STEM learning in regular and vocational high schools on the
topic of scientific menu card fabrication

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Abstract. Only a small percentage of high school graduates in Indonesia successfully enter university and the rest returned to their community without life skill. Therefore, it is crucial to stimulate entrepreneurial practices among students by integrating with science and technology. This study was initiated by developing STEM students’ worksheet and subsequently tested the effectiveness for regular and vocational high school students. The worksheet was previously developed with R and D method following STEM syntax on the topic of scientific-menu-card fabrication. The STEM project related to student’s innovation on fabricating of scientific menu card that containing nutritional data and the efficacy of fruit juice beverage. Students respond to STEM learning process were collected based on product assessment sheets, and questionnaire. The vocational students have a higher score in design card which general high school students were better in menu card presentation. There was not significantly different score among students except on indicator of motivation to accomplish the project, entrepreneurship motivation, and vision broadening. Vocational students have better responds on these indicators. STEM worksheet was recommended by students & teachers to use as an alternative teaching material in entrepreneurial learning.

1. Introduction
Indonesia has more regular high schools which reached 70% of 4,135,975 students and 30% of which was vocational school high students. From the total high school graduates, it was only 29% successfully enter university and the rest returned to their community without life skill [1]. Therefore, it is crucial to stimulate entrepreneurial practices among students, by integrating with science and technology. Learning model that accommodate science, technology, and innovation for entrepreneurship is known as STEM learning. Science, technology, engineering, and mathematics (STEM) is a learning approach that integrating content and skill of science, technology, engineering and mathematics in real life situations simultaneously [2,3].

Learning with STEM approach from several researches demonstrated a positive influence [4]. STEM-based learning can improve motivation since the students actively explore their ideas and learning experience. It also provides experience in the engineering process. It motivates more students in learning and participation in the class [5,6]. However, very few STEM module commercially available and barely any STEM learning practice especially in high schools. This because STEM is considered a new model, it will take time to introduce for educators.

This study aimed to explore teacher response and student capability to use STEM worksheets to integrate science and technology as well as the effect on student learning motivation and
entrepreneurship awareness among students. The implementation was carried for chemistry classes in regular and vocational schools on the topic of fabrication scientific menu cards.

2. Methods
This study was initiated by developing STEM module using R and D approach with the model of ADDIE (analysis, design, develop, implementation and evaluation). Based validity assessment the STEM module with the nearly maximum score (91.15%), it was considered eligible to implement in a class. The validated STEM module was implemented in chemistry classes at regular and vocational high schools. The project was conducted by 26 students; 6 males and 20 females from a regular high school in Aceh Besar. It is suburb school and most of the students’ parents were farmers. The other class was 32 students; 23 males and 9 females from a vocational high school in Banda Aceh). The school located in Banda Aceh, a capital of Aceh and the student parents were not dominantly farmers.

Students’ worksheet was developed to train students to fabricate scientific-menu card of juice type beverage. Students were guided to explore literature and to sort list fruit or leaf extract that have nutritional data and the efficacy for health from scientific sources as well as familiar foods. There were several criteria for fruit choice; it should be a familiar fruit juice for Indonesians, it has been reported the nutritional contents in scientific journal. Subsequently, the students prepared the beverage, served for the taste test, took photos and fabricated the scientific-menu-card. The teachers assessed the project process and product with several rubrics. Before and after class activities, students were asked to fill in a questioner to express their impression on STEM learning and entrepreneurship motivation.

3. Result and discussion
Before STEM project started, the students fill in the questioner (pre-test) to answer what their expectation the STEM classes. Will the STEM class motivate them to learn? Will it improve their creativity? Will it provide a source of knowledge? Will it explore their self-potential? Will it provide information they need? The Similar questioner was given after STEM project accomplished (post-test). The students’ responses have been compared between pre-test and post-test at the end of this section. The Students read the STEM module and the worksheet containing several information on fruit juice including the nutritional data and health benefit quoted from scientific journals.

