Development of 21st Century Skills in Mathematics Learning with STEAM in MTs Negeri 2 Wonogiri

Agus Setyarto^{1,*}, Budi Murtiyasa², Sumardi²

¹Graduate School, Universitas Muhammadiyah Surakarta, Indonesia

²Postgraduate School, Universitas Muhammadiyah Surakarta, Indonesia

Received July 29, 2020; Revised September 4, 2020; Accepted September 29, 2020

Cite This Paper in the following Citation Styles

(a): [1] Agus Setyarto, Budi Murtiyasa, Sumardi, "Development of 21st Century Skills in Mathematics Learning with STEAM in MTs Negeri 2 Wonogiri," *Universal Journal of Educational Research*, Vol. 8, No. 11, pp. 5513 - 5528, 2020. DOI: 10.13189/ujer.2020.081155.

(b): Agus Setyarto, Budi Murtiyasa, Sumardi (2020). Development of 21st Century Skills in Mathematics Learning with STEAM in MTs Negeri 2 Wonogiri. *Universal Journal of Educational Research*, 8(11), 5513 - 5528. DOI: 10.13189/ujer.2020.081155.

Copyright©2020 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract The aim of the research to develop 21st century skills includes 4C (Critical Thinking, Communication, Collaboration, Creativity) in learning mathematics with STEAM in MTs Negeri 2 Wonogiri through a kite-making math program. This qualitative research case study strategy discovery, focuses on the development of 21st century skills including 4C (Critical Thinking, Communication, Collaboration, Creativity) in learning mathematics with STEAM. Data collection techniques include: observation, interviews, documentation, and triangulation/combination. The collection of data is that the researcher participates in the object under study, conducts direct observations, in-depth interviews and documentation studies. Validity test includes: Data Credibility Test, Transferability Test, Dependability Test, Confirmability Test. Data analysis techniques in this study use the Interactive Model of Analysis. A qualitative case study design is based on a kite-making project that integrates 21st Century skills (4C) in mathematics learning with STEAM in MTs Negeri 2 Wonogiri. The conclusions in this study include: 1)Implementation of development Critical Thinking and the results of the Critical Thinking Integration Questionnaire showed 50.32% were categorized as good; 2)Implementation of development Communication and the results of the Communication Integration Questionnaire showed that 52.80% were categorized as very good; 3)Implementation of development Collaboration and the results of the Collaboration Integration Questionnaire

showed 50.18% were categorized as good; 4)Implementation of development Creativity and the results of the Creativity Integration Questionnaire showed 52.42% were categorized as very good.

Keywords Development, 21st Century Skills, Learning. Mathematics, STEAM

1. Introduction

Education plays an important role in the survival of the nation and state. The government seeks to improve the quality of education in line with the objectives of national education, which is to improve the quality of education in every type and level of education including reforming education through improving the curriculum. Renewal of national education needs to be carried out in order to achieve a targeted, planned and sustainable education system. The national education system must be able to guarantee equitable education, quality improvement and the relevance and efficiency of education management in facing the challenges of changing lives both locally, nationally and globally [1]. According to Law No. 20 of 2003 Article 3 concerning the National Education System states that:

The 21st century is full of challenges, changes occur very quickly, difficult to predict in all aspects of life [2].

One of the main roles of education is to prepare future generations to face the challenges of the times. According to Prihadi in Sugiyarti [3] states that: The government designed 21st century learning through a 2013 curriculum based on students. In formal schools, learning has been demanded to apply 4C (Critical Thinking, Communication, Collaboration, Creativity) abilities. This can be realized quickly not only demands on teacher performance in changing teaching methods, but also the roles and responsibilities of non-formal educators in getting children used to implementing 4C in their daily lives. According to Redhana [4] states that one must master the literacy of technology, information and communication. This literacy is very important for someone in choosing, criticizing, evaluating, synthesizing, and using information. The Industrial Revolution 4.0 in the 21st century marked the emergence of super computer technology, artificial intelligence, and other digital technology devices. The government prepares it through changes in the national curriculum in the form of a 2013 curriculum based on the 21st century. According to Hadinugrahaningsih (2017) states that the 2013 curriculum there are demands on each competency covering 3 (three) domains, namely the realm of knowledge, the realm of attitude and the realm of skills [5]. The 2013 curriculum also seeks to improve the balance and the relationship between hard skills and soft skills [6], and use information. The Industrial Revolution 4.0 in the 21st century marked the emergence of super computer technology, artificial intelligence, Artificial Intelligence (AI), and other digital technology devices. The government prepares it through changes in the national curriculum in the form of a 2013 curriculum based on the 21st century [7].

The purpose of learning mathematics according to the 2013 Ministry of Education and Culture includes increasing intellectual ability and developing students' character. Learning does not only focus on student learning outcomes, but has an important role in providing the experience of students in terms of the dimensions of mathematics as knowledge, processes and products, application or application, development of attitudes and scientific values.

According to Bell [8] in Dewi Fenita [9] states that project-based learning can be an alternative learning model that supports the improvement of 21st century skills [10]. Students determine their own collaborative learning processes, conduct research, make creative projects, reflect knowledge they have [11]. One of the project-based learning models is the STEAM learning model (Science, Technology, Art and Mathematics) in the form of mathematical engineering techniques integrated into the learning curriculum, it can be used as an extracurricular activity in the form of STEAM clubs to strengthen the skills of students in scientific disciplines, craft art and mathematics. According to Liliawati [12], the

Science of Mathematical Arts Engineering Technology (STEAM) is an extension of the Mathematical Engineering Technology Science (STEM), by including art elements which are positive, rich, and strong elements in civilization and in many ways can take decisive positions. The integration of art in learning can be done by way of students communicating ideas of science through visual information that contains concepts of science combined with pictures, text, and others.

