

Implementation of STEM-based Student Worksheet to Increase Student Entrepreneurial Innovation through the Development of Candied Nutmeg Products

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Abstract. The research has been carried out to develop STEM-based Student Worksheets to determine their effectiveness in increasing students' entrepreneurial innovation through the development of candied nutmeg products and the responses of teachers and students to the Student Worksheet. The research was conducted using the research and development (R & D) method using the ADDIE model. The sample in this study were 34 students of class XI IPA 1, selected using a random sampling technique. The research data were obtained from expert assessment sheets, Student Worksheets, and questionnaires for teachers and students. The results of the STEM-based Student Worksheet feasibility test by the experts showed that the Student Worksheet developed was classified as very worthy, with an average percentage value of 94.17%. The percentage of Yes responses obtained from teachers and students was 100.00% and 92.06% in the very good category. Based on the results of the study, it can be concluded that the developed STEM-based Student Worksheet can increase students' entrepreneurial innovation and can be used as alternative teaching material in craft and entrepreneurship materials, and get positive responses from teachers and students.

Keywords: Student Worksheet; STEM; innovation

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Introduction

The 2013 curriculum provides changes to the subject sector by incorporating craftsmanship and entrepreneurship into new subjects for grade X SMA students (Pamungkas and Sutrisno, 2014). Craft and entrepreneurship subjects aim to foster an entrepreneurial spirit from an early age and to prepare for the birth of entrepreneurship (Purbaningrum, 2016). The failure of education to produce alumni who are ready to use and who have entrepreneurial spirit will have an impact on the high unemployment rate (Hutasuhut, 2013). Data from the Central Statistics Agency shows that around 7.37% of people still do not have jobs (Central Statistics Agency, 2019). Lack of creativity and skills is one of the contributing factors. Therefore, students must have the creativity and be brave in entrepreneurship (Aprilianty, 2012).

The results of case studies and interviews that have been conducted at SMAN 3 Banda Aceh show that students are less active in the learning process of craftsmanship and entrepreneurship. This is due to the lack of teaching materials in the form of student worksheets which can support the activeness of students in the process of teaching and learning activities. Student Worksheet is one of the learning media (Nugraheny, 2018). Student Worksheet is used as teaching material to direct students in learning. Student Worksheet is also used as a guide so that students can carry out active and independent learning activities (Novelia, et al., 2017).

Student Worksheet can be combined with a learning approach. The approach that fits the requirements of the 2013 curriculum is the STEM approach (Ramli, et al., 2020). STEM is a learning

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approach that can create a fun and independent learning atmosphere.

The STEM approach is not just memorizing concepts, but rather understanding scientific concepts and their relation to everyday life. Learning that is associated with the environment so that a fun learning process can be realized for students (Herak, 2019). STEM is an approach to four components of science, namely: knowledge, technology, engineering, and mathematics (Khoiriyah, et al., 2018). STEM can solve the problems of students by combining science, technology, and mathematics (Rahmiza, et al., 2015). Therefore, STEM-based learning is suitable for application in the teaching and learning process.

Nutmeg (*Myristica Fragrans* Houtt) is a native Indonesian plant originating from the Banda and Maluku islands which then spread and developed to various islands including Aceh, North Sulawesi, and Papua (Atmaja, et al., 2017). Nutmeg is also a spice that has high economic value (Kamelia and Silalahi, 2018). The price of nutmeg is very affordable, besides that, it has many health benefits. In Aceh, nutmeg seeds are often added to food as a spice, while the pulp is used as sweets. Candied nutmeg, which is known to the people of Aceh, only has a sweet taste of sugar, so many are less interested in consuming it. Even if innovated, candied nutmeg can have a high selling value and can attract consumers to buy it. Based on the background of the problem, the researcher is interested in conducting a study with the title "Application of STEM-based Student Worksheet to Increase Student Entrepreneurial Innovation through the Development of Candied Nutmeg Products".

Method

Research data collection was carried out at SMAN 3 Banda Aceh in the odd semester of the 2020/2021 academic year from 8 to 27 November 2020. The research was conducted using this type of research and development research method, which aims to produce a product in the form of a Student Worksheet. The development model used is ADDIE which includes the following steps: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

The stages of the ADDIE development model are (1) Analysis, which consists of analyzing the needs of teaching materials and analyzing the character and condition of students. (2) Design, making Student Worksheet designs based on analysis that has been carried out on a STEM basis and according to the criteria of a good Student Worksheet preparation; (3) Development, conducts a development process to realize a Student Worksheet design that is in accordance with the needs of the learning process. Then, validation

by experts on the physical and content of the Student Worksheet. Based on the results of the validation, the Student Worksheet was revised and then implemented in schools; (4) Implementation, the results of the Student Worksheet products obtained were given to students to work on, then questionnaires were distributed to teachers and students to see their responses to the Student Worksheet; (5) Evaluation, evaluating Student Worksheet to see the success of Student Worksheet. The evaluation was carried out in the form of giving scores to the Student Worksheet, determining the impact of learning, and analyzing the responses of teachers and students to the STEM-based Student Worksheet that had been developed.

