used very well. These data can be compared with the graph which can be seen in Figure 1 as follows.

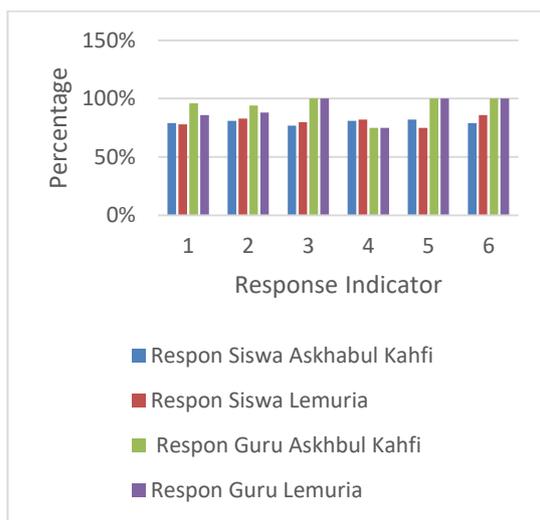


Figure 1. Comparison of Student and Teacher Responses

The results of the comparison calculation from students and teachers response of Askhabul Kahfi and Lemuria Vocational Schools in Figure 1 showed that the responses were very good. Student responses were taken in order to see how far they respond to learning using modules. Askhabul Kahfi and Lemuria students showed a positive response by participating enthusiastically in the lesson. The first aspect measured by the students of Askhabul Kahfi and Lemuria Vocational High School was the content aspect of the module with an average gain of 79% and 78%, these results indicated that the content responded by the students was good. The second

aspect was the presentation of the material content with an average gain of 81% and 83%, this showed that students responded very well. The third aspect was the language of the module with an average gain of 77% and 80%, this showed that students also responded well. The fourth aspect was the petroleum module with an average gain of 81% and 82%, this showed that students responded very well. The fifth aspect was conservation characteristics with an average gain of 82% and 75%, this showed that students respond very well. The sixth aspect was student entrepreneurship with an average gain of 79% and 86%, this showed that students responded very well.

Meanwhile, after taking the student's response, the teacher's response was obtained. Teacher response consisted of 6 aspects with more questions in it. The response to this module was given to teachers of Askhabul Kahfi and Lemuria Vocational High School. The results of the response of each teacher obtained an average score of 94% and 91%, this made the module even more feasible to use with the excellent teacher response. Previously students responded very well to the modules which make them become more interested in participating to the learning process. This was the same as previous research which showed that student responses have an average score of 84.73%, this showed a very good response to the development of a Science Project-Based Module with integrated STEM on pressure material (Sugianto, et al., 2018).

This means that students were very enthusiastic in participating to learning using STEM-based modules with integrated CEP. In line with the research of Rahayu & Sudarmin (2015), it was stated that the first time students saw the science module being developed, they seemed enthusiastic about the developed science module. This could also be seen from the acquisition of student responses percentage from each class, namely the science module developed was at very good criteria. After being responded by both teacher and students, students were given an evaluation to see the effectiveness of the module.

The results of the average test calculation obtained  $t_{count}$  for the posttest score of the Askhabul Kahfi students, namely 5.25 with  $\alpha = 5\%$ ,  $df = 27$  and obtained  $t_{table} = 2.05$ . These results indicated that  $t_{count} > t_{table}$ , meaning that the average posttest score of the Askhabul Kahfi

Students exceeds the actual pass limit score. While the calculation results for the Lemuria student obtained  $t_{\text{count}}$  posttest score of 5.27 with  $\alpha = 5\%$ ,  $df = 22$  and obtained  $t_{\text{table}} = 2.06$ . These results indicated that  $t_{\text{count}} > t_{\text{table}}$ , meaning that the average posttest score of Lemuria Students exceeds the actual pass limit score.

The results of the average calculation obtained by Askhabul Kahfi and Lemuria Vocational High School students showed that the students' posttest scores exceeded the actual pass limit score. Therefore, the application of STEM-based modules with integrated CEP was effective in increasing students' cognitive scores.

The results of the calculation of classical completeness test for the posttest score of Askhabul Kahfi students obtained  $Z_{\text{count}}$  which was 3.05 and the obtained  $Z_{\text{table}} = 0.99$ . These results indicated that  $Z_{\text{count}} > Z_{\text{table}}$ , meaning that the average posttest score of Askhabul Kahfi students classically completed 75%. While the results of the calculation for the posttest score of Lemuria students obtained  $Z_{\text{count}} = 1.81$  and obtained  $Z_{\text{table}} = 0.96$ . These results indicated that  $Z_{\text{count}} > Z_{\text{table}}$ , meaning that the average posttest score of Lemuria students completed classically 75%.

The results of the N-Gain test showed that there was an increase in grade X students of Askhabul Kahfi Vocational High School from the pretest to posttest scores was 0.68 which was included in the moderate criteria. Meanwhile, the increase of class X SMK Lemuria students from the pretest to posttest scores was 0.69 which was included in the moderate criteria. This Gain score also showed that the indicators of the success of this study are fulfilled, namely the Gain score was more than 0.3. The comparison between pretest and posttest can also be seen in Figure 2.

The results of the effectiveness calculation for each test showed that the module was effectively applied to the STEM-based module with integrated CEP. This is in line with previous research that explained the development of STEM-based student worksheets in improving creative thinking skills, showing that applying STEM-based worksheets can develop students' creative thinking abilities (Sukmagati, et al., 2020). In addition, the same research showed that STEM-based teaching materials are able to support science learning become more effective (Oktavia, 2019). Other studies also support the

results of this study, namely the science module based on Additives Ethno-science in foodstuffs for class VIII obtained a  $t_{\text{test}}$  of 10.98 and N Gain of 0.67 in the moderate category so that the developed module proved feasible and effective to be used in learning (Rosyidah, et all., 2013).