According to data from the Central Statistics Agency [13], human development in Indonesia shows that the Human Development Index (HDI) in 2019 will reach 71.92 [8]. That number increased by 0.53 points or grew by 0.74 percent compared to 2018. According to VIVAnews (2019) states a student ability survey issued by the PISA (Program for International Student Assessment) on Tuesday 3 December 2019 in Paris puts Indonesia in the ranking -72 of 77 countries. The results of the PISA study state that Indonesia scored 371 in the reading category, 379 in mathematics and 396 in science. The results of the PISA assessment provide valuable input for evaluating and improving the quality of education in Indonesia in facing 21st century challenges [14].

Mathematics learning by teachers is still lacking in making students' intellectual challenges resulting in low ability to solve problems. The learning atmosphere is less pleasant, learning is less contextual for students because there is no opportunity for students to learn according to their wishes, the tendency of teacher centered (teacher-centered learning) causes students to think critically less seriously. Mathematics learning should emphasize providing direct experience to develop students' competencies, be able to understand, explore the surrounding environment in a scientific and natural way. Meaningful learning is expected to form a critical mindset of students that is applied to everyday life in line with the development of creative power, innovation based on the latest developments in science and technology. According to Murtiyasa [15] states that mathematics education research, on the one hand is needed to help solve mathematical learning problems, on the other hand it is also an effort to develop mathematics education

The purpose of this research is to find out how the 21st century skills development includes 4C (Critical Thinking, Communication, Collaboration, Creativity) in learning mathematics with STEAM in MTs Negeri 2 Wonogiri.

2. Research Method

This research is a directed qualitative research carried out to examine the development of 21st century skills in mathematics learning with STEAM in MTs Negeri 2 Wonogiri. This qualitative research has a case study strategy, focusing its studies on selected aspects 21st century skills including 4C (Critical Thinking,

Communication, Collaboration, Creativity) on mathematics learning with STEAM based on the interests of the researchers' interests and interests.

A qualitative case study design is based on a kite-making project that integrates 21st Century skills (4C) in mathematics learning with STEAM in MTs Negeri 2 Wonogiri.

Integration of several subjects in learning mathematics with the STEAM model will build students' understanding of the material and its relationship with other subjects. Integration of STEAM (Science, Technology, Engineering, Art and Mathematics) is an approach to learning mathematics integrating science, technology, engineering, art and mathematics into mathematics learning.

Table 1. Models for STEAM and Content

STEAM	Content
Introduction	Introduction to Project-Based Learning/ Project Based Learning motivation
Determine the Subject and Planning	Determine the topic; Define subtopics and create a team; Learning Resources
Become one with the project	Investigate and investigate, share data, meet and collaborate, share and expand ideas; Express the subject with elements of art
Presentation of Results	Representing results; Compare your own results with others through representation

Table 1 shows the steps in learning with the STEAM model. Delivering information to students on the importance of mastering mathematics as a strong foundation in mastering other disciplines. Curiosity about the results of 21st century (4C) skill development in mathematics learning with STEAM at MTs Negeri 2 Wonogiri. Delivery of information will use a project-based mathematics learning model (PjBL) to support skills improvement in the 21st century (4C). Giving an understanding of project-based mathematics learning (PjBL) that students can determine their own collaborative learning process, conduct research, create creative projects, reflect the knowledge they have. Delivered that project-based learning (PjBL) is a STEAM (Science, Technology, Art and Mathematic) learning model in the form of mathematical art engineering techniques integrated into the learning curriculum. The integration of art in learning is done by communicating scientific ideas through visual information containing science concepts combined with images, text, and others.

Table 2 describes a project to make a kite in mathematics learning using the STEAM model. Topic: Get Up Flat; Sub Topic: Kites. Make a team / group with research subjects class VIII B of MTs Negeri 2 Wonogiri Academic Year 2019/2020 as many as 31 people consisting of 21 boys and 10 girls. Learning Resources: Math Books for Class VIII SMP / MTs Publisher Erlangga, Mathematics Teaching Materials Class VIII Mathematics MGMP Kab. Wonogiri, BSE Mathematics class VIII, Internet.

Table 2. Mathematics Program: Making Kites

Unit	Get up flat, kite
Learning objectives	Make a kite using the size of the angle and length of the ribs
STEAM	S : Materials for making kites T : Use of ICTs to search for kite materials and designs E : Techniques and procedures for making kites A : Kite design M : The nature of the kite, its size, angle, material requirements, price, and so on
Activity Details	Various types of materials for making kites; Techniques and procedures for making kites; Making kites with various designs; Understand the nature of flat kite wake

Data, Data Sources and Resources

Data

There are two data, namely: Data from field research results, in the form of data directly from the field called primary data; and documentation data, in the form of relevant past research data in the form of international scientific journals, also called secondary data. Both data are based on ownership in the form of internal data and external data

Data Source

Data sources include: Primary Data. Data obtained directly from respondents (data sources) through questionnaires, interviews, observations, reflective journals; and Secondary data obtained from existing sources including: notes or documentation in the form of attendance, student data, photos.

The research subjects were 31 students of class VIII B, consisting of 21 men and 10 women. The cognitive abilities of students of class VIII B in preparation for learning mathematics vary.