The instruments used were the needs analysis sheet, the Student Worksheet product quality assessment sheet, the observation sheet for the improvement of students' innovation abilities, a questionnaire sheet, and an assessment sheet for the appearance and taste of the product that had been validated by experts in their fields.

The population in this study were students of class XI SMAN 3 Banda Aceh. The sample in this study was 34 class XI IPA1 students, selected using a random sampling technique which was determined based on the advice of the chemistry teacher at SMAN 3 Banda Aceh.

The data obtained during the next study were analyzed. The percentage (P) of the validity of the Student Worksheet, the increase in the innovation ability of students, is calculated using the following formula (Usman & Akbar, 2006).

$$P = \frac{\text{Gotten score}}{\text{Ideal score}} \times 100\%$$

To provide an assessment score can be seen in Table 1.

Table 1. Student Worksheet Feasibility Assessment Criteria

No	Student Worksheet Eligibility (%)	Category
1	81-100	Very Worth it
2	61-80	Well worth it
3	41-60	Decent enough
4	21-40	Not worth it
5	0-20	Not feasible

(Source: Arikunto, 2013)

Then, the percentage of teacher and student responses is calculated using the following formula (Trianto, 2009).

$$P = \frac{\text{Sum of chosen by respondent}}{\text{Total respondent}} \times 100\%$$

The criteria for describing the responses of teachers and students can be presented in Table 2.

Table 2. Description of the Response Values of Teachers and Students

No	Response Score (%)	Category
1	86-100	Very good
2	76-85	Good
3	60-75	Enough
4	55-59	Less
5	0-54	Very less

(Source: Purwanto, 2004)

Furthermore, the data obtained from the assessment of the candied nutmeg food product were calculated using the following formula.

$$\text{Score} = \frac{\text{Total gotten score}}{\text{Total ideal score}} \times 4\%$$

The description criteria are presented in Table 3.

Table 3. Description of the Product Score of Candied Nutmeg Foods

No	Response Score (%)	Category
1	3.66-4.00	Very good
2	2.66-3.65	Good
3	1.66-2.65	Enough
4	1.00-1.65	Less

(Source: Ministry of Education and Culture, 2014)

Results and Discussion

Development of STEM-based Student Worksheet

The development of the STEM-based Student Worksheet aims to determine the ability of students to innovate in craft and entrepreneurship materials. The method used in this research is research and development (R&D) with the ADDIE model. The description of each ADDIE stage carried out by researchers in the development of the Student Worksheet is as follows:

1. Analysis

At this stage, an analysis of literature studies and field studies are carried out by digging up information about the teaching and learning process that has been carried out so far at SMAN 3 Banda Aceh. In addition, an analysis of the availability of teaching materials in schools was also carried out. Researchers conducted a needs analysis by providing a questionnaire containing questions in terms of the learning process and teaching materials. The results of the needs analysis are as follows:

a. Learning Process

Teachers rarely use teaching materials and still use the lecture method when students make certain products in the learning process.

b. Teaching Materials

Teaching materials that are often used by teachers are only in the form of textbooks available in schools so that it does not improve the innovation abilities of

students. So it takes a teaching material that is able to foster student innovation.

The results of the needs analysis show that the handcrafted and entrepreneurial learning that is carried out in science classrooms has not yet linked science, teachers also rarely use Student Worksheet. Basically, the Student Worksheet is very important to determine the success of students in absorbing and mastering the knowledge that has been given (Widodo, 2017). Teachers need teaching material in the form of a Student Worksheet that can be used in science learning. The application of STEM is suitable for use in science learning (Permanasari, 2016). The ability of students in the fields of science and mathematics can be improved through the application of STEM (Mu'minah and Aripin, 2019). Therefore, researchers developed a teaching material in the form of a STEM-based Student Worksheet which is suitable for use in science learning and can foster students' innovation.

