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## Practicum Design for Making Edible Film from Starch Based on STEM to Improve Student Creativity in Learning Polymer Topics

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### ABSTRACT

One of the 21<sup>st</sup> century skills that students need is creativity. Creativity in Indonesia is still lacking based on several previous studies. Therefore, learning innovations are needed that can increase student creativity, namely through STEM-based practicum learning. This STEM-based practicum learning integrates aspects of Science, Technology, Engineering and Mathematics in practicum learning. This research aims to produce a STEM-based practicum design for making edible films from starch poured in worksheets. The research method used the DBR (Design Based Research) method. The steps of this research are: 1) Design of practicum design, 2) Optimization results of practicum design for making edible film from starch, 3) Analysis of the relationship between the curriculum on the topic of polymer with STEM and creativity aspects, 4) Analysis of the existence of practicum procedures for making edible films in high school chemistry books class XII, 5) Expert validation. The data collection technique is done by studying the literature, optimizing the experimental results of the practicum design and the results of validation. Data analysis was performed by calculating the percentage of each aspect and interpreting it in the validation criteria table and the result was 91% with very valid categories.

## 1. Introduction

Creativity is one of the 21<sup>st</sup> century skills needed by students in dealing with technological advances (Kemendikbud, 2016). This is supported by one of the goals of the 2013 curriculum, which is to develop student creativity (Kemendikbud, 2018). Therefore, exploring student creativity is very important. Here are some research results that prove that the development of creativity in Indonesia is not optimal in terms of the learning process with reference to the

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indicators of creativity, fluency, flexibility, originality, elaborative and evaluative (Hepytrianti, 2014; Rahmi et al., 2016; Jumi et al., 2018 ).

The importance of an educational program that is deliberately aimed at developing creativity, especially in the context of schools, so that schools are expected to stimulate student creativity through the learning process (Trilling & Fadel, 2012). As said above, school is one of the factors that can develop student creativity, one of which is through the learning process using certain models or strategies (Zimmerman, 2010). Efforts to increase creativity can be done with various innovations in learning.

In order for student creativity to increase, teachers must try to innovate in designing learning that makes students active in the learning process. The active intention in the learning process is that students participate in learning so that their psychomotor and affective skills can be seen. One of the activities that can make students active is by doing practicum. In addition to making students active, with practicum students can understand chemical material concretely so that it will be easier to understand the concept. To increase creativity through this practicum activity, of course, it must be designed in such a way that it fits its purpose, namely to increase student creativity. In this research, the practicum design is designed based on STEM. STEM was chosen because currently, knowledge in science, technology, engineering and mathematics (STEM) has become a global central issue (National Research Council, 2011). Practicum with the STEM approach can form students who are able to solve problems in real life, make updates (innovation), discover / design new things, understand themselves, do logical thinking and master technology. The novelty of this research is to develop a practicum design with a STEM approach to increase student creativity.

The practicum design that will be developed is making edible film from starch. The making of edible films from starch is related to the chemistry of SMA class XII semester 2 which is contained in KD 4.11. The choice of this material is due to its many applications in everyday life, one of which is by making edible films from starch (carbohydrates). Edible film is a thin layer made of materials that can be eaten by coating food components or placed between food components that serve as a good barrier for mass transfer (moisture, lipids, light, solutes, O<sub>2</sub> and CO<sub>2</sub> gases), or as a carrier of food ingredients or additives, and can prevent the loss of volatile compounds in the distinctive aroma or flavor of a food product (Skurtys et al., 2010).

The reason for making edible film is because the use of packaging in everyday life is very important to protect products or foodstuffs so that it can extend the shelf life of products or foodstuffs, but the use of synthetic packaging in everyday life can have a negative impact on the environment and also for health. Therefore, to reduce the negative impact of synthetic packaging on the environment and health, a type of packaging that can be naturally decomposed and does not cause adverse health effects is required.

In this study, the practical design of making edible films was written in the form of worksheets used in the learning process. Researchers hope that learning with

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this worksheet can provide learning that is relevant to facts in the field and can care more about the environment. Based on the description above, this study aims to obtain a worksheet for making edible films from STEM-based starch that is suitable for the learning objectives on the topic of polymers in high school that are suitable for use.