Students have learnt some of STEM component skills after applying STEM worksheets in their learning experience. Science part was represented by knowledge on fruit that has nutritional and health benefit. Students have learnt to create their own recipe of fruit juice beverage with nutritional and health benefit consideration. They learnt the chemical composition of several fruit and in its role in nutritional and health. They learnt how to prepare and serve the beverage that looks attractive and nice taste. Technology aspects were developed by students when they were composing a scientific menu card containing scientific information and attractive beverage pictures, which are not common uses in the restaurant. Engineering skills were practiced when students used food photography technique & processing, as well as choosing the right material for menu cards. They used a small cardboard equipped with lighting as a mini studio for their food photography. Mini studio was prepared by teacher but the photography technique was based on student creation after they learnt it from google searching. The mathematical calculation was involved in cost processing, nutritional doses for each menu and potential revenue gain and the size of the market. Activities of students during STEM project learning are displayed in Figure 1. These practiced skills have confirmed the STEM learning aspects that are found in the literature [7].

Menu card and fruit juice drink that served and presented by students are further assessed by the teachers. The results of the assessment are presented in Table 1. Table 1 showed that student vocational high school has the higher score in creativity aspect in menu card design and better taste of their fruit juice drink. Therefore, STEM worksheet was effective to develop student creativity. This finding seems similar to previously reported [8]. Students from the vocational school have a better score than their counterpart might have a correlation with their experience in their own school that is
trained to be skilful workers with entrepreneurship vision and such skill is not experienced by regular school students.

![Image 1](image1.jpg) ![Image 2](image2.jpg) ![Image 3](image3.jpg)

**Figure 1.** Activities of students during STEM project learning.

**Table 1.** The results assessment of the menu card and fruit juice presentation.

| Student-assignment performance indicators | Regular high school\(^a\) | Industrial vocational high school\(^b\) |
|------------------------------------------|--------------------------|--------------------------------------|
| Menu card                                | 78.75                    | 78.75                                |
| Physical appearance                      |                          |                                      |
| Content                                  | 87.50                    | 85                                   |
| Creativity                               | 62.50                    | 81.25                                |
| Juice                                    | 85.00                    | 90                                   |
| Taste                                    | 80.00                    | 84                                   |
| Average                                  |                          |                                      |

\(^a\)6 males and 20 females  
\(^b\)23 males and 9 females

Gender as shown in Table 1 also might be influenced, vocational students dominating by male students would have more enthusiastic to use the computer to creatively design the menu card compared to students in the regular high school where more female [9,10]. This is consistent with studies that find that men are superior in technology than women so they prefer a career in technology while women are superior in the field of science [11,12]. However, from the physical aspect of the menu card, the score was not significantly different between the group. However, in the aspect of the image, content and layout on the menu card, the regular high school presented more attractive presentation. There were 8 menu cards that were fabricated by students, each class had 4 groups of students and each group presented one menu cards. The representatives of menu cards are displayed in Figure 2.
Translation the figure legend:

- Tamarillo Juice
- Rich of antioxidant content

Nutrition content:
- Carbohydrate: 8.25 g
- Protein (1.03 g)
- Fat (0.36 g)
- Vit. C (29.5 mg)
- Vit.B1 (0.043 mg)
- Vit. B3 (0.271 mg)
- Vit B6 (0.198 mg)
- Vit B9 (4 µg)
- Vit. A (189.17 mg)
- Vit. E (2.08 mg)
- Ca (10 mg)
- Mg (20.6 mg)
- K (321 mg)
- Na (3 mg)
- Zn (0.8 mg)
- P (38.9 mg)

Health benefit:
- Increase endurance (Asih et al, 2005)
- Preventing obesity (Kadir et al, 2015)
- Reducing blood glucose & cholesterol (Asvita & Berawi 2016)
- Reducing cancer risk (Mutarlib et al, 2017)
- Reducing high blood pressure (Fabon, 2016)

Figure 2. Representations of menu cards fabricated by (a-1) vocational school student, (a-2) and (a-3) are representative zoom legend in the menu (English Translation). Figure 2 (b-c) by menu cards fabricated by regular high school students.
The teachers from both schools were asked to respond on STEM worksheets by filling in a questionnaire consisting of 10 questions. The summaries of the questions including would STEM worksheets be used as an alternative material for student creativity and entrepreneurship workshops? Did it match with learning objectives, did it contain STEM skills and students' abilities?, was the content easy to understand and easily to teach to students, was it systematics writing?, did the guideline have completed instructions, was it attractive to the view, and was it increasing to learn?. All teachers gave 100% positive response. Student responses were also recorded by giving a questionnaire and the findings are presented in Table 2.

