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Exploring Collaborative Problem Solving in STEM Contexts for Middle School Students

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Abstract

In the 21st century, advances in science and technology require students to adapt. Classroom dynamics are still often dominated by passive learning methods, such as lectures, which result in a lack of student participation. PISA evaluation shows the low problems-solving abilities of Indonesian students. Therefore, the STEM approach emerged as a solution with a focus on essential 21st century skills, such as collaborative problem solving. The aim of the research is to investigate and analyze the collaborative problem solving process of junior high school students in solving STEM problems. The research method used is a case study with a qualitative approach. The research population included all students of SMP PGRI 13 Surabaya. Data collection techniques include observation, interviews, and questionnaires. Research instruments include questionnaires, observation sheets, and structured interviews. The research results show that collaborative learning in STEM context problem solving can help students develop problem solving skills. Students demonstrate good collaborative skills and their response to this learning is very positive. Evaluation of student learning outcomes also shows an increase, indicating the success of STEM-based learning methods in increasing student motivation. This research contributes to the understanding of the importance of learning approaches that integrate STEM with collaborative problem solving.

Keywords: Collaboration, problem solving, STEM

Abstrak

Dalam abad ke-21, kemajuan ilmu pengetahuan dan teknologi menjadi tuntutan bagi siswa untuk beradaptasi. Dinamika kelas masih sering didominasi oleh metode pembelajaran pasif, seperti ceramah, yang mengakibatkan kurangnya partisipasi siswa.Evaluasi PISA menunjukkan rendahnya kemampuan pemecahan masalah siswa Indonesia. Oleh karena itu, pendekatan STEM muncul sebagai solusi dengan fokus keterampilan abad ke-21 yang esensial, seperti memecahkan masalah secara berkolaborasi. Tujuan penelitian yaitu untuk menginvestigasi dan menganalisis proses pemecahan masalah kolaboratif siswa SMP dalam menyelesaikan masalah STEM, Metode penelitian yang digunakan adalah Studi kasus dengan pendekatan kualitatif. Populasi penelitian mencakup seluruh siswa SMP PGRI 13 Surabaya. Teknik pengumpulan data meliputi observasi, wawancara, kuesioner. Instrumen penelitian mencakup kuesioner, lembar observasi, dan wawancara terstruktur. Hasil penelitian menunjukkan bahwa pembelajaran kolaboratif dalam pemecahan masalah konteks STEM dapat membantu siswa mengembangkan keterampilan pemecahan masalah. Siswa menunjukkan keterampilan kolaboratif yang baik, dan tanggapan mereka terhadap pembelajaran ini sangat positif. Evaluasi hasil belajar siswa juga menunjukkan peningkatan, menandakan keberhasilan metode pembelajaran berbasis STEM dalam meningkatkan motivasi siswa. Penelitian ini memberikan kontribusi pada pemahaman tentang pentingnya pendekatan pembelajaran yang mengintegrasikan STEM dengan cara pemecahan masalah kolaboratif.

Kata kunci: Kolaborasi, pemecahan masalah, STEM

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Introduction

In the 21st century, the development of science and technology has accelerated rapidly. Students must be able to adapt to these developments in order to participate in these advances. Currently, it is not only knowledge and technology that students must learn, but also understanding its social implications is

very important (Zubaidah, 2019). However, in reality, several problems often arise in class dynamics which are dominated by the view that students tend not to be expected to be active in the learning process, but rather play a role as recipients of the material. As a result, passive learning methods can cause students to be more inclined to imitate, memorize or follow examples without really understanding the meaning, and the role of the teacher as the main source of knowledge still dominates the learning process. Many teachers still use the lecture method, which can make students less active and less likely to acquire 21st century skills (Mansur et al., 2022); (fina Zitari. & Masriyah, 2019).