## 2. Methodology

The method used in this research was the DBR (Design Based Research) method. Design Based Research (DBR) or research-based design is a systematic instructional design process in which it has a process of analysis, design, evaluation, and revision activities so as to get satisfactory results (Clark, 2013).

The research procedure was limited to the planning stage. At the planning stage of designing this practicum, several stages were carried out, namely: 1) Analysis of the curriculum relationship on the topic of polymer with STEM and creativity aspects, 2) Analysis of the existence of practicum procedures for making edible films in class XII high school chemistry books, 3) Optimization results of practicum making edible films from starch, 4) Design of practicum design for making edible film, and 5) expert validation. The validation was carried out by two chemistry lecturers and three chemistry teachers. This validation was carried out in order to determine the validity level of the worksheets. The validity of the LKS depends on the score given by the validator. Data validation results were processed in the following steps: Calculating the score for each statement in the validation sheet based on the validator's assessment; Calculating the percentage score for each aspect with the following calculations: Percentage score = (total score for each aspect obtained) / (maximum score) × 100%. Then, interpretation of the percentage will be based on Table 1:

Table 1. Criteria for Validation Test Results

No	Interval (%)	Criteria
1	81%-100%	Very Valid
2	61%-80%	Valid
3	41%-60%	Enough Valid
4	21%-40%	Less Valid
5	0%-20%	Invalid

(Riduwan, 2014)

## 3. Results and Discussion

### *The design of a new practicum design for making edible films*

Based on the optimization results, a new procedure for making STEM-based edible films was obtained. This practicum has several characteristics, among others.

- Practicum title : Making edible films from starch based on STEM to increase student creativity
- Practicum objectives : • Students can design edible film practicum from STEM-based starch  
 • Students can make edible films from STEM-based starch

No	Tool	Total	Material	Total
1	Wok / pan	2 pieces	Cassava Starch	4,5 gr
2	Stove	1 piece	Plasticizer gliserol	1,75 mL
3	Spoon	1 piece		
4	Teflon	1 piece		
5	Sodet	1 piece		
6	Tray	1 piece		
7	Filter	1 piece		
8	Blender / grater	1 piece		

The design of new practicum procedures using the STEM approach to increase student creativity on polymer topics can be seen in Table 2:

Table 2. Procedure for Making Edible Film from Starch with the STEM Approach

No	Trial Procedure	STEM aspects
1	<p><b>Making Starch Powder</b></p> <ul style="list-style-type: none"> <li>• Starch material (free of any type of starch based on the source or student creativity) 1 Kg peeled then washed and shredded / blended.</li> <li>• The grated starch plus 1 L water is squeezed and then filtered</li> <li>• The resulting filtrate is precipitated 24 hours then discard the filtrate</li> <li>• The starch deposits are dried in the sun and then mashed</li> <li>• Obtained powdered starch</li> </ul>	<p><b>Science</b> Choose the starch type</p> <p><b>Technology</b></p> <ul style="list-style-type: none"> <li>• Use of the internet when searching for information sources</li> <li>• Utilization of a blender</li> <li>• Accurate use of the scale</li> <li>• Accurate use of measuring cups</li> </ul> <p><b>Mathematics</b> Knowing the right ratio of starch and water.</p>
	<p><b>Edible Film Making</b></p> <ul style="list-style-type: none"> <li>• Powdered starch (4.5 g) added with 100 mL of water and added with glycerol (1.5 mL)</li> <li>• Then heat it in a pan and stir until it becomes a paste</li> <li>• The starch paste is then thinly molded in Teflon and heat over low heat until dry</li> <li>• The starch sheets are removed from the Teflon and dry in the sun to dry</li> <li>• Get Edible Film sheets</li> </ul>	<p><b>Technology</b></p> <ul style="list-style-type: none"> <li>• Use of a Teflon heater</li> <li>• Accurate use of the scale</li> <li>• Accurate use of measuring cups</li> </ul> <p><b>Engineering</b> Making edible film from the determined starch by adjusting the ratio of starch and plasticizer</p> <p><b>Mathematics</b> Knowing the right ratio of starch and plasticizer ingredients.</p>

The table above shows that the procedure for making this practicum is made using the STEM approach, where students will determine their own starch ingredients based on the sources obtained and the students' creativity. In addition to determining the material by themselves, at the time of its implementation students were given the opportunity to determine the tools and procedures for making edible films this was done to see students' creativity.