Resource

Resource persons in this study are the Head (Drs.Mujiyono, S.Ag.M.Pd.) And Deputy Head of Curriculum Affairs (Suyanto, S.Pd.) At MTs Negeri 2 Wonogiri.

Data Analysis

Data analysis techniques in this study used the Miles and Huberman model. According to Miles & Huberman [16] in Sumardjoko [17] consists of three main components including: data reduction, data presentation, and drawing conclusions or verification. The three components are involved in the process and are interrelated and determine the final results of the analysis. In this study, researchers used an Interactive Model of Analysis.

When the data collection was over, the researcher began trying to draw conclusions by verifying them based on everything contained in the data reduction and data

presentation. Before the researcher concludes the process of formulating his research conclusions, the activity of deepening the field of study data is carried out for the robust results of the research.

3. Discussion and Results

STEAM integration in project-based mathematics learning is done by applying 6 stages in project-based learning.

Table 3 describes mathematics lessons with a project to make a kite in an integrated manner in the STEAM learning model. Students and their groups are directly involved in PjBL. Investigating and sharing data / information between students about what needs to be known in the material of the Kite shape. Each student is encouraged to collaborate with his group to dig, know the general shape of the kite, how to draw it, how to make, how to modify, create and know the nature of the kite. Expansion of ideas: students with their groups discuss conveying their respective ideas, making compromises in

making classical and modern kites. Each student and their group are encouraged to always apply 4C in making kite projects. Express the subject with art elements: students and their groups express their artistic ability to decorate, beautify the shape of the kite (for example: painted, colored, kite color combinations).

Table 3. STEAM Integration in the Kite Making Project

No.	Aspect	Seen / Shown / Indicators
1	<i>Science</i>	The integration of science is seen in the mathematics learning of Bangun Datar material, making kites
2	<i>Technology</i>	Technology integration can be seen from the use of ICT in obtaining information related to kites, for example equipment selection, materials, and sizes.
3	<i>Engineering</i>	Engineering integration is demonstrated by the working principle of making a kite.
4	<i>Arts</i>	Integration of arts (arts) indicated the existence of student activities related to the design of the kite model.
5	<i>Mathematics</i>	Mathematical integration is seen when students apply the characteristics of a kite.

Table 4. Stages of 21st Century Skill Development Project for Kite Making Project by Integrating STEAM into Mathematics Learning

No.	Stages	Treatment
1	Give essential questions	Provide open-ended questions to students relating to the material of flat wake in daily life; the fundamental question is, what events relate to the use of a flat figure in everyday life; 4C Development
2	Make project plans	Students discuss with researchers and between students. Project planning participation (kite making; 4C development)
3	Develop a project schedule	The preparation of the project schedule through discussion between students and teachers (researchers) about the time of project completion, reporting time; Developing students' responsibility for the time the project was completed; 4C Development
4	Monitor students and project development	The first meeting, namely: Submission of general material to get up flat, special material Kite; Compilation of project schedules and division of group members. The research subjects of class VIII B students consisted of 31 people consisting of 21 women and 10 men. Formation of 6 groups of cognitive abilities varied, randomly selected; The search for a kite model by browsing on the Internet (using ICT) at the School Computer Laboratory is done by students and their groups; Monitor students, choose the model/design of the kite by asking what model/design will be made along with the reasons for choosing the design/model; 4C Development Meeting II, namely: The process of making modern kites; Selection of tools and materials; Monitor students; 4C Development Meeting III, namely: The process of making modern kites; Selection of tools and materials; Monitor students; 4C Development Meeting IV, namely: The process of making a classic kite; Selection of tools and materials; students; 4C development Meeting V, namely: The presentation process of the modern and classic kite making project for each group; 4C Development
5	Assess or test results	The first meeting, namely: Assessing the ability to control the material of the kite; Assessing the application of ICTs in choosing kite models/designs. Meeting II namely: Assessing the process of making modern kites; Judging in the selection of tools and materials; Assessing students in the development of 21 st century skills (4C) Meeting III namely: Assessing the process of making modern kites; Assessing in the selection of tools and materials; Assessing students in the development of 4C Meeting IV namely: Assessing the process of making a classic kite; Judging in the selection of tools and materials; Assessing students in the development of 4C Meeting V, namely: Assessing students to present the results of group project work using the project appraisal rubric that has been made; 4C Development
6	Evaluating experience	Experience evaluation activities are carried out to reflect the mathematics learning activities that have been carried out.; Giving students the opportunity to convey the obstacles they experienced, conveying their feelings during the mathematics learning activities (the kite making project); Developing students' communication honestly, convey it openly. Constraints and feelings of students can be known through the Student Reflection Journal.

Table 4 describes the 21st century skills that can be developed in learning mathematics using the STEAM model. The results of the finished kite project are presented by each group. In each presentation, you will see various shapes / models of various kites. We can compare the extent of each group's creative ability. The final results of the presentation of each group obtained a similarity in the form of conclusions from the flat shape of the kite (regarding the general shape, properties, materials, tools, methods / techniques for making it)

Table 5. Character of Class VIII B Students in MTs Negeri 2 Wonogiri in the 2019/2020 Academic Year

No.	Group	Character of its Members (dominant)
1	1	4C, honest, diligent, disciplined, confident, brave, responsibility
2	2	4C, honest, diligent, disciplined, confident, brave, responsibility
3	3	4C, honest, diligent, disciplined, confident, brave, responsibility
4	4	4C, honest, diligent, disciplined, confident, brave, responsibility
5	5	4C, honest, diligent, disciplined, confident, brave, responsibility
6	6	4C, honest, diligent, disciplined, confident, brave, responsibility

Table 5 shows the results of the student's dominant character from each group.