This learning does not provide opportunities for students to be active and exchange opinions between students. When students are given problems, students feel difficulty and are less able to express the concepts they have. Education has an important role in preparing individuals who are able to face the challenges of contemporary developments. The skills that are essential for students to face rapid changes in today's world are known as 21st century skills. According to the Partnership for 21st Century Skills (2019); (Partnership for 21st Century learning, 2015), 21st century skills in the context of learning and innovation include critical thinking and problem solving skills, innovation and creativity, as well as the ability to communicate and collaborate (Qomaria & Wulandari, 2022).

If students are limited to learning that only emphasizes remembering and repeating knowledge and practicing certain skills, such as traditional learning methods, it is feared that they will only be prepared for certain types of work. Ironically, the specific skills taught may no longer be a significant selling point in today's world of work (Mu'minah & Suryaningsih, 2020). This creates a mismatch with the demands of 21st century work, as reflected in the results of program evaluations managed by the Organization for Economic Co-operation and Development (OECD), namely the Program for International Student Assessment (PISA), a context model which is divided into 4, including personal , occupational, social and scientific with the aim of evaluating the education system globally. The results of PISA 2022 also emphasize the government's failure to achieve the targets contained in the RPJMN (Medium Term Development Plan). The RPJMN target for reading scores is 396, while the 2022 PISA score is 359, down 12 points from 2018. For mathematics, the government in the RPJMN is targeting a score of 388, while the 2022 PISA score is 366, down 13 points from 2018. And for science, the RPJMN target is 402. while the 2022 PISA score is 383, down 12 points from 2018 (OECD (Organization for Economic Co-operation and Development), 2023). Based on the PISA survey results, it appears that Indonesian students' abilities in problem solving are still low. Problem solving is defined as a person's cognitive ability to understand and solve problems whose solutions are not clearly known (OECD, 2016) in (Hannania et al., 2022).

One solution to provide students with more opportunities to interact and share ideas is through the application of contextual collaborative learning. In this approach, students can work together in study groups to undergo a more involved and in-depth learning experience (Ulfiana & Asnawati, 2018) . In order to face the challenges of 21st century learning mentioned above, it is necessary to use appropriate learning models. One approach that can overcome this problem is implementing a collaborative learning

model based on science, technology, engineering, and mathematics (STEM). According to the Ministry of Education and Culture, the 21st century learning paradigm emphasizes students' ability to gather information from various sources, collaborate in problem solving, and think creatively (Etistika Yuni Wijaya et al., 2016) .

The ability to collaborate and problem solving skills are key aspects in life, this is in accordance with the views of the 2012 basic education commission, which identified problem solving and collaboration skills as an integral part of the skills needed in the 21st century era (Lertcharoenrit, 2020). (OECD, 2017) underlines the importance of collaborative problem solving as an important competency required for learning and work, because it can increase students' ability to find effective solutions to problems through collaboration in groups and other reasons for working together in solving problems has the potential for greater benefits than solving problems individually.

The skills needed by students to face the rapid development of today's world can be done with an appropriate learning approach, one model that can be utilized is STEM (science, technology, engineering, mathematics). STEM education does not only focus on mastering scientific and mathematical concepts, but students are encouraged to integrate their knowledge and skills in solving complex problems, designing solutions, and creating original works (Nurfajariyah & Kusumawati, 2023) . According to the Partnership for 21st Century Skills, STEM education is becoming increasingly important in preparing students to face the challenges of the modern world (Qomaria & Wulandari, 2022). One important aspect of STEM education is problem-solving skills, which require students to work collaboratively to solve complex problems. At the junior high school level, collaborative problem solving becomes a very relevant skill to acquire, because it reflects the work environment and the development of social skills.

Previous research has shown that most studies have only focused on the use of various techniques, approaches, and concepts that support problem-solving processes and group work. Therefore, along with the integrated nature of STEM education, previous researchers have shown that collaboration provides benefits such as combining diverse perspectives, expertise and experiences (Hesse et al., 2015). According to Lertcharoenrit (2020), there are six main characteristics in STEM-based education which include (1) an integrated teaching approach to science, technology, engineering, and mathematics with a focus on STEM understanding and knowledge; (2) innovation framework in the learning process; (3) context-based learning; (4) learning that is relevant to the demands of the 21st century; (5) use of design and problem solving activities; and (6) authentic assessment and evaluation.