2. Design

Student Worksheet design is designed in such a way and is based on STEM. Student Worksheet consists of six main elements, namely the title, study instructions, basic competencies or subject matter, supporting information, assignments or work steps, and assessment (Directorate of Senior High School Development, 2010). In this Student Worksheet design, there are several components in the form of cover, competence and objectives, instructions for use, learning materials and supporting information, as well as tasks/work steps that students must do. The components are described as follows: 1) Cover is the front page of the Student Worksheet which contains the title of the Student Worksheet and the identity of the student. This section also contains pictures related to candied nutmeg. 2) Competencies and learning objectives contain the competencies and goals to be achieved by students. 3) Instructions for use contain how to use Student Worksheet to make it easier for students to learn. This section also shows the STEM components and more details can be seen in Table 4.

Table 4. Concepts Related to STEM Components

STEM Components	Related Concepts
Science	Knowledge of the benefits of the candied nutmeg ingredients
Technology	Making product packaging (in the form of stickers) candied nutmeg using technology such as computers
Engineering	Technique and processing of candied nutmeg, as well as selecting the appropriate ingredients for candied nutmeg food products
Mathematics	Calculations are required in calculating the materials used and profits

- a. Learning materials and supporting information contain information about the knowledge of nutmeg which is presented in step I. Observation.
- b. Tasks steps that students must do. Students are asked to follow step II. New Ideas, processing nutmeg, and generating new ideas about candied nutmeg innovations. Step III. Innovation (Innovation), innovating processed nutmeg sweets. Step IV. Creativity, making packaging stickers for candied nutmeg products has been innovated. The final step V. Society calculates the approximate selling price of candied nutmeg.

The design results obtained are submitted to the experts to be asked for suggestions so that the Student Worksheet that has been designed is better. The initial design of the Student Worksheet is presented in Figure 1.



Figure 1. Initial Design of STEM-based Worksheet

3. Development

At this stage, validation is carried out by expert validators of the STEM-based Student Worksheet that has been developed. Student Worksheet quality assessment is based in terms of material, learning components, presentation, language, physical, illustrations in pictures, and completeness. The validation instrument was adapted and modified from the National Education Standards Agency (BSNP) and adapted to the characteristics of the Student Worksheet developed by the researcher. The validation results obtained in the form of suggestions and improvements for each component of the Student Worksheet are presented in Table 5.

Table 5. Validator Suggestions Against Student Worksheet

Validator	Suggestion
I	<ul style="list-style-type: none"> - Replace the image on the cover with an innovative product image from candied nutmeg - Make sure every step of Engineering Science Engineering (EST) is clearly and systematically listed on the Student Worksheet
II	<ul style="list-style-type: none"> - Change the command sentence in the science section (the benefits of the ingredients used), the word from should not be put at the beginning of the sentence - Arrange the question sentence in the engineering section into a more effective sentence, changing the question mark into an exclamation point in the second sentence - Put a period after the abbreviation of the name of the author of the article in journal taken in the bibliography
III	<ul style="list-style-type: none"> - Adjust the color of the writing with the Student Worksheet background - Display the table in the science section to make it easier for students to write down the benefits of the materials used - Create command sentences in the science section (the preservative nutmeg used) so that students understand the author's intent

The results of the revised Student Worksheet based on suggestions from the validator can be seen more clearly in Figure 2.

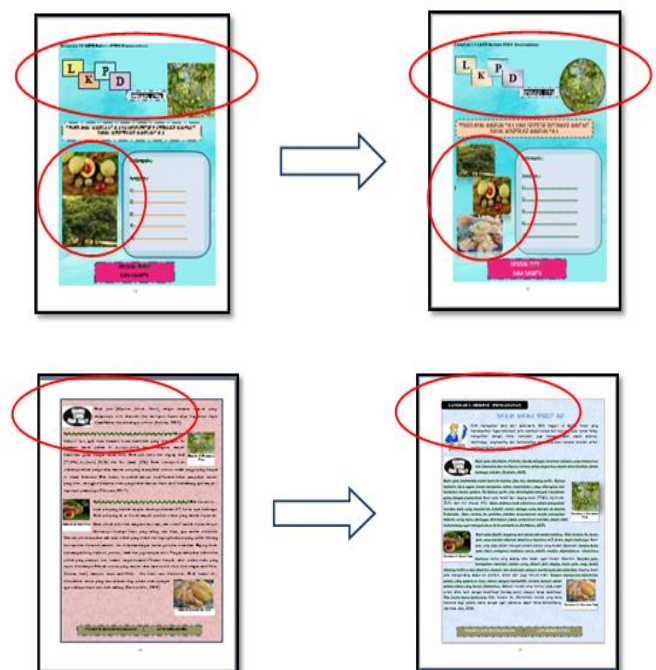


Figure 2. Design Revision Results

Student Worksheet products that have been assessed for quality by experts for more details can be

seen in Appendix A5. The results of the validation by each validator can be seen in Table 6.

