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Feasibility Analysis of Stem-PjBL Mod El to Build Creativity and Communication Capabilities of Students

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A B S T R A C T

This study aims to obtain an appropriate STEM-PjBL learning model in building students' creativity and communication skills. STEM-PjBL is a project learning model that integrates Science, Technology, Engineering, and Math (STEM). In this study using descriptive evaluative research method with 5 research steps. The first is to determine the problem, determine the type of information needed, choose a data collection procedure, choose a procedure for data processing and the last stage is drawing conclusions. The instruments used in this study were the TCOF assessment instrument, validation sheets and student questionnaires. TCOF data was processed and categorized based on the interpretation of Al-Abdali and Al-Balushi scores. The validation data is processed based on the interpretation of Riduwan's score. From the results of the TCOF assessment, the average score obtained is 2.73 which is included in the high level. In the validity test the average score for the creativity of students is 81.2% in the very good category, the communication skills of students are 86.5% in the very good category. Based on the results of the analysis of the 3 assessment instruments, the STEM-PjBL learning model is feasible to be used in improving students' creativity and communication skills.

1. Introduction

Current education not only emphasizes knowledge but also emphasizes students to be able to explore themselves through the learning process and creativity (According to Chen (2010) and Ministry of Education (2000), in Lou, (2017). Creativity is considered as the beginning of a series of births science, because with creativity the latest innovations are born and it is these innovations that produce knowledge. Creativity cannot be separated from communication skills. This communication ability is needed when conveying ideas to others orally or in writing. In the demands of the 21st century, students must have soft skills

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including creativity and communication skills. Designing a new learning model is needed to be able to support the above demands. According to Lou (2017), Triana (2020), Hanif (2019), Setiawan (2020), Mukaromah (2020) and Siew & Ambo (2014) one solution that can be used is is STEM project-based learning. Based on research that has been done by researchers, it is stated that STEM integrated learning can answer today's challenges.

In addition to creativity and communication, learning in the Industrial Revolution 4.0 era requires us to promote technology-based learning, because with digitalization, students and educators must be able to adapt to change. Research conducted by Arizona (2020) states that project-based learning can still be carried out even though using online media. One of the online media that we can use is the Zoom application. According to Wibawanto (2020), this zoom application has a relatively good quality, this is evidenced by the zoom application being used by companies that are included in the fortune 500 category. The advantage of this zoom application is also conveyed by Wena (2020) that the zoom application can accommodate a large number of participants. many, namely 500 participants if using the premium add-on application and 100 participants if using the free application.

The use of the STEM-PjBL model in science learning can increase students' interest, motivation, attention in science and they can also express their creative ideas from the given project (Jho, 2016). One of them in learning chemistry on acid-base material. In the KD 4.8 acid-base material, students are required to be able to analyze the pH change trajectories of several indicators extracted from natural materials through experiments. In this study, students will be asked to make indicators made from natural tubers, because tubers are very easy to find.
Based on the discussion above, we can see how important STEM-based project learning is to hone students' creativity and communication skills in preparing themselves to meet the demands of the 21st century. Although there have been many studies on STEM-based project learning models conducted in Indonesia, but according to data from In 2015 Indonesia's GCI (Global Creativity Index) was ranked 115 out of 139 countries with a global creativity index of 0.202 (Febriana et al., 2016). Therefore, researchers feel the need to conduct research to see the feasibility of learning the PjBL model with a STEM approach based on TCOF to build students' creativity and communication in preparing themselves for the demands of the 21st century.

2. Methodology

Based on the focus of the problem that has been formulated, the research method used is descriptive evaluative to determine the feasibility of the PjBL learning model with the STEM approach to build students' creativity and communication skills. To determine the feasibility of the STEM-PjBL learning model, researchers used 3 instruments, namely the TCOF assessment instrument, a validation sheet to test the internal feasibility of the STEM-PjBL learning model in building creativity and communication skills of students and a student questionnaire to see

the implementation of the STEM-PjBL learning model. The TCOF instrument was adapted from a journal Al-Abdali & Al-Balushi (2016), for validation data and the questionnaire was processed according to the interpretation of Riduwan's score.

