JURNAL TARBIYAH

E-ISSN : 2597-4270 | P-ISSN : 0854-2627
Volume 31, Number 1, June 2024, pp. 17-31

STUDENTS' COLLABORATIVE SKILLS WITH AN APPROACH ETHNO-STEAM PROJECT *OTK-OTOK* GAME CONTEXT IN MATHEMATICS LEARNING

Marah Doly Nasution[1], Ismail Saleh Nasution[2], Suci Perwita Sari[3]

[1,2,3] Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia
[1]marahdoly@umsu.ac.id, [2] ismailsaleh@umsu.ac.id, [3] suciperwita@umsu.ac.id

DOI : http://dx.doi.org/10.30829/tar.v31i1.3059

ARTICLE INFO

Article History
Received : October 13, 2023
Revised : May 5, 2024
Accepted : June 13, 2024

Keywords
Ethno-STEAM project,
Collaborative skills,
Otok-otok,
Matematic Learning

ABSTRACT

The traditional otok-otok game as a STEAM (Science, Technology, Engineering, Art, and Mathematics) based project can be used for mathematics learning. Research like this has never been done. The aim of this research is to describe students' collaborative skills through the Ethno-STEAM Project learning approach. The research subjects were 32 students with a pre-experimental research type with a one-shot case study design. Data regarding students' collaborative skills was obtained from student self-report questionnaires and data was strengthened through collaborative activity observation sheet forms. Data analysis uses descriptive statistics in the form of total scores and average percentages for each aspect or subdomain. The application of Ethno-STEAM Project learning in the context of otok-otok games produced results, namely that students' collaborative skills were in the high category 56%, in the medium category 31%, and in the low category 13%. Aspects of collaborative skills in the high category include motivation, contribution, problem-solving, time management, group dynamics, and interaction with group members. Aspects that need further development are in the categories of work quality, group support, readiness, roles, and reflection. The application of the Ethno-STEAM approach to the *otok-otok* game project in mathematics learning can be an alternative for developing students' collaborative skills.

Introduction

Education has an important role in preparing society to face current developments. In the era of Industrial Revolution 4.0 and entering Society 5.0, students' abilities and skills must be adequate according to the demands of their development to develop and survive well. In this era, students not only focus on studying science and technology, but students must also learn about its social impact (Zubaidah, 2019). The skills that students must have to face this very

fast development era are known as 21st-century skills. The learning and innovation that students must have in the 21st century consist of critical thinking and problem-solving skills, innovation and creativity, as well as communication and collaboration (Mu'Minah & Aripin, 2019)

The focus of this research is developing 21st-century skills, namely students' collaborative skills. Collaborative skills are cooperation skills, in sharing responsibilities and roles to achieve several common goals to solve problems and find solutions (Fitriyani et al., 2019). Collaborative skills must be possessed by students in learning because collaborative skills are very useful in supporting student learning achievement (Ulhusna et al., 2020). Students with collaborative skills abilities can contribute individually at different times or places or can do so separately with other team members simultaneously (Falcione et al., 2019). Collaborative skills can play a role in connecting people for a better life. Considering the rapid development of the world with different opinions and perspectives for each individual on various topics, students must be well equipped with these collaboration skills.

Based on the results of interviews with sixth-grade elementary school mathematics teachers, students' collaborative skills were categorized as not having developed optimally. Some of the problems that occur are that students still have difficulty managing work and assignments effectively, students still experience difficulties in dealing with differences of opinion that arise in group discussions and assignments, and students' low motivation to be directly involved in individual and group problem-solving activities. This is in line with research conducted by Hermawan et al., (2017) stated that elementary school students' collaborative skills are still categorized as low. This is reinforced by research conducted by Balqist et al., (2019) dan Ulhusna et al., (2020) where this is caused by several things, including teachers still using monotonous learning methods and teaching materials, teachers who do not yet ready in carrying out learning design, and the existence of student anxiety in learning.

