STEM learning of "value-added on banana chips" to enhance students' motivation and entrepreneurship attitude in a rural school

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Abstract. The unemployment of high-school graduates continuously increases because they do not have the required skill to work. Life skill training is not programmed for such general schools; however, entrepreneurship practice is introduced in the regular curriculum. Life skill learning, which integrates science and technology, is known as STEM learning. This study aims to investigate the implementation of STEM learning with the topic of "the increase of value-added on banana chips" to enhance student motivation and entrepreneurship attitude in rural senior high schools. The STEM module was previously developed with the research and development method and ADDIE model. The module was validated before being used. Several student worksheets were used to collect data on motivation and entrepreneurial attitude before and after STEM learning was conducted. STEM-based student worksheet had been validated, and it was valid to be used. The scale of student creativity during the implementation of STEM was categorized high with the component of elaboration (83.3%), originality (87.5%), and fluency (75%). The accumulation of mean score indicators of student motivation and entrepreneurship attitude increase from 46.8% to 75.6%, which means students are very interested in entrepreneurship. Entrepreneurship character can be induced by STEM learning.

1. Introduction
In the 21st century, sophisticated science and technology rapidly develop. Then students are demanded to master specific skills to compete globally. The conventional curriculum has not overcome the unemployment problem. A large number of high school graduates who do not continue their higher education studies are jobless. Unemployment data in Indonesia in August 2017 was 7.04 million or 5.5% percent, which was from various fields.

Meanwhile, the level of unemployment in Aceh province in August 2017 and 2018 reached 6.57 million and 6.36 million [1]. The highest graduate in Indonesia is at the level of senior high school with a percentage of 70. However, only 29 percent of the graduates go to university; while, other graduates are jobless. Also, only a few graduates who are from vocational schools have skills for working [2].
Even if pure science is taught in senior high school and can increase science skills through the learning process using the inquiry method [3], it does not directly relate to science, technology, and social problems. Science learning needs to be integrated to solve technical issues that are multidisciplinary in a community environment. One of the integrated science learning models is STEM [4]. STEM learning has been currently implemented in several countries. STEM, thus, becomes the main trend in global education [5].

Moreover, STEM is often integrated with entrepreneurship as one of the learning models within the entrepreneurship subject and has been implemented to cope with life skill-related activities unavailability at non-vocational schools [6]. STEM-based learning can train students in implementing their knowledge to make a design as a form of problem-solving related to the environment using technology [7]. STEM is considered a way to help senior high school students develop their particular STEM content abilities at the university level [8]. STEM has five principles: the integration of STEM content, problem-focused learning, inquiry-based learning, design-based learning, and cooperative learning [9].

STEM learning requires students to accomplish science projects as part of the school curriculum [10]. STEM is one of the disciplines that its teaching system is integrated and coordinated to solve problems in the real world [11]. Teachers admit that STEM education can promote 21st-century skills, including thinking skills, collaboration, problem-solving, and research skills. All these are hoped will be useful to choose a career in science [12]. STEM in the 21st century encourages students to be skillful, critical thinking, and have a high inspiration to create entrepreneurship [13]. Generally, STEM deals with engineering and mathematics to build a connection between working units and problems that exist in real life [14]. Implementing STEM learning at schools worldwide aims to prepare the future workforce by strengthening the scientific background and mathematics skills.

This proves that students can directly involve in the STEM learning process as this learning can help students develop their ideas for creating a particular product. STEM learning can be applied to Indonesian schools to produce competitive human resources in developed countries, leading the global economy [15]. Apart from this, students can learn to be an entrepreneur through STEM learning. STEM learning, furthermore, can enhance student learning motivation, in particular, chemistry learning. Student perceptions that assume chemistry subject is challenging to learn caused students lack motivation in learning chemistry. A student who is not well motivated during the teaching and learning process will be passive compared to other students who have good motivation[16]. One of the purposes of motivating chemistry subject is to teach entrepreneurship attitude. Motivation, including self-confidence and having information access to entrepreneurship opportunities, is needed to develop a new business [17].

Motivation is a process of initiating and defending an activity that leads to the achievement goal [18]. Whereas, entrepreneurship attitude is a description of innate personality through physical motion and thinking response about entrepreneurship [19]. This matter shows that motivation contributes to forming an entrepreneurship attitude. Someone will have a positive entrepreneurship attitude if it is supported by business motivation and vice versa.