3. Results and Discussion

A. Internal Feasibility of PjBL Model With STEM Approach To Build Creativity and Communication Ability

Validation was carried out by 3 expert lecturers and one senior educator. From the internal feasibility test, several things can be found, including the following:

1) PjBL learning model with STEM approach to Build Student Creativity

In designing the PjBL learning model with a STEM approach that can build the creativity of students, learning activities must be adjusted to the creativity indicators. Creativity indicators are taken from several creativity indicators according to William. The average validation results of the four validators can be seen in Table 1.

Table 1. Average Results of Staged Validation of Learning Activities on Student Creativity

No	PjBL Learning Stage	Creativity Sub-Indicator	Learning Activities	Average Validation Results (%)	Category
1	Start With the Essential Question	1. Asking lots of questions	1. Students ask questions to educators, after showing several image simulations	75	Strong
		2. Answer with a number of answers if there are questions	2. Students answer questions given by educators which aim to direct students in designing projects..	83	Very strong
2	Design a Plan for the Project	1. Fluently expresses his ideas	1. Students discuss things that need to be done to be able to answer essential questions in groups	83	Very strong

	2. Provide various interpretations of an image, story or problem.	2. Students provide a variety of actions in response to the images displayed by the educator.	67	Strong
	3. Give consideration to situations that are different from those given by others	3. Students express their respective opinions on the given situation	83	Very strong
	4. If given a problem, usually think of various ways to solve it	4. Students look for solutions to the problems given	83	Very strong
	5. Thinking about problems or things that other people don't think about	5. Students propose solutions that are different from other students	75	Strong
	6. Designing a work plan from the ideas that come up	6. Students discuss the framework of the manufacturing project that will be carried out	83	Very strong
	7. Choose asymmetry in describing or making designs	7. Students design the project framework through group discussions	75	Strong
	8. Give consideration based on your own point of view	8. Students exchange opinions with group members in the process of designing the project framework	92	Very strong
	9. Generate your own opinion about something	9. Students are able to express their opinions in working on the project	75	Strong

			framework		
3	Create a Schedule	1. Answer with a number of answers if there are questions	1. Students ask or respond to other students' questions in discussion forums	83	Very strong
		2. Able to think spontaneously	2. Students are able to think spontaneously in answering questions	75	Strong
4	Monitor the Students and the Progress of the Project	1. After reading and listening to ideas, work on finalizing new ones	1. Students carry out projects according to the designs that have been prepared in groups under the supervision and guidance of educators	92	Very strong
		2. Work faster and do more than anyone else.	2. Learners can work optimally and are able to work on projects to reduce acid-base indicators from natural ingredients to the maximum and complete the project within the agreed time	75	Strong
5	Assess the Outcome and Evaluate the Experience	1. Try or test the details to see which direction to take	1. Students try to measure the pH of a solution of an acid or base using a natural acid-base indicator.	75	Strong
		2. Have rational reasons that can be justified	2. Students answer questions from other group members with rational and accountable answers	83	Very strong

	3. Has a strong sense of beauty, so he is not satisfied with an empty or simple appearance	3. In groups, students discuss the preparation of practical reports honestly, responsibly and make interesting reports	92	Very strong
	4. Adding lines, colors and details to your own or someone else's drawings	4. Students make group reports neatly and add color to add beauty to the project report.	92	Very strong

From Table 1 it can be seen that overall the STEM-PjBL learning model gets a good average score with strong and very strong categories. There are some learning activities that get a low score when compared to other learning activities. The lowest score obtained is 67% at the design a plan for the project stage, the creativity sub-indicator provides various interpretations of an image, story or problem. The validator advises at this stage that the word "interpretation" is not appropriate to use in sentences and it is better to replace the word with a word in the form of student action in giving a response. However, at this stage it is still in the strong category.