In line with 21st-century educational trends, the separation of learning topics is not too relevant, but instead students are given the opportunity to master various knowledge and solve non-routine problems (Norhaqikah & Kamisah Osman, 2017). The relevant learning approach related to 21st-century skills is STEAM (Zubaidah, 2019). STEAM is a learning approach that combines five disciplines, namely Science, Technology, Engineering, Arts, and Mathematics. These five disciplines can be studied simultaneously. In the STEAM approach, students are given many opportunities to integrate the five disciplines in developing problem-solving ideas. Students can utilize technology to study science and use mathematical language to represent ideas into problem-solving designs, then by using engineering, students can create prototypes

of their creative work by considering the element of art as an aesthetic element. (Cholily, 2020). Several previous studies have proven that successful learning using the STEAM approach can develop 21st-century skills. (Qomaria & Wulandari, 2022; Widarwati et al., 2021; Yuntiaji et al., 2020)

According to the National STEM Education Center, STEM education is a learning approach that focuses on solving problems that occur in everyday life (Astawan et al., 2019). Therefore, learning with a STEAM approach should focus on presenting contextual problems. The contextual problems presented are to encourage students to connect the knowledge they have and apply this to their lives (Isharyadi, 2018). Contextual problems are expressed in the local cultural context and the application of local cultural education can be a solution to conflict and disharmony that exists in society (Mesiono et al., 2017). The combination of local culture with the STEAM approach is called Ethno-STEAM. The Ethno-STEAM integration approach can be used to solve real problems in a cultural context (Sumarni & Kadarwati, 2020)

North Sumatra, which is rich in culture, has potential as a source of learning Mathematics in elementary school. Through the Ethno-STEAM approach, mathematics teachers and cultural practitioners can work together to solve problems in a cultural context that can be solved by integrating science, technology, engineering, art, and mathematics. One of the local cultures of North Sumatra that can be used as a lesson in science, art, and mathematics is *otok-otok*. The word *otok-otok* is a traditional toy made from bamboo that makes a distinctive sound when rotated or pushed. This game is a human-made game played by a group of traditional practitioners on Kecamatan Percut Sei Tuan, Desa Kolam, and Kabupaten Deli Serdang. Based on an interview with Suhendra, one of the *otok-otok* craft activists, he said that this *otok-otok* game can be found when the month of *Ramadhan* arrives, when children in the village pass the time before breaking the fast by playing *otok-otok*. The *otok-otok* game also has a competition event, each match is judged on the aspects of beauty and speed.

The *otok-otok* game can be explored from various scientific perspectives such as Science, Technology, Engineering, Arts, and Mathematics. This traditional game has the potential as a learning resource that can be presented through Project Based Learning. Project Based Learning has a principle on the importance of projects as learning centers and knowledge builders (Condliffe et al., 2017). Project Learning will foster students' ability to learn independently and think positively, and critically and solve problems and find solutions through a learning process that focuses on practical problems and students are encouraged to carry out group discussions (Safarini, 2019; Uziak, 2016).

The results of previous research conducted by Rizkiyah et al., (2020); Saenab et al., (2019); dan Triana et al., (2020) Through the application of the STEM-PjBL approach, show that the learning approach can develop students' collaborative skills in the effective category. The difference between this research and previous research is the addition of art elements. Apart from that, the context used is the *otok-otok* game which is a traditional North Sumatran toy. The context used, namely *otok-otok*, has never been applied in previous studies.

The aim of this research is to describe students' collaborative skills developed through the Ethno-STEAM learning approach. The focus of this project is the otok-otok toy which comes from the traditional game of North Sumatra. Collaborative learning activities in the context of students' lives and skills. Students can develop and plan joint ventures. The hope of this research is the development of student learning activities through collaborative skills in a context that is close to the student's own lives.

Research methods

Berisi jenis penelitian, waktu dan tempat penelitian, target/sasaran, subjek penelitian, prosedur, instrumen dan teknik analisis data serta hal-hal lain yang berkait dengan cara penelitian dilakukan. Target/sasaran, subjek penelitian, prosedur, data dan instrumen, dan teknik pengumpulan data, serta teknik analisis data serta hal-hal lain yang berkait dengan cara penelitiannya dapat ditulis dalam sub judul.