The main point of this research is to identify how collaborative processes in STEM problem solving contribute to favorable or unfavorable outcomes by using visualization and tracking individual understanding. Researchers want to investigate and analyze the process of collaborative problem solving abilities of junior high school students in solving complex STEM problems through social interaction between group members (collaboration), which contributes to the results of collaborative problem solving in a STEM context.

Literature review

Collaborative Problem Solving

Collaboration has become a focus of research in a variety of disciplines, with varying motivations. If you look at the several explanations about collaborative learning above, the main essence is how important interaction between groups is to broaden each individual's understanding. This includes an understanding of human social and cognitive development from early infancy (Vygotsky, 1978), analysis of collective problem solving (Roschelle & Teasley, 1995), exploration of collective work (Schmidt, 1994), as well as the study of specific psychological processes such as collaboration in memory (Edward & Middleton, 1986) in (Baker, 2015) .

Fundamentally, collaborative learning refers to constructivism theory, especially the social constructivism theory developed by Vygotsky. This theory emphasizes the important role of social interaction in children's cognitive development. Vygotsky emphasized that social interactions with individuals around children form new ideas and accelerate their intellectual development. The focus of Vygotsky's research is on the dynamic relationship between individuals and society, where social interaction has a significant influence on learning outcomes (Suparno in (Widjajanti, 2008) .

Collaboration is defined as a form of interaction approaching each other to achieve common interests and goals. In the context of learning, cooperation refers to the act of helping each other or participating together to achieve a goal, which can involve the exchange of assistance between individuals. Collaborative learning, as a learning approach, can be implemented by providing group assignments that allow students to work together to complete a challenge or project. This approach aims to develop active learning and provide valuable experience in collaboration (Hasanah et al., 2022) . According to Ted Panitz in (Husain, 2020) , collaborative learning is not just a learning technique in the classroom, but a personal philosophy. He stated that collaboration is a philosophy of interaction and lifestyle that views cooperation as an interaction structure designed to facilitate collective efforts to achieve common goals.

Apart from collaboration skills, problem solving abilities are also an important need for students. The combination of these two skills is known as collaborative problem solving skills, which are two dimensions of 21st century skills. Collaborative problem solving is a form of cooperation between two or more people who have a common goal to solve a particular problem Dillenbourg in (Hannania et al., 2022) . Collaborative problem solving skills involve a student's ability to engage effectively in the learning process with two or more students, with the goal of solving problems through shared understanding and joint effort. This process involves combining the knowledge and skills necessary to achieve a problem-solving solution (OECD, 2019) . Collaborative problem solving skills view the process of cooperation between students in solving a problem as the main element for building their own knowledge construction. The steps in collaborative problem solving skills include a combination of problem solving steps and collaborative skill steps. According to (Wulandari et al., 2022) in their article, Collaborative problem solving is a concept that includes a series of skills that integrate cognitive

and social aspects through collaboration with other individuals to achieve common goals. Collaborative problem solving ability can be defined as the effective involvement of individuals with two or more individuals or agents to solve problems by sharing understanding, knowledge, skills and efforts to achieve solutions (OECD, 2017). Collaborative skills steps include (a) building and maintaining shared understanding, (b) taking appropriate action to solve problems, and (c) establishing and maintaining a team organization. Thus, collaborative problem solving involves combining cognitive and social skills through cooperation with other individuals, while attending to specific collaborative skill steps to achieve desired outcomes. According to Brookfield in (Khoiriyah, 2016), with such learning characteristics, he believes that the collaborative process in learning can encourage initiative, creativity, critical thinking skills and dialogue in students. According to Palloff & Pratt also states that collaborative learning can deepen deeper understanding, encourage initiative, creativity and critical thinking, enable students to create shared goals and form learning communities, accommodate various learning styles & suit individual learning styles, and consider aspects culture and includes cultural issues. With proper implementation through an appropriate collaborative learning process, characters such as integrity, responsibility, self-confidence, mutual respect and the desired social skills can be formed. The existence of differences in collaboration between students can lead to optimal results, not cause divisions.