Table 6. Results of Student Worksheet Validation and Research Instruments

No	Validator	Rating Score (%)	Criteria
1	I	95.00	Very Worth it
2	II	92.50	Very Worth it
3	III	95.00	Very Worth it
Average		94.17	Very Worth it

The average value obtained indicates that the feasibility value of the Student Worksheet is in the very feasible criteria with an average value of 94.17%. This is consistent with the research conducted by Simatupang, et al. (2019) that the average percentage of feasibility for developing STEM-based Student Worksheet is 94.64% with the very feasible category. This is also in line with the Student Worksheet feasibility score described by Arikunto (2013) which states that the 81-100% value range for the Student Worksheet feasibility assessment is in the very feasible category. Based on the results obtained from the validator, the STEM-based Student Worksheet that has been developed can be used at the trial stage.

4. Implementation

At this stage, the Student Worksheet that has been validated by experts is then implemented to students. The implementation was carried out at SMAN 3 Banda Aceh. Student Worksheet was implemented in class XI Science 1, totaling 34 students. Researchers looked at activities during implementation in general, namely: (1) the researcher distributed STEM-based Student Worksheet to each group, (2) Students processed the nutmeg into candied nutmeg, (3) Innovated the candied nutmeg that had been made and made packaging stickers, (4) asked for an assessment of the nutmeg candy innovation made, (5) presented the results of their work.

Students are asked to solve various problems, from processing the nutmeg into sweets, innovating the candied nutmeg that has been made, designing and designing candied nutmeg packaging stickers, and being able to calculate the estimated selling price of candied nutmeg. All of these things are expected so that students gain knowledge and can develop their innovation and creativity. STEM learning has been shown to increase the creativity of students (Fathoni, et al., 2020).

5. Evaluation

Based on the development model used, this is the final stage in the development process. This stage is carried out to evaluate the entire series of teaching and learning processes that have been carried out and

provide value to STEM-based Student Worksheet. Evaluation is carried out by analyzing the responses of teachers and students to the developed STEM-based Student Worksheet. The responses of teachers and students will be explained as follows:

a. Teachers' responses to STEM-based Student Worksheet

Teachers' responses to the STEM-based Student Worksheet that have been developed were obtained by distributing questionnaires to 6 teachers who teach craftsmanship and entrepreneurship at SMAN 3 Banda Aceh. The questionnaire given contains 10 questions with indicators that include Student Worksheet material as an alternative to craft material, the suitability of Student Worksheet with learning objectives and STEM components, ease of understanding the discussion, systematic writing, completeness of instructions for use, display of Student Worksheet, ease of being taught to students, the interest of readers, and conformity with the abilities of students.

Based on the 10 questions given, the percentage value is 100%, included in the very good category. This shows that the teacher agrees that learning using STEM-based Student Worksheet can be an alternative material for craftsmanship and entrepreneurship because the materials and projects provided at the Student Worksheet can increase the innovation and creativity of students, and students gain knowledge that can be applied to entrepreneurship, by the objectives of learning. This is in accordance with the statement of Hanif, et al. (2019) stated that STEM project-based learning can be used as an alternative teaching strategy. In addition, the Student Worksheet also includes work steps to innovate candied nutmeg which includes STEM field skills. Very good responses can also be seen in the material presented in the STEM-based Student Worksheet, all teachers answered that the material presented was systematic and the language used was easy to understand.

The manual for using Student Worksheet is also considered complete because it includes all components that can make it easier for students to learn it. In addition, the Student Worksheet appearance is already attractive because the images are shown and the color combinations used are appropriate. This is in accordance with the statement of Purnamasari, et al. (2020) that Student Worksheet draws compatibility between text and images, and also uses colors that are not striking. All teachers also think that the use of the Student Worksheet can increase students' interest in learning because it can encourage curiosity and make students more active in learning. The next response given by the teacher was related to the content of the Student Worksheet, namely the discussion on the content of the Student Worksheet was easy to understand so that

it was in accordance with the abilities of students. With the ease of understanding the material contained in the Student Worksheet, students can easily do all the exercises given (Diani, et al., 2019).