This research is pre-experimental research with a one-shot case study design. The experimental class used is class VI A SD Negeri No. 104201, Desa Kolam, Kecamatan Percut Sei Tuan, Kabupaten Deli Serdang consisting of 32 students. Stages of research procedures include; preparation, implementation, observation, and evaluation. In the preparation stage, researchers conducted interviews with mathematics teachers to determine students' general collaborative skills and prepare learning tools and research instruments. At the implementation stage, learning was implemented using the Ethno-STEAM project approach. The steps in the implementation phase include 1) introduction and project planning; 2) collection of information; 3) product design and initial evaluation; 4) product revision; and 5) presentation and final evaluation (Bender, 2012). Next, at the observation stage, observations are made of individual performance and group performance. The final stage is evaluation. At the evaluation stage, students are involved in filling out a collaborative skills questionnaire. Next, researchers, teachers, and observers conducted a Focus Group Discussion (FGD) to discuss the results of student questionnaires and observation findings.

Data on each student's collaborative skills was obtained through student self-report questionnaires in learning using the Ethno-STEAM Project approach using an auto-tock context and reinforced with collaborative activity observation sheets filled in by three observers. The student self-report questionnaire was adapted from the Collaboration Self-Assessment Tool (CSAT) which was developed by Kathleen Ofstedal and Kathryn Dahlberg in their research Collaboration in Student Teaching: Introducing the Collaboration Self-Assessment Tool where a case study approach was used to explain how this tool can be used to improve collaboration between cooperating teachers and prospective teachers, thus paving the way for more successful and meaningful student teaching experiences (Dahlberg, 2009). The aspects of collaborative skills that are measured are student contribution, student motivation, quality of student work, student time management, support for groups, the readiness of students and their groups, problem-solving carried out by students with their groups, dynamics that occur in groups, student interactions with group members, role, and reflection. Observation sheets focus on individual activities and group performance. Group performance was observed based on aspects of collaborative skills adapted from Safarini's research: 1) students work together; 2) students share responsibility fairly; 3) students make substantive decisions together; 4) the results of students' work are interdependent. Individual activities are observed based on aspects of the self-report questionnaire (Safarini, 2019).

Measurement of the collaborative skills aspect uses a 1-4 Likert Scale. Data analysis for each aspect of collaborative skills uses descriptive statistics in the form of total scores for each student's category and average percentages. The following is a categorization of collaborative skills per student and aspect.

Table 1. Collaborative Skill Categories Per Student

Total Score	Category
35-44	high
26-34	medium
10-25	Low

Table 2. Collaborative Skill Categories Per Aspect

Percentage (%)	Category
$75 < x \leq 100$	high
$26 < x \leq 34$	medium

$10 < x \leq 25$	Low

Results

The implementation of learning using the Ethno-STEAM Project approach in the context of *otok-otok* went well. Each research procedure was carried out sequentially. The self-report questionnaire is filled in completely by students. Analysis of collaborative skills data per student as a whole shows that the collaborative skills results of 32 students showed that 18 students got the high category, 10 students got the medium category, and 4 students got the low category. The following is a percentage table in Table 3.

Table 3. Categories of students' collaborative skills based on gender.

Category	Amount	Percentage (%)
high	18	56
medium	10	31
Low	4	13
Amount	32	100

Collaborative skills data analysis per aspect was carried out by calculating the average percentage score for each aspect. The aspects assessed are student contribution, student motivation, quality of student work, student time management, support for groups, the readiness of students and their groups, problem-solving carried out by students with their groups, dynamics that occur in groups, student interactions with group members, roles, and reflection, the results of data analysis are presented in Table 4

Table 4. Students' collaborative skills per aspect

Aspect	Amount	Percentage (%)	Category
Contribution	28	88	high
Motivation	24	75	high
Work quality	22	69	medium
Time management	29	91	high
Support for Groups	23	72	medium
Readiness	24	75	high
Solution to problem	26	81	high
Group dynamics	27	84	high

Interaction	25	78	high
Role	23	72	medium
Reflection	22	69	medium

Based on the data in Table 5, it can be seen that the aspects of collaborative skills that are in the high category are student contribution, student motivation, student time management, the readiness of students and their groups, problem-solving carried out by students with their groups, dynamics that occur in groups, student interactions with group members. Meanwhile, the aspects of collaborative skills that are in the medium category are the quality of student work, group support, roles, and reflection.

Discussion

Based on the implementation of learning using the Ethno-STEAM Project approach in the context of otok-otok, it was found the results of observations on the quality of work aspect show that some students' work and assignments still need to be repeated or completed by other group members. This is caused by anxiety, mistakes, and a lack of student self-confidence. This aspect of work quality is related to how students strive to do their best in each job and responsibility. Efforts that can be made to minimize anxiety and increase student self-confidence are to accustom students to dare to express their opinions create a pleasant learning environment and make themselves as comfortable as possible.. This is in line with research conducted by (Primadhini, 2021; Prodromou and Frederiksen, 2018) where anxiety and self-confidence in learning mathematics can influence several reactions including cognitive, affective, and psychomotor.