### ***Optimization Results of Practicum Making Edible Film from Starch***

Optimization of practicum procedures was carried out to obtain optimal practicum procedures. Suboptimal procedures can cause lab results not as expected. This optimization is done to determine the good procedure, good edible film results and the time required for the process of making edible films. In order to be used as a guideline for the design of the developed practicum design.

Optimization was carried out by varying the amount of use of glycerol plasticizer, namely 1.5, 1.75, 2 mL. For use, the amount of cassava starch is fixed at 4.5 grams. This variation is done to get a good edible film texture, both in terms of thickness, elongation and tensile strength. Then the experiment was carried out three times on each of these variations to see the consistency of the edible film results from these variations. The results of the experiment with variations of glycerol plasticizer and varied with cassava starch can be seen in Table 3.

Table 3. Experiment Results of Glycerol Plasticizer Variations with Cassava Starch

Trial	Total		Edible Film Texture		
	Cassava Starch	Plasticizer Gliserol	Thickness	Elongation	Power
I	4,5 gr	1,5 mL	0,18 mm	40 %	128 gr
	4,5 gr	1,5 mL	0,18 mm	42 %	90 gr
	4,5 gr	1,5 mL	0,15 mm	32 %	118 gr
II	4,5 gr	1,75 mL	0,18 mm	40 %	216 gr
	4,5 gr	1,75 mL	0,2 mm	42 %	122 gr
	4,5 gr	1,75 mL	0,2 mm	54 %	196 gr
III	4,5 gr	2 mL	0,12 mm	40 %	112 gr
	4,5 gr	2 mL	0,16 mm	42 %	208 gr
	4,5 gr	2 mL	0,14 mm	30 %	112 gr

Based on the experimental results in the table above, the resulting edible film textures are different. There is an effect of the amount of use of glycerol plasticizer on the texture of the edible film. The experimental results showed the amount of glycerol plasticizer 1.75 mL with 4.5 g of cassava starch with the best results and consistent results. To be more convincing, optimization was carried out in experiment II for three times in order to obtain optimum results and consistency of variations in the amount of 1.75 mL glycerol plasticizer with 4.5 g of cassava starch. The results of the optimization of experiment II can be seen in Table 4.

Table 4. Optimization Results of Experiment II (Plasticizer Glycerol 1.75 mL)

Trial	Total		Edible Film Texture		
	Cassava Starch	Plasticizer Gliserol	Thickness	Elongation	Power
II	4,5 gr	1,75 mL	0,2 mm	42 %	210 gr
	4,5 gr	1,75 mL	0,19 mm	42 %	128 gr
	4,5 gr	1,75 mL	0,2 mm	50 %	190 gr
	<b>Average</b>		0,196 mm	44,67 %	176 gr

Based on the table of optimization results above, it shows the consistency of the edible film, ranging from thickness, elongation and strength. Edible film with a plasticizer variation of 1.75 ml, can be seen in Figure 1:

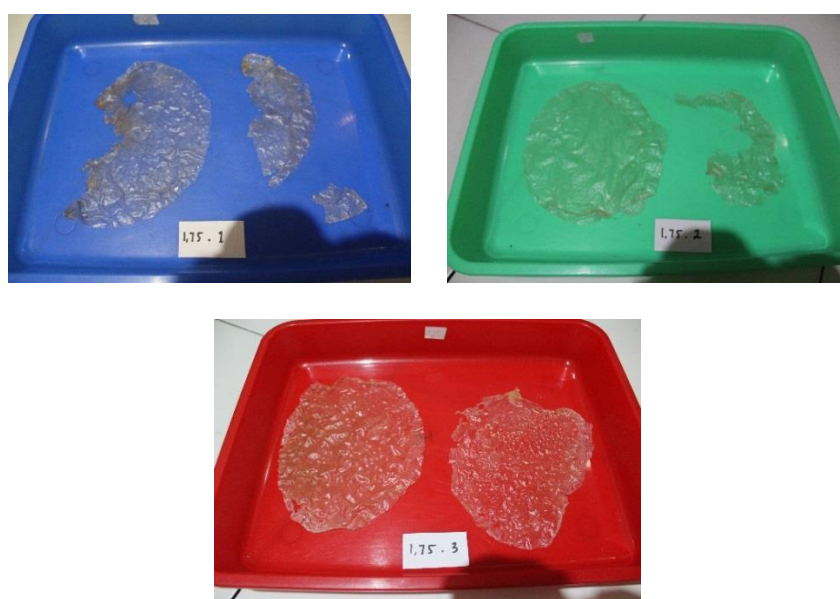


Figure 1. Edible Film with a Plasticizer Variation of 1.75 mL

### **Curriculum Analysis**

Curriculum analysis was carried out by analyzing the relationship between basic competencies, indicators, objectives, and learning materials. This analysis aims to determine the compatibility between the material to be applied in research with the Basic Competencies (KD) in the current 2013 curriculum. Based on the results of the SMA curriculum analysis, it shows that edible film is one of the products of polymer, this topic of polymer is taught in chemistry subjects in class XII Semestert 2. In the 2013 curriculum, the topic of polymers related to making edible films is included in Basic Competence (KD) 4.11 Reasoning for the manufacture of a product of macromolecules. KD 4.11 is then developed into a GPA (competency achievement indicator) which is divided into 3 indicators. The relationship between topics and STEM and creativity can be seen in Table 5.

Table 5. KD and GPA of Polymer Topic in Edible Film Making

Indicators of Competence Achievement		STEM aspects	Creativity Indicators
4.11.1	Designing practicum for making edible films from alternative raw materials that are environmentally friendly.	<p><b>Science</b> When designing the practicum students must have prior knowledge of:</p> <ul style="list-style-type: none"> <li>• Use plastics in life</li> <li>• Knowing the dangers of plastic</li> <li>• Chemical aspects of high school related to edible film</li> <li>• Know how to make edible films from environmentally friendly materials</li> </ul> <p><b>Technology</b> Use of the internet when looking for reading sources.</p> <p><b>Engineering</b></p> <ul style="list-style-type: none"> <li>• Designing practicum procedures for making edible films</li> <li>• Determine tools and materials for practicum for making edible films</li> </ul> <p><b>Mathematics</b> Knowing the right ratio of starch and plasticizer ingredients.</p>	<p><b>Think creatively</b></p> <ul style="list-style-type: none"> <li>• <i>Fluency</i></li> <li>• <i>Flexibility</i></li> <li>• <i>Orisinalitas</i></li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Curiosity</li> <li>• Dare to take risks</li> <li>• Respect.</li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Work preparation</li> </ul>
4.11.2	Doing practicum making edible films.	<p><b>Science</b> Knowing the procedure for making edible films</p> <p><b>Technology</b></p> <ul style="list-style-type: none"> <li>• Use of heating devices</li> <li>• Accurate use of the scale</li> <li>• Accurate use of measuring cups</li> </ul> <p><b>Engineering</b> Making edible film from the determined starch by adjusting the ratio of starch and plasticizer</p> <p><b>Mathematics</b> Knowing the right ratio of starch and plasticizer ingredients.</p>	<p><b>Think creatively</b></p> <ul style="list-style-type: none"> <li>• <i>Fluency</i></li> <li>• <i>Flexibility</i></li> <li>• <i>Evaluation</i></li> <li>• <i>Orisinalitas</i></li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Curiosity</li> <li>• Dare to take risks</li> <li>• Respect.</li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Work process</li> </ul>
4.11.3	Presenting the results of practicum making edible films.	<p><b>Science</b></p> <ul style="list-style-type: none"> <li>• Knowing the appropriate ratio of starch and plasticizers to make edible films.</li> <li>• Knowing the characteristics of a good edible film</li> <li>• Knowing which starch is good for making edible films</li> </ul> <p><b>Technology</b></p> <ul style="list-style-type: none"> <li>• Use of computers / laptops and projectors</li> <li>• Present a compelling PPT or video presentation.</li> </ul>	<p><b>Think creatively</b></p> <ul style="list-style-type: none"> <li>• <i>Fluency</i></li> <li>• <i>Flexibility</i></li> <li>• <i>Evaluation</i></li> <li>• <i>Orisinalitas</i></li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Curiosity</li> <li>• Dare to take risks</li> <li>• Respect.</li> </ul> <p><b>Be creative</b></p> <ul style="list-style-type: none"> <li>• Work result</li> </ul>