STEM

The Science, Technology, Engineering and Mathematics (STEM) learning concept includes four sciences, namely knowledge, technology, engineering and mathematics, which are interrelated as problem solving patterns. The STEM method aims to create students who dare to take risks, engage in experiential learning, persist in problem solving, embrace collaboration, and work through creative processes. STEM originated in America and has become the basis for several schools that combine science, engineering, engineering and mathematics, encouraging students to study and integrate various types of science (Hasanah et al., 2022) .

The STEM learning approach is a method that can improve abilities and create quality human resources in accordance with the demands of 21st century skills (Nuryani Y. Rustaman, 2016) . In the context of STEM Education learning, real daily experiences are integrated into learning activities with the aim of attracting students' attention to the material being taught. In addition, this approach aims to convey the problems that exist around students' environment, with the hope of stimulating their understanding. The provision of material should be closely related to the students' environment so that learning is more applicable and students can practice the material directly in their daily lives.

Method

The type of research that the researcher conducted was a qualitative approach. With a case study research method. Qualitative research is a research method based on the philosophy of postpositivism, used to examine the conditions of natural objects, (as opposed to experiments). The data source in this

research is all students of SMP PGRI 13 SURABAYA who take part in STEM learning. In this case the researcher took the main research informants who were all students at SMP PGRI 13 Surabaya and where the researcher was the key instrument. As researchers involved 30 students from grades 7, 8 and 9 as respondents to observations and questionnaires. 2 student representatives as interview respondents.

In this research, researchers used data collection techniques, namely triangulation techniques in the form of observation, interviews and questionnaires as well. The observation technique focuses on teacher "independence", namely the activities of implementing the Merdeka curriculum in the classroom starting with joint planning between the researcher, observer and those being observed. The instrument is a questionnaire which is applied by asking questions via Google Form which is distributed via WhatsApp and filled in by respondents. The respondents involved in this research were all students of SMP PGRI 13 SURABAYA with a total of 30 students consisting of 4 students from class 7, 18 students from class 8 and 8 students from class 9. In this case the data was collected using the results of technique triangulation, (1) Structured observation by observing using observation instruments that are structured and ready to use, the observer only needs to put a check list mark (√) on the observation sheet which consists of several aspects, namely collaboration skills which include working productively, showing respect, compromise and responsibility, where each indicator has a scale of 4 - 1 according to a predetermined rubric; (2) Conduct interviews, by making a structured list of questions as an interview guide and utilizing recording tools involving 2 student representatives from a total of 30 students in the school; (3) Filling out a Likert scale questionnaire (Favorable item) where each indicator has a scale of 5 - 1 according to the rubric that has been given.

Analysis of triangulation results refers to indicators of collaborative problem solving criteria in each aspect of problem solving as follows:

Table 1. Collaborative criteria indicators in every aspect of problem solving

Aspects of Collaboration Skills	Very good (Score 4)	Good (Score 3)	Enough (Score 2)	Not enough (Score 1)
Work productively	Uses all time efficiently to stay focused on tasks and produce required work. Each group member does his or her job	Collaborates well and for the most part stays on task until team members complete the work. Each team member performs almost all assigned tasks	Sometimes working together, but not all team members contribute or do their work, making it difficult to get the job done	It really doesn't work well together. All team members want to do their own thing and tell other team members what to do so they don't focus on the task
Show respect	All team members respectfully listen and discuss the ideas shared	Most team members listen and interact respectfully	Some team members have difficulty respecting other people's ideas	Members do not want to listen to others and argue with teammates

Compromise	All team members are flexible in working together to achieve common goals	Compromise to advance and complete group work more quickly	Requires more team members to compromise to make work faster	There was a lot of disagreement, and some team members wanted it just their way
Responsibility	All team members do their best work and follow the assigned task	Most of the team members work on the assigned tasks	It is difficult to get all team members involved in group work	really can't rely on all the team members to do their jobs