Aspects of support for groups also need to be developed. Some students are just responsible and focus on the work they are responsible for. They pay less attention to group activities. Students' less-than-optimal collaborative skills can be identified because these students tend not to be involved in the results of the group as a whole (Atun & Latupeirisa, 2021). The optimal collaborative skills of students in the quality aspect of work are proven by each student being responsible for themselves and helping friends in one group (Yaqin et al., 2018). The teacher as a facilitator needs to provide reinforcement that the problems presented in the group need to be faced together (Dahlberg, 2009).

The role aspect also needs to be developed because, from the results of observations, some students tend to choose the monotonous role of being a follower in every group activity. In fact, group discussions require good leadership strategies. Leadership in question is a person's ability to encourage a number of other people to take responsibility and work together in carrying out activities in an orderly and directed manner to achieve common goals. (Kuswara et al., 2018). Several efforts can be made to develop these abilities, according to Gialamas et al., (2020) by involving students directly in learning, giving students the opportunity to take responsibility for their activities and efforts, giving students material about the basics of good leadership, and provide guidance to make good choices.

The next aspect that is in the medium category is the reflection aspect. The reflection aspect still needs to be developed further so that students can regularly reflect on themselves. Reflection is carried out when collaborative activities are going well or when there are problems in collaborative activities. The existence of reflection allows students to learn from each other, students provide opportunities for other students to have freedom in expressing the ideas and thoughts they find (Listiyani, 2018). This reflection is very important in collaborative activities so that students can make better contributions. At the end of each lesson, teachers can familiarize students with reflecting on things that happened during learning activities. This can be done by providing an assessment of yourself and your colleagues. This method is able to facilitate deep student involvement in learning, foster trust, and have a positive impact on learning (Hidayat, 2018; Yusuff, 2015).

The application of learning using the Ethno-STEAM approach to this project is divided into six groups. Based on the observation results, the group with the best performance was group 1 (one). This group shows cooperation, has a fair role of responsibility, makes decisions together, and depends on each other to complete the work (project). Groups with a combination of high and medium collaborative skills, namely groups 2 (two), 3 (three), and 6 (and), generally show the same indicators as group 1 (one), but sometimes the division of tasks within the groups is less clear. In groups 5 (five) and 4 (four) the observation results showed a combination of collaborative skills in the high, medium, and low categories. In this group, it appears that some members are too dependent on other members so the task completion process is less than optimal. In this group, they share responsibility but not all participate in decision-making in the group. Overall, the results or products of this group have been completed well, but the group's performance in collaborative activities still needs further improvement.

Observation results showed that there were several small conflicts that arose due to differences of opinion, but each group had the ability to resolve them well. Conflict in learning activities can affect cooperation. The way students resolve conflicts in groups can improve their collaborative skills (Lee, D., Huh, Y., & Reigeluth, 2015)

Project Based Learning is a learning model that focuses on results and these results are a product (Ummah et al., 2019). Overall the research results show that most students are responsible and each individual makes a contribution to the group. Several studies show that implementing PjBL has a positive impact on student engagement, motivation, and self-efficacy (Condliffe et al., 2017).

STEAM is a learning method that evolved from the STEM approach by adding art or artistic elements to it. Previously, a STEM approach that integrated science, technology, engineering, and mathematics was developed by the National Science Foundation (DeCoito, 2016). STEM is a holistic approach, not just grouping and mixing scientific disciplines (Zubaidah, 2019). STEAM learning can also help students to understand other people, understand different points of view, and understand culture so that they can maintain their identity and communicate and work together well. (Yakman & Lee, 2012). This means that students who participate in STEAM do not only study a field of knowledge but become more adaptive learners. The product produced through Ethno-STEAM Project Project Based Learning is a game of otok-otok. The following is Figure 1. shows an example of otok-otok carried out by students and Figure 2. Student group work activities

Figure 1. Example of Traditional *Otok-Otok*

Figure 2. Student group work activities

One context of daily life that can be integrated into STEAM is the cultural context. Learning that integrates local culture can help students expand their knowledge through contextual problems so that learning becomes more meaningful. In this context, students are encouraged to participate in learning. Utilizing culture as a learning resource not only provides opportunities for students to develop their thinking abilities but also shows and preserves their culture (Bakhrodin et al., 2019).