### ***Analysis of the Existence of Practicum Procedures for Making Edible Films***

Before designing a practicum for making edible films based on STEM on the topic of polymers (carbohydrates), an analysis of the XII grade SMA / MA chemistry book was first carried out which aims to see the existence of practicum procedures for making edible films on the topic of polymers. The results of the package book analysis are shown in Table 6.

Table 6. Analysis of the Existence of Practicum Procedures for Making Edible Films on Polymer Topics in Class XII High School Chemistry Books

No	Source Book Identity	Practicum carbohydrates		Existing practicum
		Yes	No	
1	Sutresna, N., Solehudin, D., dan Herlina, T. (2016). <i>Buku Siswa Aktif dan Kreatif Belajar Kimia SMA/MA Kelas XII</i> . Jakarta: Grafindo Media Pratama	√	-	1. Observing the hydrolysis of cellulose and starch 2. Test the biuret
2	Sudarmo, U. (2013). <i>Kimia untuk SMA/MA Kelas XII</i> . Bandung: Erlangga	√	-	Hidrolisis polisakarida
3	Watoni, A.H., Kurniawati, D., Juniatri, M. (2018). <i>Kimia untuk Siswa SMA/MA Kelas XII</i> . Bandung: Yrama Widia	-	√	Protein test
4	Watoni, A.H., Juniatri, M. (2015). <i>Kimia untuk Siswa SMA/MA Kelas XII</i> . Bandung: Yrama Widia	√	-	1. Reducing sugar practicum 2. The project to make anti-burn asbestos from Styrofoam and coconut husk
5	Umiyati, N. (2016). <i>Buku Siswa Kimia untuk SMA/MA XII</i> . Bandung: Mediatama	-	√	1. Analyze the polymer formation reaction 2. Investigate polymer properties

The Table 6 shows the five books of Chemistry for Class XII, there were no practicum on making edible films. Of the five books analyzed, there are three carbohydrate practicums and most of them are polysaccharide hydrolysis tests, there are two protein tests, two about polymers and one contextual practicum, namely making asbestos from styrofoam and coconut husk, so that the practicum of making edible films has never been done and this is a novelty practicum for high school students.

### ***Expert Validation***

The validation on this worksheet was carried out by two chemistry teachers and three chemistry teachers. This aims to determine the validity of worksheets based on language, graphic and content criteria. The score of expert validation results is calculated and a percentage then interpreted in the validation criteria table. The validation results can be seen in Table 7.



Table 7. Validator Results

Assessment Indicators	Percentage	Criteria
Language	95%	Very Valid
Display	85%	Very Valid
Contents	93%	Very Valid
Average	91%	Very Valid

#### 4. Conclusion

The optimum conditions were obtained in variation II with 4.5 grams of cassava starch and 1.75 mL of glycerol. The practicum design of making edible films from starch based on STEM with science in the practicum of making edible films from starch is choosing the type of starch, the technology used is the use of a blender, measuring cup, scales and the internet, engineering, namely engineering the comparison of starch and plasticizer and mathematics, namely calculating the right ratio of starch and plasticizer ingredients. Then the results of the validation of the worksheets have a percentage with very valid criteria, meaning that the worksheets for making STEM-based edible films are valid and suitable for use.

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