The following are the results of the interview, Journal of Student Reflection, and observations in this study include:

"I was a member of the group for the first time in putting together a bamboo frame. It was still difficult, the determination of symmetry was not yet appropriate. All of that needs a process. The first time pulling the yarn at each end of the kite was also not tight. The glue isn't sticky and it doesn't look good. After trying it then the kite can be well formed, symmetrical, and good. " (Student 2, Interview, Friday 6 March 2020)

The first time in making a kite, we find it difficult. Because arranging a diagonal 1 frame with a diagonal 2 frame must adjust the thickness of its size, it needs to be knotted, equated with a knife/cutter of the same size, the process of attaching the skeleton using a rope must be strong/tight, must be symmetrical to the left and right. (Student 28, Reflection Journal, Friday 6 March 2020)

Figure 1 shows the activities of students in finding kite designs using the internet network at schools.

Figure 1. Browsing on the Internet with his group searching for design/art at meeting I

Figures 2, 3, 4, 5, 6, 7, and 8 show the final results of the kite making projects for each group

"Today's learning is fun, interesting, today we can learn how to make a kite with two different designs, one modern kite design and the other a classic design kite" (Student 31, Interview, Friday 6 March 2020)

"In my opinion today's learning activities are fun but the time is lacking, because I am not good enough in making classic and modern kites." (Student 4, Interview, Friday 6 March 2020)

Figure 2. Final Results of the Kite Making Project Modern and Classical Group 1

Figure 3. Final Project Making Results Modern Kite Group 2

Figure 5. Final Results of the Kite Making Project Modern and Classical Group 3

Figure 4. Final Project Making Results Kite Classics Group 2

Figure 6. Final Results of the Kite Making Project Modern and Classical Groups 4

Figure 7. Final Results of the Kite Making Project Modern and Classical Groups 5

Figure 8. Final Results of the Kite Making Project Modern and Classical Groups 6

Figure 9. Design of a Kite Project with STEAM

Figure 9 illustrates the design of a kite that balances STEAM, the science of kite building, technology about the selection of tools and materials, engineering about the working principles of making kites, art about kite model design, and mathematics about the application of kite properties.

Application of 21st Century Skills in Mathematics Learning in the Kite Making Project

Critical thinking

An increase in the ability to think higher level is indicated by:

Students 12 give their ideas that the kite to be made should be interesting, design/shape like a bat, fish. Making both classic and modern kites must pay attention to symmetry, so you can fly. (Student 25, Observation, Friday 6 March 2020)

The statement shows an increase in the ability to evaluate (able to judge, deny, or support an idea and provide reasons that can strengthen the answers obtained).

The proper use of bamboo (straight, dry, bamboo slats on a large segment) allows us to easily form a kite as we wish. (Student Participants14, Reflection Journal, Monday 9 March 2020)

The statement showed an increase in the ability to create (design a way to solve problems or integrate information into the right strategy).

The occurrence of analytical skills is indicated by:

"We as a team must provide input to each other, information in solving a problem in the form of a kite making project from the zero process to becoming a kite with good design / art as a joint agreement from our team." (Student 23, Interview, Monday 2 March 2020)

Students 2 help attach motif paper to modern kites using glue. We should use paper that has been cut, just formed rather than painted. To shorten the work time and we can use motifs / art designs according to our taste. Student 6 helps him and attaches it to the kite. (Student 19, Reflection Journal, Friday 6 March 2020)

The statement shows students are able to give reasons why an answer or approach to a problem is reasonable.

"Based on the results of group 4 discussion we can conclude what material (tools and materials) will be used, design / shape, art/artistic of the kite that we will make". (Student 20, Interview, Friday 6 March 2020)

The statement shows the process of making and

evaluating general conclusions based on investigation or research.

The observation shows that the results of discussions and information from each group (6 groups) are able to predict or draw conclusions or decisions. (Student 29, Reflection Journal, Friday, March 13, 2020)

The statement shows the process of predicting or drawing conclusions or decisions from appropriate information.

Based on observations obtained that each member of the group (6 groups) there is an interaction of arguments (opinions) by deductive thinking (how to draw conclusions from general matters to specific problems) and inductive (ways of drawing conclusions from special things to problems general in nature) in a kite making project and that is perfectly valid. (Researcher, Observation, Friday March 13, 2020)

The statement shows that students consider the validity of the argument (opinion) by deductive and inductive thinking.

All students in each group argue (argue) based on supporting data that what is expressed as an answer contains an element of truth "(Student 7, Reflection Journal, Monday 2 March 2020)

The statement shows the use of supporting data in explaining why the method used in the answer is correct.

An increase in mind processing is indicated by:

"I think by reading a lot from various mathematics books, we can answer question and get new knowledge and learn to analyze the results of a kite making project assignment" (Student 13, Interview, Friday 6 March 2020)

The statement shows an increase in reading.

Answering the question there must be symmetry in the frame and wings of the kite so that it is easy to fly and lift up/better even with varying shapes/models/designs. " (Student 27, Observation, Friday 6 March 2020)

The statement shows an increase in the imagination of students.

Learners can identify the relationship between the symmetry of the kite and the natural state (air). (Student 28, Reflection Journal, Monday 9 March 2020)

The statement shows the emergence of soul energy that gives strength in realizing the imagination.

Based on these data it can be seen that students have developed Critical Thinking.

Figure 10. Application of Critical Thinking Project Completion at meeting III

Figure 10 shows the activity of making a kite by discussing from the design to gluing the paper.