Table 2. Students' response to STEM worksheets.

| No. | Indicators                                      | Regular schools | Vocational school |
|-----|------------------------------------------------|-----------------|-------------------|
| 1.  | Compliance with learning objectives            | 96.15           | 90.6              |
| 2.  | Easy to comprehend the elaboration            | 92.31           | 96.9              |
| 3.  | Broadening vision                              | 96.15           | 100.00            |
| 4.  | Guiding students to search for additional literature | 73.08           | 81.30             |
| 5.  | Appropriate writing composition                | 88.46           | 90.60             |
| 6.  | Containing a systematic instruction            | 92.31           | 93.80             |
| 7.  | Interesting worksheet for students             | 92.31           | 93.80             |
| 8.  | Enhancing motivation in entrepreneurship       | 88.46           | 100.00            |
| 9.  | Presenting attractive image to motivated students | 88.46           | 96.90             |
| 10. | Stimulating students to accomplish the STEM project | 92.31           | 100.00            |
|     | Average                                        | 90.00           | 94.38             |

Table 2 showed that the average positive responses from regular and vocational high school were 90.00% and 94.38% respectively. This finding is in line with the previous study that learning using STEM made students innovative, gain knowledge better and stimulated entrepreneurship [13]. In addition, STEM learning can enhance students' ability in science and innovate in technology products to compete globally [14-17]. Through STEM learning, students gain impressed experience following the learning stages and it generates motivation and interest in learning [18-19].

Students' responses on entrepreneurial learning before and after learning using STEM worksheets were also different and data are presented in Table 3.

Table 3. The students' response to the entrepreneurial learning.

| No.     | Indicator                          | Percent of answers “Yes” | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest |
|---------|------------------------------------|---------------------------|---------|----------|---------|----------|---------|----------|---------|----------|
|         |                                    | Regular school            |         |          | Vocational school |         |          |         |          |         |         |
| 1.      | Students are motivated              |                           | 65.38   | 88.46    | 87.50   | 96.88    |         |          |         |          |         |         |
| 2.      | Supports creativity                 |                           | 69.23   | 84.62    | 84.38   | 90.63    |         |          |         |          |         |         |
| 3.      | Use of teaching materials           |                           | 38.46   | 84.62    | 59.37   | 93.75    |         |          |         |          |         |         |
| 4.      | Developing self-potential           |                           | 84.62   | 88.46    | 81.25   | 100.00   |         |          |         |          |         |         |
| 5.      | In accordance with the wishes       |                           | 73.08   | 88.46    | 78.12   | 93.75    |         |          |         |          |         |         |
| Average |                                    |                           | 66.15   | 86.92    | 78.13   | 95.00    |         |          |         |          |         |         |

Table 3 showed that students' responses from both schools on entrepreneurial aspect improved after learning STEM project. This was in line with their response on STEM worksheets. Before the implementation of STEM learning, the average positive response of students from regular school was lower than from vocational school although STEM objective had been explained at the beginning of the class. Probably beginning regular high school students have low expectation STEM model until
they experienced directly they thought it would be just like a common class. Vocational school students have higher score even at beginning compare to the regular students because of the STEM project matched with their learning goal that was trained to be an entrepreneur or skillful worker. The improvement on the positive response was higher in regular schools.

4. Conclusion

STEM module and students’ worksheets effectively drilled STEM knowledge and skills. It generated students’ creativity and innovation as well as entrepreneurial motivation. It was accepted by teachers and students as interesting learning material and practical works. Vocational students who were most were male show more skill in using computer compared to regular high school who were dominantly female. There was not significantly different score among students except on indicator of motivation to accomplish the project, entrepreneurship motivation, and vision broadening. Vocational students have better responds on these indicators. Vocational students have better responds on these indicators because they realized that entrepreneur will be one of their careers.

Acknowledgment

We would like to thank regular high school of SMA Negeri 1 Darul Imarah and the vocational school of SMK SMTI Banda Aceh who has participated in this research.

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