The result of a case study carried out in Senior High School No.1 Samalanga showed that half of its graduates did not continue their studies on higher education with various factors, including parent economic problems. Because of this condition, the students began trying to produce an item of trade, namely banana chip, which has been known as one commodity in this area. Processing and packaging are traditionally done, and there is no variation in the product. From SERAMBINEWS.COM Banda Aceh in August 2019, it was found that the level of open unemployment from students who graduated from the vocational schools was 10.70 percent. The second highest open employment level (8.5%) was students who graduated from senior high schools. From the literature review and direct observation of some schools, the Senior High School No.1 (Samalanga) has not applied the STEM student worksheet integrated with entrepreneurship [20].

This research was developed by integrating entrepreneurship with STEM-based student worksheets that agreed with the local potential and applied it at the relevant school as a model of the development
of STEM at school and in other environments. STEM learning can guide students to do innovation toward the product, such as making a unique packaging and providing various tastes and forms of chips. It can also explore the technical processing of banana chips. Student creativity, motivation, and entrepreneurship attitude before and after the implementation of STEM-based student worksheets are compared.

2. Methods
This study used R and D method aiming to produce a particular product and examine the product [21]. The pattern is ADDIE model involving 5 steps that are Analysis (need analysis), Design (product design), Development (product development), Implementation (product testing), and Evaluation [22]. Before student worksheets and research instruments were used, they were validated by experts. Student worksheets were applied for 16 rural senior high school students with school quality as 'middle or not excellent' category. The school is located in the district where banana chips are their main commodity. The variables compared were student creativity scale and student motivation and entrepreneurship attitude before and after the application of STEM. Several instruments were used in this study, including the lesson plan, STEM-based student worksheet, student creativity observation sheet, questionnaire sheet of student motivation, and entrepreneurship attitude. Data were collected by direct observation of the implementation of STEM learning, including observation of student learning activity in the classroom and questionnaire distribution. Data Analysis includes the appropriateness validation of STEM student worksheets using the Likert scale with a percentage formula.

3. Results and Discussion
Based on our interview, literature review, and direct observations at the school, we found that there was still no STEM-based worksheet of integrated entrepreneurship on the topic of banana-chips innovation. Therefore, this student worksheet is required by the teachers for learning chemistry and entrepreneurship. The choice of topic is quite relevant to the social needs in the school neighborhood.

We developed several teaching materials in the design phase, including student worksheet grading rubric, student tasks, and assignments, with the appropriate layout. Student worksheet design followed the STEM learning phase, integrating STEM content, problem-focused learning, inquiry-based learning, design-based learning, and cooperative learning. In composing the STEM module, we followed the reference, which comprised learning-media, method, the limitations, and the self-assessment section. All were arranged systematically and interestingly to achieve the expected competency according to its complexity [23]. Each of these phases was consulted with the expert, and each suggestion was followed up and validated by experts. The valid STEM student worksheet was applied in the chemistry class for conducting a project on banana chips innovation. The procedure is displayed in Table 1.

Table 1 shows that STEM learning activity stimulates students to learn science and math and be trained in life skills and entrepreneurship [24]. Also, it would improve student learning motivation [25]. Three experts validated the STEM student worksheet and the assessment rubrics. They stated that all instruments are valid to be used as teaching materials to increase student motivation and entrepreneurship attitude. Before being valid, the student worksheet has been revised several times to follow up on the expert suggestion as shown in Table 2. Validation scores are tabulated in Table 3. As shown in Table 3, the student worksheet is categorized appropriately (score: 80 percent) and very relevant (score: >80 percent) on all indicators, and it can be applied in the classroom.

Two observers observed the student learning activities and filled in the assessment rubric to monitor the project achievement, including the creativity scale, as shown in Figure 1. The average score of student creativity was very high, especially in product originality and elaborating on the new commodity.

Student creativity on the elaboration indicator means that students can think about a business done in the future [26]. Students had begun thinking about what materials and media needed within a
business. Students also began reviewing the number or measurement of materials and media needed to make banana chips such as banana, salt, sugar, chocolate, oil, and other materials.