2) PjBL Learning Model with STEM Approach to Students' Communication Ability

In this study, the sub-indicators were adapted from research conducted by Oktaviani & Hidayat (2015). The average results of the validation of the four validators can be seen in Table 2.

Table 2. Average Results of Staged Validation of Learning Activities on Students' Communication Skills

No	PjBL learning stage	Communication Sub-Indicator	Learning Activities	Average Validation Results (%)	Category
1	Start With the Essential Question	1. Dare to ask questions to educators	1. Students ask questions to educators, after showing several image simulations	92	Very strong
		2. Can answer questions from educators or other students	2. Students answer questions given by educators which aim to direct students in	92	Very strong

			designing projects.		
2	Design a Plan for the Project	1. Able to express opinions and be able to listen to the opinions of others	1. Students discuss things that need to be done to be able to answer essential questions	75	Strong
3	Create a Schedule	1. Delivering the results of the discussion systematicall y	1. Students present the project design that has been prepared with group members.	100	Very strong
		2. Dare to ask educators and other students 3. Can answer questions from educators or other students	2. Students ask or respond to other students' questions in discussion forums	83	Very strong
4	Monitor the Students and the Progress of the Project	1. Dare to ask educators and other students	1. Students ask educators if needed during the project work process.	75	Strong
5	Assess the Outcome and Evaluate the Experience (Evaluasi)	1. Able to master the material presented	1. Students present the project results obtained	75	Strong
		2. Reports are prepared systematicall y and clearly	2. In groups, students discuss the preparation of practicum reports in a systematic and clear manner as well as making interesting reports.	100	Very strong

In Table 2, it can be seen that there are several learning activities that get the lowest average score. The lowest average value obtained is 75% and is included in the strong category. Some of the inputs given by the validator include the following: at the design a plan for the project stage, learning activities with sub-indicators used are not appropriate, so the validator suggests changing learning activities to "students express other people's opinions and listen to other people's opinions regarding activities to answer essential questions. The validator also provides suggestions for making sub-indicators and learning activities into two ideas. The first idea is that students are able to express opinions and the second idea is that students are able to listen to the opinions of others.

At the stage of monitoring the students and the progress of the project, In learning activities at this stage, the validator suggests adding sub-indicators of communication skills and learning activities. The validator also criticized the sentences in the learning activities that were not appropriate, so the validator suggested changing the sentences to "students ask the educators if needed during the project work process". At the stage of assessing the outcome and evaluating the experience, the validator criticized that in the first learning activity, the words contained in the sub-indicator of communication skills did not connect with each other, namely between the words mastering the material and the words presenting.

B. Feasibility of Pjbl Model With STEM Approach Based on TCOF (The Teaching For Creativity Observation Form) To Build Creativity and Communication Ability

TCOF is an assessment instrument developed by Al-Abdali & Al-Balushi in 2016. The TCOF feasibility test was conducted by two observers. The results of the raw data processing of the TCOF test can be seen in Table 3.

Table 3. Average Observation Score by Observer TCOF

	Category	**Question Items**	**Obtaining Scores for Each Stage of PjBL Learning**				
			Stage1	**Stage2**	**Stage3**	**Stage4**	**Stage5**
a.	Strategy in asking questions	1	2.5				
		2	3				
		3	3				
		4	3				
		5	3				
		6	2.5				
b.	The teacher's response to the ideas/ideas of students	7		2.5			
		8		3			
		9		2.5			
		10	3		3		3
		11		2			
		12	2.5	2.5	2.5		2.5
		13			2.5		
c.	Activities in the classroom that can be done to encourage creativity	14				2.5	
		15		3			
		16				2	
		17					2.5
		18				3	
		19		2			
		20					2.5
d.	Models	21		3		3	

applied to all subjects in order to foster creativity	22 23	3 3			
Average Score of Each Stage of PjBL Learning	**2,81**	**2,65**	**2,67**	**2,63**	**2,63**
Category	**High**	**High**	**High**	**High**	**High**