Communication

A process of understanding, managing and creating effective communication is indicated by:

"For me, communicating with friends should be effective, not just chatting, debating without a clear foundation/base, immediately focusing on what we are going to do, immediately doing, immediately finishing the kite making project" (Students) 1, Interview, Friday 6 March 2020)

The statement shows that there is an understanding of effective communication.

"If a team / group has been formed, I as a member of group 5 must establish good communication with a group friend. We must manage communication well so that the process of discussion, exchanging ideas/opinions can be effective " (Student 9, Interview, Friday 6 March 2020)

The opinion above shows the existence of effective communication management.

"I was appointed as the group leader trying to give an understanding to my group that a team must have mutual understanding, manage, communicate well and effectively, in an atmosphere of kinship, togetherness, tolerance, not winning alone, deliberating for the success of the kite-making project this overpass " (Student 26, Interview, Monday 9 March 2020)

The opinion above shows the creation of effective communication between students.

The occurrence of the delivery of thoughts, ideas effectively in various forms and contents both verbally, written, and multimedia, shown by:

In the observations obtained an overview that all students in each group do not hesitate, confident, dare

to convey their thoughts, ideas effectively along with their reasons in various forms and contents orally. (Researcher, Observation, Friday 6 March 2020)

The statement shows the effective delivery of thoughts, ideas in various forms and contents verbally,

"I, as a member of group 1, have the courage to convey thoughts, ideas by sketching shapes or kite designs according to my imagination, even though we still have to discuss them with friends from one group. Anyway I am happy and excited about making this project" (Student 31, Interview, Friday 6 March 2020)

The statement shows the effective delivery of thoughts, ideas in various forms and contents in writing.

"I have conveyed my thoughts, ideas of my thoughts with me searching on the internet, kite designs that I like, I downloaded, I printed later I will discuss them with my group" (Student 3, Interview, Friday 6 March 2020)

The statement shows the existence of the delivery of thoughts, ideas effectively in various forms and contents in a multimedia.

The process of effective listening to understand meaning, including knowledge, values, attitudes, and interests, is indicated by:

Students in each group seriously listen to the delivery of material from the teacher effectively, trying to understand the meaning and value of knowledge. (Student 15, Reflection Journal, Friday 6 March 2020)

The statement shows that there is an effective process of listening to understand meaning.

"For me, every knowledge that the teacher conveys is very important because this mathematics subject discusses Bangun Datar with a kite making project is certainly a new experience for me. I am very grateful to be able to participate in this project " (Student 22, Interview, Monday 9 March 2020)

The statement shows that there is an effective listening process for understanding knowledge.

"In my opinion in order to obtain effective results on this kite making project we have to listen carefully, be full of concentration, not noisy, earnest to understand, gain additional knowledge so that I can better master this subject matter, gain new insights and experiences." (Student 7, Interview, Friday 13 March 2020)

The statement shows that there is an effective listening process for understanding values.

"For me to be able to absorb mathematics effectively from the teacher, I must be more respectful, more polite to him, realizing that the teacher is a source of knowledge. I believe by behaving like that we can listen to the teacher's instructions effectively."

(Student 11, Interview, Friday 6 March 2020)

The statement shows that there is an effective listening process for understanding attitudes.

"In my opinion if the teacher is explaining the subject matter, especially mathematics to students, it is better to listen seriously, effectively so that we understand, can absorb the knowledge conveyed by him. If we understand, of course we are increasingly interested in mathematics, especially if the material is to make a project. " (Student 12, Interview, Friday 6 March 2020)

The statement shows that there is an effective listening process for understanding interest.

The use of communication for various purposes is indicated by:

The implementation of the kite-making project work makes all students actively communicate, which can be seen by the interaction by providing various information obtained from the use of IT (browsing on the internet). (Researcher, Observation, Friday March 13, 2020)

The statement shows the use of communication for various purposes (providing information).

Each group leader gives instructions to each member to immediately carry out the project work based on the agreement of the results of the group discussion. (Researcher, Observation, Monday 9 March 2020)

"For group 3, let's carry out the project work quickly, make the best possible, show our group's abilities!" (Student 23, Interview, Friday 13 March 2020)

The statement shows the use of communication for various purposes (giving instructions).

All students communicate to convey information, the purpose and purpose of what is said, motivate each other to immediately work to complete the kite making project based on the results of the discussion of each group. (Researcher, Observation, Friday March 13, 2020)

The statement shows the use of communication for various purposes (providing motivation).

The implementation of the kite-making project makes all students actively communicate, and they convey and present information according to their individual linguistic abilities so that others understand the aims and objectives it conveys, often speaking Javanese as the language of daily communication" (Researcher, Observation, Monday 9 March 2020)

The statement shows the use of communication for

various purposes (providing persuasion).

The occurrence of the use of communication media and technology, knowing how to assess its effectiveness and impact, is shown by:

The implementation of the project to make kites for students utilizes communication media and technology. Seen together go to the Computer Laboratory to browse the internet to find information about kites such as examples / designs, selection of motifs/decoration/art, procedures for making modern kites or classic kites. (Researcher, Observation, Friday 6 March 2020)

The statement shows the use of communication media and technology.

All students actively communicate with their group members in the Computer Laboratory, discuss effectively about what forms / designs will be modeled, modified, created and express the extent of the difficulty in making them. (Researcher, Observation, Friday 6 March 2020)

The statement shows students know how to assess their effectiveness and impact.