Table 2. Categories of collaborative skills per aspect

Percentage (%)	Category
$80 < x \leq 100$	Very good
$60 < x < 80$	Good
$40 < x < 60$	Enough
$20 \leq x < 40$	Not enough

Calculating data using a Likert scale, the results are compared with the interval formula as in table 3 (Puji & Maria, 2016)

Table 3. Student collaboration impact questionnaire per individual aspect

Percentage (%)	Category
$3.25 < x \leq 4.00$	Very good
$2.50 < x \leq 32.5$	Good
$1.75 < x \leq 2.50$	Not good
$0 < x \leq 1.75$	Not good

In this research, the data analysis technique follows the approach suggested by Miles and Huberman (1992) in (Budiarto Muhammad Arif, 2023) which involves three main steps: data reduction, data presentation, and verification (drawing conclusions). The data reduction process begins by identifying and separating irrelevant interviews related to students' Collaborative problem solving in STEM Contexts. Next, relevant interview data is simplified and then presented in transcript form. This data will be discussed together with survey results via questionnaires to determine the effectiveness of learning in STEM lessons through problem solving using collaborative methods. After the data is presented, conclusions will be drawn based on analysis of survey results through questionnaires and interviews, in order to better understand students' Collaborative problem solving abilities in the STEM Context. The final step is to prepare a research report that summarizes the results of the investigation and analysis of junior high school students' collaborative problem solving process in solving STEM

problems. Students also reported emotional and cognitive indicators that describe their participation and engagement in collaboration. Emotional indicators expressed include interest, joy, happiness, pride, feelings of connection, emotional management, positive learning experiences, and a conducive work atmosphere. Apart from that, students also show empathy, mutual respect, positive attitudes, motivation, and perseverance. On the other hand, indicators of cognitive engagement experienced include conveying ideas and clarifying ideas, developing additional ideas, mutual understanding, exploring fundamental concepts, creating alternative solutions, using metacognitive strategies, evaluating self-thoughts, improving, adjusting goals, searching for information. necessary, recognizing the importance of the information, and demonstrating determination to resolve the problem.

This qualitative research method is expected to provide a comprehensive understanding of the application and obstacles in implementing the STEM integrated thematic learning approach. It is hoped that the research results will provide benefits in enhancing and improving the learning process, as well as becoming a guide for teachers and policy makers in the world of education.

Results and Discussion

The main objective of this research is to investigate and analyze the collaborative problem solving process of junior high school students in solving STEM problems. The research focus includes understanding how students work together , communicate, and support each other in completing the STEM tasks they face and how this can influence students' understanding of STEM concepts and motivation at the junior high school level.

At the beginning of STEM learning activities, students seemed less motivated when participating in learning. This is because students only learn through information from teachers and books without direct practicum. STEM learning was carried out on 30 students who were divided into 5 groups and in each group there were 6 people paying attention to the activities carried out by the students. There are several activities that students must do in learning activities, for example, students explore the stages of making water filtration and how to freeze ice using simple tools.

Based on this main objective, the results and discussion in this section are presented by researchers collecting data by administering questionnaires, tests, observations and interviews.

Students' problem solving collaboration skills

The results of this research are in the form of structured observations consisting of 4 aspects, namely collaboration skills which include working productively, showing respect, compromise and responsibility, where each indicator has a scale of 4 - 1 according to a predetermined rubric.

In this activity, students began to collaborate with their groups so that researchers also took turns accompanying all groups in the STEM learning process and making observations by observing students' activities when carrying out STEM collaboration. It was found that there were 3 groups who experienced problems in Filtration activities where the ratio and proportion in calculating the amount of filtration material needed based on the amount of water to be filtered was not quite right, causing

failure in the manufacture, as well as making rotating ice using simple tools, there were several groups who experienced The problem is in the comparison and ratio used between the amount of water dissolved in ice cubes and the addition of crushed salt used in making ice, then the level of freezing of water into ice (freezing point) which estimates the change, rate and speed based on the time needed to freeze the water solution. in the can, so this causes failure in making ice due to the effect of the freezing process which is quite long and thawing occurs quickly when the product is ready. So for this problem collaboration between groups is also needed.