**Table 1.** STEM learning project procedure (students were asked to arrange the disordered pictures as the project procedure).

| STEM Phase | STEM Activity | The task must be accomplished by students |
|------------|---------------|------------------------------------------|
| Science    | Students are expected to learn fried oil characteristics, including chemical content and use time. | Explore the chemical properties of fried oil, including chemical content and the expired time |
| Technology | Students propose a new banana slice shape, taste variation, and make a unique packaging | Review existing banana chips on the internet, modify it with slice shapes, taste variation, design, the new packaging |
| Engineering| Students find out the ideas for the frying technique and removing oil refinement on banana chips | -Design a new chips slice, plan the taste variation and construct the attractive packaging -Discuss how to fry effectively and cleanse oil from banana chips -Do a project to make the modified product and attractive packaging |
| Mathematics| Students calculate the cost production and predict the break-even point of the banana chips business | Count capital and estimate benefit |

**Table 2.** Revision of student worksheet during the validation process.

| No | Expert suggestion | Expert comment after revision |
|----|--------------------|-------------------------------|
| 1. | Student worksheet must be presented systematically | The student worksheet has been systematically presented. |
| 2. | Learning materials should be clear, simple, and easily understood by students | Student worksheet has already easy to understand |
| 3. | The discussion section must stimulate student learning motivation | The discussion section has already motivated to learn |
| 4. | The instruction should be explicit and understandable | Instruction is already relatively clear. |
| 5. | STEM syntax should be followed | STEM syntax has been already followed |
Table 3. Validation score of STEM-based student worksheet.

| No  | Assessment Indicator | Validator I (%) | Validator II (%) | Validator III (%) | Average (%) | Category        |
|-----|----------------------|-----------------|------------------|-------------------|-------------|-----------------|
| 1.  | Usage                | 80.0            | 90.0             | 95.0              | 88.3        | Very appropriate|
| 2.  | Content              | 80.0            | 84.0             | 88.0              | 84.0        | Very appropriate|
| 3.  | Language             | 80.0            | 80.0             | 86.7              | 82.2        | Very appropriate|
| 4.  | Format               | 91.4            | 94.0             | 80.0              | 88.5        | Very appropriate|
| 5.  | STEM-based           | 90.0            | 70.0             | 80.0              | 80.0        | Appropriate     |

Figure 1. Score student creativity per indicator based on expected respond.

Originality, students tried to be creative with their ideas or new and unique related to making process [26]. They began creating a filter tool of banana chips made from wood and used a fan to dry. Moreover, students also created a new creation in the form of packaging to increase the quality of sale and also in the form of processing of banana that is different by adding various tastes such as chocolate, spicy, etc.

Fluency, students were able to collect many ideas that had been developed to create a product that has high quality in entrepreneurship [26]. Characteristics of creativity in fluency refer to the competency in generating ideas to solve the problem and increase understanding of information [32]. It aims at gathering an advantage in entrepreneurship and can create a workplace in the future. This proves that the integrated STEM of entrepreneurship can develop student creativity in various interesting ways. Student activity that shows their creativity can be seen in Figure 2. Students created the new products of banana chips (Figure 3) during STEM learning project. The students successfully follow the student worksheet. Each group with 5 members make a new innovative commodity of banana chips.

Student entrepreneurship attitude and motivation scale were collected by questionnaire before and after STEM learning implementation, as displayed in Figure 4. The finding support by Aswar et al. stated that “Attitude related to a willingness to react positively or negatively to certain objects or the attitude is still the readiness to act and not an open reaction” [27]. Ridwan et al. described
motivation. That "Motivation is the result of a collection of internal and external forces that cause employees to choose the appropriate way to act and use of certain behaviors"[28].

Figure 4 shows that before STEM-learning and the worksheet implemented (pre-test) most students have low motivation and not expected attitudes in entrepreneurship. However, the indicator scales changed significantly after the implementation (posttest). Initially, Students were skeptical of the enhancement, but when they experienced something real and matched their expectations, they responded positively [29-31]. The research finding confirmed some theory that STEM learning related to daily life generate potential revenue [32-33].

Figure 2. Students actively involved in STEM learning activities.

Figure 3. Innovation in banana chips made by students.

Figure 4. The mean scale of student motivation and entrepreneurship attitude.

4. Conclusions
STEM-based student worksheet has an appropriate and appropriate category to apply in the classroom, even in a rural area. STEM-learning with the specific worksheets can facilitate students to learn science, technology, practice creativity and innovation. The learning strategy also improved student motivation and entrepreneurship attitude in producing an innovative commodity. The model of STEM-learning and the worksheet are recommended to be applied on different topics and at other schools.
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