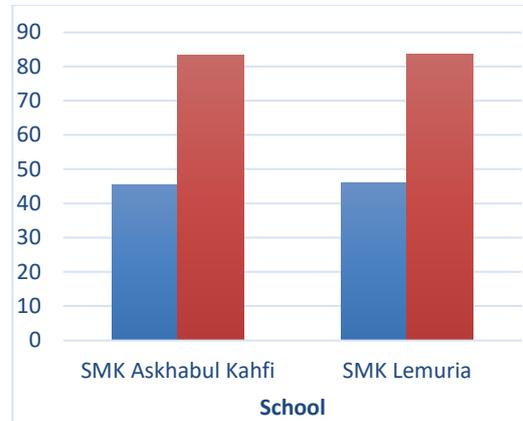


Figure 2. Comparison of Pretest and Posttest Scores

After testing the effectiveness and producing an effective module, it was also seen whether the module can increase the students' conservation character and entrepreneurial interest or not. This research was done to see the conservation character through observing and entrepreneurial interest through distributing questionnaires.

The observation results of students' conservation character and entrepreneurial interest were shown by an increase from the initial questionnaire before learning was carried out using the STEM-based module with integrated CEP and afterwards it was carried out in learning using the module. Conservation character in grade X students of Askhabul Kahfi Vocational High School showed an average increase of 0.64 while grade X students of Lemuria Vocational High School showed an increase of 0.73. These results explained that the increase in grade X Askhabul Kahfi Vocational High School was in the medium category. While the increase in grade X Lemuria Vocational High School was in the high category. This showed that the modules used by each student in Askhabul Kahfi and Lemuria schools were effective in improving the students' conservation character.

The results of the questionnaire on students' entrepreneurial interest in grade X Askhabul

Kahfi Vocational High School showed an increase of 0.68 while grade X students of Lemuria Vocational High School showed an increase of 0.79. These results explained that the increase in grade X students of Akshabul Kahfi Vocational High School was in the medium category. Meanwhile, the improvement of grade X students of Lemuria Vocational High School was in the high category. This showed that the modules used by each student in Askhabul Kahfi and Lemuria schools were effective in increasing students' interest in entrepreneurship. Based on these results, a graph can be made as shown in Figure 3 below:

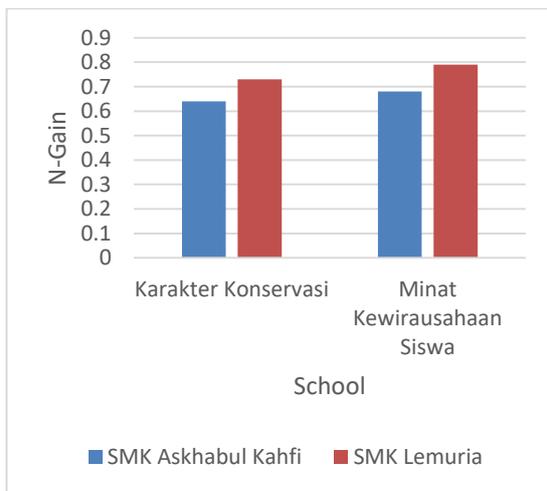


Figure 3. Comparison of Students' Conservation Characteristics and Entrepreneurial Interests

The calculation results on the observation of conservation character for X grade students of Askhabul Kahfi Vocational High School were lower than the X grade students of Lemuria Vocational High School. It was also in line with the entrepreneurial interest questionnaire of the X grade students of Askhabul Kahfi Vocational High School which was lower than the X grade students of Lemuria Vocational High School. However, both of them showed an improvement result. This showed that the implementation of STEM-based modules with integrated CEP was really effective in enhancing the students' conservation character and entrepreneurial interest. This is in line with previous research which showed that I-STEM implementation in science learning affects students' creative thinking skills and conservation character (Istiqomah, 2019). In addition, previous research also showed that students' entrepreneurial interest can increase through the development of an integrated PBL-STEM model of biology

entrepreneurship (Retnowati, 2020). Other research also showed that through an integrated science module based on ethosciences, the theme of energy in life to instill a spirit of conservation character has begun to develop (Rahayu & Sudarmin, 2015). This research showed the same result as the researcher did, but this study focused on STEM-based module with integrated CEP to improve the students' conservation character and entrepreneurial interest.

## CONCLUSION

Based on the research results on the development of STEM-based module with integrated CEP, it showed that the students of Askhabul Kahfi Vocational High School experienced an increase in conservation character after using the module, as indicated by an increase of 0.64 in the moderate category. Meanwhile students of Lemuria Vocational High School experienced an increase in the conservation character after using the module, indicated by an increase of 0.73 in the high category. The entrepreneurial interest of Askhabul Kahfi Vocational High School students has increased after using the module as shown by an increase of 0.68 in the moderate category, while the students of Lemuria Vocational High School also had an increase of 0.79 in the high category. The feasibility of the module was stated to be very feasible both from its presentation, content, and language. Meanwhile, the response of students and teachers towards the module was very good. The use of effective modules which were indicated by the average student could achieve average completeness. The proportion of student scores has reached classical completeness, and the average learning outcomes have increased and the character of conservation and entrepreneurial interest of students have increased after using STEM-based modules with integrated CEP.

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