So the researchers analyzed collaborative skills data per aspect by calculating the average percentage score for each aspect. The results of data analysis on collaborative skills per student as a whole show that out of 30 students divided into 5 groups have collaborative skills in the Good category, which are presented in Table 4 (Qomaria & Wulandari, 2022)

Table 4. Students' collaborative skills per aspect

Aspect	Score (%)	Category
Work productively	60%	Good
Show respect	80%	Good
Compromise	80%	Good
Responsibility	60%	Good

Based on the data presented in Table 3, it can be seen that all aspects of collaborative skills are in the Good category. In detail per aspect that needs to be developed, namely, working productively and responsibly.

The aspect of working productively relates to how to use all time efficiently to stay focused on the task and produce the work required, as well as each group member doing his or her job. From the results of observations on this aspect, it can be observed that some students tend to remain silent without contributing ideas, suggestions or solutions when participating in discussions and do not speak according to the context. The aspect of working productively is measured through accuracy in collecting tasks and producing products. This is in line with Greenstein's view in (Rahmawati et al., 2019) which states that working productively with other people involves using time efficiently, remaining focused on the task without needing to be directed, and producing the necessary work. Likewise, the view of (Mulyani & Fuadi 2020) in (Khoirunnisa & Sudibyo, 2023) which states that sharing information, ideas or thoughts in finding solutions can improve collaboration skills.

So this needs to be evaluated so that students can be active by contributing ideas, suggestions or solutions when participating in discussions and speaking according to the STEM context they are working in so that they can work productively with their group members in solving the problems given . So this indicator is trained at the stage of testing the results to obtain a good category.

The Responsibility aspect relates to how all team members do their best work and follow the assigned tasks. The aspect of responsibility in completing work, as explained by (Sarifah and Nurita, 2023) in

(Khoirunnisa & Sudibyo, 2023) , can be divided into three observation criteria. First, students can be assessed based on their ability to solve problems within the set time limit. Second, students can show their responsibility by actively discussing with the group in answering problem formulations, formulating hypotheses, carrying out analysis, answering discussion questions, and jointly concluding the results of the discussion. Finally, student responsibility is also reflected in their ability to search for relevant learning resources. Thus, these three criteria reflect aspects of student responsibility in responding to assignments and participating in learning activities.

From the results of observations on this aspect, it can be observed that some students in the group tend not to do their assignments well and there is a lack of responsibility for each member in doing it, some students' work still needs to be repeated or completed with the help of other group members because they are reluctant to seek information from own learning sources, whether books or the internet, and prefer to ask other groups. This policy emerged because of students' lack of initiative to search for learning resources independently, perhaps due to laziness or the desire to get instant answers without having difficulty finding information from learning sources that requires further understanding. Thus, students tend to rely on answers from other groups without making an effort to find answers from these learning sources themselves. This is in accordance with the statement (Yaqin et al., 2018) ; (Rahmawati et al., 2019) that in group activities, each student is not only responsible for himself but also helps friends in the group. The aspect of responsibility in completing work must be mastered by students so that with a sense of responsibility, students are able to carry out and check the tasks they are part of fully. Likewise, according to Khoirunnisa & Sudibyo (2023) , the aspect of responsibility in completing work must be mastered by students so that with a sense of responsibility, students are able to carry out and check the tasks that are part of them fully.

So this needs to be evaluated so that students can show their responsibility by actively discussing with the group in answering problem formulations, hypotheses, carrying out analysis, answering discussion questions, and jointly concluding the results of the discussion, so that they can take full responsibility in solving the problems given. So that this indicator was trained at the stage of testing the results to obtain a good category.