Based on the description above, it can be seen that the teacher's response to the STEM-based Student Worksheet was developed very well. Therefore, this Student Worksheet is feasible and can be used as an alternative material for craftsmanship and entrepreneurship.

b. Student responses to STEM-based Student Worksheet

The response of students to the STEM-based Student Worksheet that has been developed is known by giving a questionnaire to 34 students. The percentage of students' responses who chose the Yes option was 92.06% and included in the very good category. This shows that almost all students gave a positive response to the STEM-based Student Worksheet that was developed. This is by the research of Sulistiyowati, et al. (2018) that the results of student questionnaire responses after using the developed STEM-based Student Worksheet were 92.73% in the very good category. The results of other studies indicate that the students' responses to the developed Student Worksheet obtained an average score of 95.80% are in the very good category, so it can be concluded that the Student Worksheet given is good for use (Silvia and Simatupang, 2020).

Student Innovation Assessment

The assessment of students' innovation is based on food products produced by students through activities in their groups. Assessment is carried out before and after students innovate the material to be innovated. Three aspects are measured, the first aspect is the expected changes, namely students identify the results of the innovations that have been made. The second aspect is the expected changes, here students are required to explain the impact of innovative products on consumers. The last aspect that is measured is evaluating the results that have been obtained, students assess the risks and benefits of innovation. The assessment is determined by selecting the answer options using a range of 1 to 4. The food product innovated by students is in the form of candied nutmeg. The innovation is made in the form of modification of the taste and shape of the incisions in the nutmeg. The results of the observation sheet recapitulation of students' innovation abilities can be seen in Table 7.

Table 7. Assessment of Students' Innovation Ability

No	Innovation Capability Assessment	Before	After
1	Identify the results of innovation	0	90.44
2	Describe the impact of innovative products on consumers	0	86.76
3	Assess the risks and benefits of innovation	0	82.35
Average		0	86.52

Table 7 shows that the students' innovation ability increased from 0% to 86.52%, including in the very good category. This is because students follow the steps in STEM-based Student Worksheet which are developed in innovating to increase the knowledge of students in innovating a product. This is in accordance with the opinion expressed by Utami, et al. (2017) that STEM-based learning can improve the ability of students in science and innovate in technology products so they can compete globally. This is also supported by the statement of Zokowski, et al. (2016) that STEM-based learning can make students creative and innovative and they gain knowledge that can be applied to entrepreneurship.

Innovative products of candied nutmeg produced during the implementation of STEM-based Student Worksheet

The innovated candied nutmegs were then assessed by the teachers using the product assessment sheets that had been prepared. The range of scales used for the assessment is 1 to 4. The aspects assessed are the physical, creativity, and taste of the products produced by students. The results of the product assessment are presented in Table 8.

Table 8. Assessment Results of Candied Nutmeg Innovation

Rated Aspect	Group Score					
		I	II	III	IV	V
Manisan Nutmeg Innovation	Physical form	3.67	3.17	3.83	3.67	3.67
	Creative	3.67	3.50	3.67	3.67	3.33
	Taste	3.50	3.33	3.33	3.00	3.50
Average		3.61	3.33	3.61	3.44	3.50

Table 8 shows that the results of the assessment of the candied nutmeg innovation that were made by each group obtained an average value of 3.61; 3.33; 3.61; 3.44 and 3.50 and included in the good category. These results show that learning using a STEM-based Student Worksheet can produce students who have skills in innovating a product. In addition, STEM has a good influence on the creativity of students (Hanif, et al., 2019).

The innovation value of candied nutmeg made by groups I, III, and V were higher than the values obtained by groups II and IV. This shows that groups I, III, and V are doing their assigned tasks seriously. Healthy competition can have a good influence on the success of the learning process of students. Through competition, students can try earnestly to get the best results (Manizar, 2015). Candied nutmeg innovations made by students were in the form of candied red nutmeg, candied nutmeg for snow princess, candied nutmeg salad, sweetest candied nutmeg, and candied nutmeg jelly. The results of the candied nutmeg innovation that have been made are presented in Figure 3.



Figure 3. Innovative Results of Candied Nutmeg

Conclusion

Based on the results of the study, it can be concluded that the STEM-based Student Worksheet to increase the entrepreneurial innovation of the education students through the development of candied nutmeg products developed is classified as very feasible and usable. The entrepreneurial innovation ability of students in the application of STEM-based Student Worksheet is very good, namely 86.52%. The responses of students and teachers to the developed STEM-based Student Worksheet showed a positive response with a percentage of 100.00% and 92.06% including the very good category.

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