The occurrence of effective communication in a variety of environments (including multilingual and multicultural), indicated by:

In the implementation of the kite making project all students actively communicate in their class, utilizing language skills with their culture as a characteristic of these students. (Researcher, Observation, Monday 9 March 2020)

"In my opinion the formed group is good, fit and comfortable because between us (group members) can interact well, give each other input so that the kite-making project is quickly completed." (Student 17, Interview, Monday 9 March 2020)

The statement shows that there is effective communication in a variety of (multilingual) environments.

The exchange of information, ideas, feelings that produces changes in attitude, good relations between students through messages / information exchange from various socioeconomic and environmental diversity (Researcher, Observation, Friday 6 March 2020)

The statement shows the existence of effective communication in various (multicultural) environments.

Based on these data it can be seen that students have developed Communication.

Figure 11. Application of Communication in his group at meeting II

Figure 12. Application of Communication for Project Completion at meeting III

Figures 11 and 12 illustrate the atmosphere of the discussion at the 2nd and 3rd meetings by conveying their opinions from their respective group members.

Collaboration

The ability to work effectively in groups and with mutual respect is shown by:

All students in each group are able to work together effectively shown by the active cooperation of each member, mutual respect, promoting aspects of deliberation, a sense of brotherhood, a sense of kinship, a sense of mutual respect "(Researcher, Observation, Monday 2 March 2020)

The statement shows the ability to work effectively in groups.

"I feel that a team and its members are a way to practice working together, respecting the opinions of others, practicing mutual respect for the success of the project/work to be achieved." (Student 2, Interview, Monday 9 March 2020)

The statement shows the existence of mutual respect

between students.

Personal flexibility, willingness to help one another, compromise to achieve common goals are indicated by:

"In my opinion we must be flexible, able to adapt to the environment, willing to accept input from critics and suggestions for our good, must not force our will, compromise for the success of a task/job." (Student 18, Interview, Monday 9 March 2020)

The statement shows personal flexibility.

The atmosphere of kinship, each student shows flexibility/flexibility, be willing to accept the strengths and weaknesses of others, help each other in project work, want to accept the opinions of others, want to compromise in completing the kite making project successfully. (Researcher, Observation, Monday 9 March 2020)

The statement shows the willingness to help each other.

"In our opinion, deliberation to obtain agreement / consensus is very important in a group/team. We must put aside our sense of self-will, selfishness, superiority. We must compromise for the achievement and success of a work/project. " (Student 19, Interview, Friday 6 March 2020)

The statement shows a compromise to achieve common goals.

The process of working productively with others, being responsible and contributing to the work. Students working collaboratively in groups can produce more knowledge, indicated by:

"Group 6 members jointly worked actively to complete the making of the kite." (Student 24, Interview, Friday March 13, 2020)

The statement shows the process of working productively with others.

All group members from group 1 to group 6 have a sense of responsibility in completing the kite making project. (Researcher, Observation, Friday March 13, 2020)

The statement shows an attitude of responsibility to students.

"In my group everything works according to mutual agreement, such as measuring the length of the bamboo and then cutting it to make a kite frame, cutting the bamboo blade, trimming/adjusting the thickness of the frame, measuring the length of the framework according to agreement, designing pictures/motifs, painting, coloring kites, writing group reports, cutting paper/plastic, linking threads between the ends of the kite, gluing plastic/paper on the kite ". (Student 25, Interview, Monday 9 March 2020)

The statement shows the contribution to the work.

"Student 1 helps glue motif paper / image pieces

together with glue. Students 6 help work on making work reports. Me and 11 students helped color. " (Student 26, Interview, Monday 9 March 2020)

The statement shows that the process of collaborative work in groups can produce more knowledge.

Based on these data it can be seen that students have developed Collaboration.

Figure 13. Application of Collaboration in Kite Assembly Process III

Figure 14. Application of Collaboration in Project Completion at meeting III

Figures 13 and 14 illustrate the atmosphere of cooperation in the construction of a kite-making project.

Creativity

The ability to use various ways to generate ideas for example through brainstorming (discussion) is shown by:

In the process of discussion between groups seen all

members of the group brainstorm (discussion) to generate ideas in the project. (Journal of Student Reflections, Monday 2 March 2020)

The statement shows the process of generating ideas through brainstorming (discussion).

The existence of making new ideas and adding ideas is indicated by:

In the process of discussion between groups, it was apparent that all group members added ideas to the success of the project work in the group. (Researcher, Observation, Monday 2 March 2020)

The statement shows that the application of the Creativity skill is the addition of ideas.

The process of elaborating, refining, analyzing, evaluating original ideas to enhance and maximize creative endeavors is indicated by:

In the implementation of the kite-making project, it can be seen that students develop, implement, communicate new ideas to others (to fellow group members and with other group members) actively and effectively " (Student 10, Reflection Journal, Friday 6 March 2020)

The statement shows the process of developing, implementing, and communicating new ideas to others effectively.

"We as members of group 5 suggest that each member must be open-minded, willing to accept input, not be irritable, must not be selfish, able to respond to any problems, challenges from the kite project for the success of the work group/team. " (Students 29, Interview, Monday 2 March 2020)

The statement shows an open attitude, responsiveness to new things and diverse perspectives.

Each group member is seen receiving input from each group member, getting feedback in formulating things or ideas that support the successful implementation of the kite making project. (Researcher, Observation, Monday 9 March 2020)

The statement shows the attitude of receiving group input and feedback.

"We have to be creative, innovative by creating different forms of kites from the existing kite." (Student 6, Interview, Friday 6 March 2020)

The statement shows the ability to apply to students.