Student Responses to STEM collaborative learning

The results of filling out the Likert scale questionnaire (Favorable items) where each indicator has a scale of 5 - 1 according to the rubric that has been given to each individual, this was done with the aim of researchers wanting to know the impact experienced while carrying out STEM-based collaborative learning. Whether it has a good impact on each student or not is presented in Table 4. (Qomaria & Wulandari, 2022)

Table 5. Student collaboration impact questionnaire per individual aspect

Aspect	Score (%)	Category
Motivation	46.7% (14 out of 30 students)	Very Motivated
Learning Pleasant	51.65% (16 out of 30 students)	Very pleasant
Satisfaction	43.3% (13 out of 30 students)	Very satisfied
Involvement	50% (15 out of 30 students)	Very high
Division of tasks And Responsibility	43.3% (13 out of 30 students)	Very good
Understanding	56.7% (17 out of 30 students)	Very helpful
Communication	46.7% (14 out of 30 students)	Very helpful
Problem Solving	50% (15 out of 30 students)	Very good

Based on the data presented in Table 5, it can be seen that all aspects of the Questionnaire impact of student collaboration per individual aspect are in the Very Impactful category. This can be analyzed from the categories, based on the results of the presentation, it can be seen that the percentage score is 3.25 % . The percentage of STEM practicality can be determined by calculating the average as follows:

= (Percentage of all statement items) /(Total statements x Average number of respondents)

= (46.7% + 51.65% + 43.3% + 50% + 43.3%+ 56.7% + 46.7% + 50%) / (8 x 15)

= 3.25 %

The student response questionnaire consists of eight aspects that can explore student responses when carrying out STEM activities. Through this aspect, researchers obtained data that 3.25 % said it was very good. If these results are interpreted using a table, they are between $3.25 < x \leq 4.00$. This is in accordance with the results of research conducted by (Suriyana & Novianti, 2021) , students' responses to STEAM (Science, Technology, Engineering, Art, and Mathematics) based mathematics learning generally gave positive responses

Interview Transcription

Subject 1 is a category of students who are quiet in their class. This is based on the results of the following interview :

Q : Do you feel more motivated/happy when studying in a group? Why?
S1 : Yes, sis, I'm very happy, because I can study together with my friends
Q : What are the main benefits you find in collaborative learning? How does this affect your understanding of the subject matter?
S1 : I can learn more, but it doesn't affect my understanding because of my group friends I'm busy
Q : What do you think makes collaborative learning interesting or uninteresting? Why ?
S1 : What makes me interesting is because I can study with friends and those who don't interesting is the mathematics
Q : Do you feel that collaborative learning has helped your social skills, such as communication , cooperation, or leadership? If yes, how?
S1 : A little is possible. Because I rarely talk, all I can do is talk four eye
Q : Have you ever experienced difficulties or problems when working in a group? How do you solve this problem?
S1 : Never, because I think about it together with friends
Q : How do you and your group mates usually divide tasks in collaborative projects? How do you ensure every group member contributes?
S1 : I did it on the initiative
Q : How do you feel involved in decision making in the group? Do you feel you have made a meaningful contribution?
S1 : I followed the directions given. Yes, I contributed, for example when doing ice turns

Based on the answers and interviews above, it can be concluded that Subject 1 is able to participate in collaborative activities well in terms of interaction, motivation and contribution. Although there was a slight obstacle where subject 1 felt that he did not fully understand due to group friends who were not conducive, coupled with the nature of subject 1 who tended to be shy, this could possibly be a reference in future research regarding differences in student characteristics in the learning process.