From Table 3, it can be seen that the assessment based on TCOF is carried out per item and per category. There are 4 categories and there are 23 question items. Based on the average score of the four TCOF categories, the STEM-based PjBL learning model for building creativity is high with a score of 2.73. However, there are several categories and items that get the lowest score among other categories and items. The lowest score obtained is 2 with a medium level. Learning activities at learning stages 2 and 4, there are those who get the lowest scores. At the 2nd learning stage, question items numbered 11 and 19 got the lowest score. Question item number 11, regarding educators providing encouragement to students to be able to share ideas with other students. Educators have given direction to students to share ideas with each other, but have not been able to encourage students to share ideas and ideas. The same is the case with question item number 11, question item number 19 also gets an average score of 2 in the medium level.

At the 4th learning stage, question item number 16 got the lowest score. Item number 16 states that educators encourage students to use innovative models in presenting data. Educators have given direction to students to be able to present project results in PPT form by displaying data in graph form or in chart form. However, school rules do not allow students to bring laptops or cellphones. So that students cannot present data as suggested by students. Therefore, the TCOF observer gave a score of 2 in the medium category.

C. Implementation of PjBL Model With STEM Approach in Building Creativity and Communication Ability of Students

Filling out the questionnaire is carried out after the students complete the project. Students respond through a questionnaire by answering the statements that have been provided. If the student agrees with the statement presented, then the student checks the yes answer column. If the statement is not approved by the student, it is answered by ticking the answer column no. The average results of the questionnaires that have been filled out by students can be seen in Table 4 below.

Table 4. Average Results of Student Questionnaires

No	Stage	Statement	(%)Average score	Category
1	Start With the Essential Question	I dare to ask the teacher a question	92.5	Very good
		If the teacher asks a question, I can answer the question	82.5	Very good
2	Design a Plan for the Project	I participate in giving opinions in group discussion activities	97.5	Very good
		I participate in responding to a picture or problem given by the teacher	80	Well
		I provide solutions to the problems given by the teacher	80	Well
		I took part in designing a project that I was working on	100	Very good
		In group discussions, I listen to the opinions of others without imposing my own opinion.	100	Very good
3	Create a Schedule	I was one of those who presented the project designs that had been prepared.	100	Very good
		In the discussion forum, if there are questions, I am brave and able to answer them	90	Very good
		If there is a question addressed to the group, I dare to answer it	95	Very good
4	Monitor the Students and the Progress of the Project	I work on a project according to a previously designed plan	100	Very good
		If I experience difficulties or doubts in the process of working on a project, I am not shy to ask the teacher.	85	Very good
		The project I was working on was completed on time	100	Very good
5	Assess the Outcome and Evaluate the Experience	I participate in presenting the findings and results of the projects that have been carried out	100	Very good
		If there are questions, I answer with rational and accountable answers	82.5	Very good
		I participated in the preparation and preparation of project reports	100	Very good

From Table 4, it can be seen that the lowest response score is 80% and is in the good category. The lowest response score is in the 2nd learning stage of the PjBL model. From these data it can be concluded that students are more enthusiastic in expressing opinions in discussions than in designing a project. When viewed from the TCOF data, in this second stage, educators did not provide encouragement to share ideas with other students in their groups. So that those who participate in responding or providing solutions are only the same students. Despite getting the lowest average score, the second and third statements are in the good category with a percentage of 80%.

4. Conclusion

From the research that has been done in general, it can be concluded that the STEM-PjBL learning model is in the category of being used to build creativity and communication skills of students. Other conclusions that can be drawn from this research are as follows:

a) Based on the results of the internal feasibility test, it shows that the STEM-PjBL learning model is feasible to use to build creativity and communication skills of students. This is shown from the results of the validation of the STEM-PjBL learning model in the strong-very strong category.
b) The results of the TCOF assessment show that learning using the STEM-PjBL model is in the high category to be able to build students' creativity and communication skills.

The results of student responses to learning using the STEM-PjBL model are in the good-very good category in providing space for students to be creative and hone their communication skills.

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