The process of showing originality in work and understanding the boundaries of adopting new ideas,

"For me if implementing a project in this case makes kites, I must try to succeed in making it as good as possible. If it still fails (it is not good to make kites) it gives me the opportunity to study harder" (Student 5, Interview, Monday 2 March 2020)

The statement shows the notion that failure is an opportunity to learn.

"We have to use a strong and lightweight kite frame, we should choose to use bamboo that is really dry and old" (Student 11, Interview, Monday 9 March 2020)

"In this study we can express our ideas and opinions to decorate kites in the most attractive form possible." (Student 30, Observation, Friday March 13, 2020)

The statement shows the understanding that creativity and innovation are part of a long series of processes.

Based on these data it can be seen that students have developed Creativity.

Figure 15. Application of Creativity in Project Completion at meeting III

Figure 16. Application of Creativity with Installation of Kite Trinkets at the meeting III

Figures 15 and 16 show the creative arrangements of the students in installing decorations on their kites

3.1. Integration of 21st Century Skills Development in Mathematics Learning with STEAM in MTs Negeri 2 Wonogiri.

Integration of Critical Thinking in Learning Mathematics with STEAM.

Table 6. Recapitulation of the Results of the Critical Thinking Integration Questionnaire in Mathematics Learning with STEAM Class VIII B

No.	Question Questionnaire	Selected Results		Total
		G	VG	
1	Increase ability to evaluate	14	17	31
2	Increase creative ability	13	18	31
3	Give reasons for answers / approaches to make sense	20	11	31
4	Make, evaluate research conclusions	12	19	31
5	Forecast, draw conclusions from information	21	10	31
6	The validity of the argument of deductive and inductive thinking	14	17	31
7	Use supporting data, explain how to answer	14	17	31
8	Improve reading	17	14	31
9	Imagination improvement	13	18	31
10	Bring out the soul force (the power of imagination)	18	13	31
total		156	154	310

G (Good) = 50.32% and VG (Very Good) = 49.68%

Based on Table 6, respondents stated that 50.32% were categorized well and 49.68% were categorized very well on Critical Thinking in learning mathematics with STEAM.

The results of the analysis of interviews with observational students, Reflection Journal of Students and Questionnaire on Critical Thinking in learning mathematics with STEAM from students obtained the results:

- Implementation of the development of Critical Thinking.
- Based on the results of the Critical Thinking Integration Questionnaire in learning mathematics with STEAM from students 50.32% were in the good category and 49.68% were in the very good category.

Integration of Communication in Mathematics Learning with STEAM

Table 7. Recapitulation of the Results of the Communication Integration Questionnaire in Mathematics Learning with STEAM Class VIII B

No.	Question Questionnaire	Selected Results		Total
		G	VG	
1	Understand effective communication	11	20	31
2	Manage communication effectively	9	22	31
3	Create effective communication	19	12	31
4	Deliver thoughts, ideas effectively verbally	10	21	31
5	Convey thoughts, effective ideas in writing	20	11	31
6	Convey thoughts, ideas effectively multimedia	12	19	31
7	Listen effectively to understand meaning	10	21	31
8	Listen effectively to understand knowledge	22	9	31
9	Listen effectively to understand values	10	21	31
10	Listen effectively to understand attitude	22	9	31
11	Listen effectively to understand interests	9	22	31
12	Use communication (giving information)	22	9	31
13	Use communication (giving instructions)	10	21	31
14	Use communication (giving motivating)	23	8	31
15	Use communication for various purposes	6	25	31
16	Utilize communication media and technology	24	7	31
17	Know how to assess its effectiveness and impact	8	23	31
18	Communicate effectively in the environment (multilingual).	22	9	31
19	Communicate effectively in the environment (multicultural).	9	22	31
total		278	311	589

G (Good) = 47.20% and VG (Very Good) = 52.80%

Based on Table 7 respondents stated that 47.20% were categorized well and 52.80% were categorized very well on Communication in learning mathematics with STEAM.

The results of the analysis of interviews with students observations, Journal of Student Reflection and questionnaires on Communication in learning mathematics with STEAM from students obtained results:

- Implementation of development of Communication.
- Based on the results of the Communication Integration Questionnaire in learning mathematics with STEAM from students 47.20% were categorized well and 52.80% were categorized very well.

3.1.1. Integration of Collaboration in Mathematics Learning with STEAM

Based on Table 8 respondents stated 50.18% were categorized well and 49.82% were categorized very well on Collaboration in learning mathematics with STEAM.

The results of the analysis of interviews with students observations, Reflection Journal of Students and Questionnaire on Collaboration in learning mathematics with STEAM from students obtained results:

- Implementation of development Collaboration.
- Based on the results of the Integration questionnaire Collaboration in learning mathematics with STEAM

of the students 50.18% were categorized well and 49.82% were categorized very well

Integration of Creativity in Learning Mathematics with STEAM

Table 8. Recapitulation of the Results of the Collaboration Integration Questionnaire in Mathematics Learning with STEAM Class VIII B

No.	Question Questionnaire	Selected Results		Total
		G	VG	
1	Demonstrate ability to work together effectively	13	18	31
2	Mutual respect	15	16	31
3	Personal flexibility	19	12	31
4	Willing to help each other,	14	17	31
5	Compromise to achieve common goals	20	11	31
6	Work productively	15	16	31
7	To be responsible	12	19	31
8	Contribute to work.	18	13	31
9	Collaborate in groups, increase knowledge	14	17	31
total		140	139	279

G (Good) = 50.18% and VG (Very Good) = 49.42%

Table 9. Recapitulation of Results of Questionnaire Integration of Creativity in Learning Mathematics with STEAM Class VIII B

No.	Question Questionnaire	Selected Results		Total
		G	VG	
1	Generate ideas in discussions	14	17	31
2	Add ideas	14	17	31
3	Develop, implement, communicate new ideas	18	13	31
4	Be open, responsive to new things and diverse perspectives	11	20	31
5	Receive group input and feedback;	20	11	31
6	Demonstrate originality, understanding the limits of adopting new ideas	11	20	31
7	Regard failure as an opportunity to learn	13	18	31
8	Understand that creativity, innovation is a process	17	14	31
total		118	130	248

G (Good) = 47.58% and VG (Very Good) = 52.42%

Based on Table 9, respondents stated 47.58% were categorized well and 52.42% were categorized very well on Creativity in learning mathematics with STEAM.