Subject 2 is a category of students who are active in class. This is based on the results of the following interview:

Q : Do you feel more motivated/happy when studying in a group? Why?
S2 : Very motivated but it's better if one group contains women, because if there are any their sons did not contribute anything

Q : What are the main benefits you find in collaborative learning? How does this affect your understanding of the subject matter?
S2 : Gaining new knowledge, because we work together to solve it

Q : What do you think makes collaborative learning interesting or uninteresting? Why ?
S2 : what makes it interesting is because the activities are exciting, unlike those taught by the teacher

Q : Do you feel that collaborative learning has helped your social skills, such as communication, cooperation, or leadership? If yes, how?
S2 : yes, because collaboration makes me less awkward when interacting with people others

Q : Have you ever experienced difficulties or problems when working in a group? How do you solve this problem?
S2 : Once, when we couldn't find a solution so we searched via Google and on
When it failed to make filtration and rotating ice, we tried again with an estimate until it works.

Q : How do you and your peers usually divide tasks in collaborative projects? How do you ensure every group member contributes?

S2 : Just share (there are parts looking for answers, writing, and asking questions), To make sure, if I don't join in the work, I will be scolded

Q : How do you feel involved in decision making in the group? Do you feel you have made a meaningful contribution?
S2 : Takes a direct role and divides tasks. Yes, I definitely contribute

Based on the answers and interviews above, it can be concluded that Subject 2 is able to participate in collaborative activities well in terms of interaction, motivation and contribution. Subject 2 felt that collaboration could increase knowledge because they worked together to find the best solution together. There were no problems experienced, even if there were Subject 2 invited his group friends to find a solution.

From the results of the interviews with the 2 subjects, it can be concluded that by collaborating they can easily solve complex STEM problems through social interaction between group members, which contributes to the results of collaborative problem solving in a STEM context. Both of them feel motivated and happy when studying in groups, because they can learn from each other with friends and the activities carried out are more exciting than conventional learning. The main benefits they get are gaining new knowledge and improving social skills such as communication and cooperation. Even though both of them experienced several difficulties in group work, such as difficulty finding a solution or failing at a task, they managed to solve it by searching for solutions on the internet or by continuing to try until they succeeded. Overall, collaboration in learning helps improve understanding of subject matter, enriches learning experiences, and develops students' social skills and problem-solving abilities (Song, 2018).

Apart from similarities, there is also a slight difference between subject 1 and subject 2 in solving problems through collaborative STEM, namely Subject 1 felt that collaborative learning did not have a significant effect on understanding the material because of the noise in the group, while subject 2 felt that collaborative learning helped improve understanding. Subject 1 has never experienced problems working in groups, while subject 2 has experienced difficulties in finding solutions to the problems they face. Subject 1 experienced a slight improvement in his social skills, while subject 2 experienced a more significant improvement, especially in overcoming awkwardness when interacting with other people. When dividing tasks in a collaborative project, subject 1 relies more on his own initiative, while subject 2 monitors the contributions of group members more and provides warnings if necessary. Subject 1 follows the directions given in the group, while subject 2 is actively involved in decision making and task distribution. Although there were variations in their experiences and approaches to collaborative learning, both subjects demonstrated success in solving problems together and felt they had a meaningful contribution to the group. This research is in line with Salim (2017) that the application of a collaborative problem solving learning model can improve elementary school students' mathematical representation abilities.

Conclusion

Based on the research results, it can be concluded that Collaborative Problem Solving in the STEM Context for students at SMP PGRI 13 Surabaya contributes to good results, which can be explained through collaborative learning and problem solving can help students develop solving skills from this process. In observing student activities in groups, the results showed that the average collaborative skills data score per aspect of 30 students divided into 5 groups had collaborative skills in the Good category. Student responses to collaborative problem solving in STEM contexts generally have a very good impact, with the average student providing a positive response. Evaluation of student learning outcomes after receiving result-based learning can be concluded if by collaborating they can easily solve complex STEM problems through social interaction between group members, which contributes to the results of collaborative problem solving in a STEM context. Beside that, the application of a STEM approach can make a positive contribution to students' collaborative activities, motivation, and development of collaborative competencies in the context of project-based learning. This implementation can help students develop relevant skills in preparation for facing current and future world challenges so that there are similarities in the research that will be carried out by researchers, namely to obtain information or an overview of the collaborative problem solving process of junior high school students in solving STEM problems.

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