The results of the analysis of interviews with students observations, Reflection Journal of Students and Questionnaire Creativity in learning mathematics with STEAM from students obtained the results:

- Implementation of development Creativity.
- Based on the results of the Integration Questionnaire Creativity in learning mathematics with STEAM of the students 47.58% were categorized well and 52.42% were categorized very well.

4. Conclusions

Based on research that has been done can be concluded as follows:

- The implementation of the development of Critical Thinking and the results of the Critical Thinking Integration Questionnaire showed 50.32% of good categories.
- The implementation of Communication development and the results of the Communication Integration Questionnaire showed 52.80% were categorized as very good.
- Implementation of the development of Collaboration and Questionnaire results Integration Collaboration to show 50.18% were categorized as good.
- Implementation of development Creativity and Questionnaire results Integration Creativity shows 52.42% were categorized very well.

REFERENCES

- [1] U. S. P. Nasional, "Introduction and Aim of the Study," *Acta Paediatrica*, vol. 71, pp. 6–6, 1982.
- [2] Bhriku K Lahkar and Büyükçolpan, *No 主観的健康感を中心とした在宅高齢者における健康関連指標に関する共分散構造分析 Title*, vol. 23, no. 3. 2019.
- [3] L. Sugiyarti, A. Arif, and Mursalin, "Pembelajaran Abad 21 di SD," *Pros. Semin. dan Disk. Nas. Pendidik. Dasar*, pp. 439–444, 2018.
- [4] I. W. Redhana, "Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia," *J. Inov. Pendidik. Kim.*, vol. 13, no. 1, 2019.
- [5] T. Hadinugrahaningsih *et al.*, "Keterampilan Abad 21 dan STEAM (Science, Technology, Engineering, Art, and Mathematics) Project dalam Pembelajaran Kimia," *LPPM Univ. Negeri Jakarta*, pp. 1–110, 2017.
- [6] Kemendikbud, "Permendikbud Nomor 103 Tahun 2014 Tentang Pembelajaran Pada Pendidikan Dasar dan Pendidikan Menengah," *Pedoman Eval. Kurikulum*, 2014.
- [7] J. Watson and K. Beswick, *Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia Edited by .*
- [8] L. D. C. Conner, C. Tzou, B. K. Tsurusaki, M. Guthrie, S. Pompea, and P. Teal-Sullivan, "Designing STEAM for Broad Participation in Science," *Creat. Educ.*, vol. 8, no. 14, pp. 2222–2231, 2017.
- [9] S. Hartman and D. Dani, "Full STEAM Ahead: Creating Interdisciplinary Informal Learning Opportunities for Early Childhood Teacher Candidates," *J. STEM Teach. Educ.*, vol. 54, no. 1, p. 3, 2020.
- [10] B. Keupula, "Jurnal Pendidikan Progresif," vol. 10, no. 1, pp. 146–153, 2020.
- [11] D. W. Aulia and M. Khafid, "Role of Learning Discipline in Mediating The Influence of Parent's Parenting Towards Student's Learning Achievement," *J. Prim. Educ.*, vol. 7, no. 2, pp. 155–162, 2018.
- [12] S. Bahrum, N. Wahid, and N. Ibrahim, "Integration of STEM Education in Malaysia and Why to STEAM," *Int. J. Acad. Res. Bus. Soc. Sci.*, vol. 7, no. 6, pp. 645–654, 2017.
- [13] C. Paxson and N. R. Schady, "The allocation and impact of social funds: Spending on school infrastructure in Peru," *World Bank Econ. Rev.*, vol. 16, no. 2, pp. 297–319, 2002.
- [14] F. Rizkamariana, S. Diana, and A. R. Wulan, "Assimilation .," vol. 7260, no. 1, pp. 19–23, 2019.
- [15] Etrina, N. Anriani, and M. Fathurrohman, "Pengembangan Bahan Ajar Matematika Berbasis Kompetensi Abad 21 untuk Guru SMP/MTs," *Pros. Semin. dan Disk. Nas. Pendidik. Dasar*, pp. 1–5, 2019.
- [16] M. R. Apriliana, A. Ridwan, T. Hadinugrahaningsih, and Y. Rahmawati, "Pengembangan Soft Skills Peserta Didik melalui Integrasi Pendekatan Science, Technology, Engineering, Arts, and Mathematics (STEAM) dalam Pembelajaran Asam Basa," *JRPK J. Ris. Pendidik. Kim.*, vol. 8, no. 2, pp. 42–51, 2018.

- [17] H. Sulistyaningrum, A. Winata, and S. Cacik, "Analisis Kemampuan Awal 21st Century Skills Mahasiswa Calon Guru SD," *J. Pendidik. Dasar Nasant.*, vol. 5, no. 1, p. 142, 2019.