Even though the field of collaborative skills still requires further development, learning with an ethnic-STEAM approach through auto-bike projects can be an alternative learning method and approach to developing collaborative skills. This is supported by the results of the learning implementation, namely that the majority of students showed a high level of cooperation. This learning also gave an average of six of the eleven aspects of collaboration measured a high rating. FGD studies conducted with Mathematics in Class VII show that students are better at doing their assignments, able to handle differences of opinion, and most students participate more actively in learning. Collaborative skills development should not be done with just one or two activities but must be done continuously using learning resources, approaches, and a good learning environment.

Conclusion

Based on the research results, it can be concluded that during learning using the Ethno-STEAM project in the context of otok-otok, it was found that 56% of students had collaborative skills in the high category, 31% in the medium category, and 13% in the low category. Students who have strong team skills are usually trustworthy people in the group. Students with moderate collaborative skills should consistently engage in group problem-solving without interfering

with others' contributions. Students with low collaborative skills need to be more involved and communicate more of their ideas and thoughts. Aspects of students' collaborative skills include participation, motivation, time management, problem-solving, group dynamics, and interaction with group members. Aspects of work quality, group support, willingness, role, and reflection are classified in the medium category so follow-up and development are necessary. Of the six groups formed, four groups worked together well, divided responsibilities fairly, and made decisions together, while in the other two groups, not all members were involved in group decision-making. Future research is proposed to include more experimental research design factors so that the influence of Ethno-STEAM learning projects in the context of auto-bikes with collaborative skills can be studied further. Apart from that, these learning skills can also be tested to develop skills for the 21st century, such as critical thinking, creative thinking, and communication skills. Deeper research into the topic in the context of the traditional otok-otok game with mathematical concepts can also be carried out.

Acknowledgments

Thank you to LPPM UMSU because this research is research sourced from internal grant funds from the Universitas Muhammadiyah Sumatera Utara

Bibliography

Atun, S., & Latupeirisa, V. P. S. (2021). Science KIT Teaching Aid for the Earthquake in Improving Students' Collaboration Skills and Creative Thinking in Junior High School. *European Journal of Educational Research*, *10*(1), 187–197. https://doi.org/10.12973/EU-JER.10.1.187

Bakhrodin, B., Istiqomah, U., & Abdullah, A. A. (2019). Identifikasi Etnomatematika Pada Masjid Mataram Kotagede Yogyakarta. *Jurnal Ilmiah Soulmath : Jurnal Edukasi Pendidikan Matematika*, *7*(2), 113–124. https://doi.org/10.25139/smj.v7i2.1921

Balqist, A., Jalmo, T., & Yolida, B. (2019). Penggunaan Model Discovery Learning Untuk Meningkatkan Keterampilan Kolaborasi dan Berpikir Tingkat Tinggi. *Jurnal Bioterdidik*, *7*(2), 103–111. http://jurnal.fkip.unila.ac.id/index.php/JBT/article/download/17287/12315

Bender. (2012). *Project-Based Learning: Differentiating Instruction for The 21St Century.* California: Corwin.

Cholily, Y. M. (2020). Matematika dan Pembelajaran Berbasis STEAM. *Prosiding Seminar*

Nasional Matematika Dan Pendidikan Matematika FKIP UMP 29 Agustus 2020, *1–5*.

Condliffe, B., Quint, J., Visher, M. G., Bangser, M. R., Drohojowska, S., Saco, L., & Nelson, E. (2017). Project-based Learning: a Literature Review. *Mdrc : Building Knowledge to Improve Social Policy*, *P-12 Education*, 2. https://www.mdrc.org/publication/project-based-learning

Dahlberg, K. O. & K. (2009). Collaboration in Student Teaching: Introducing the Collaboration Self-Assessment Tool, Journal of Early Childhood Teacher Education. *Evaluation & the Health Professions*, *30*(1), 37–38. https://doi.org/10.1080/10901020802668043

DeCoito, I. (2016). STEM Education in Canada: A Knowledge Synthesis. *Canadian Journal of Science, Mathematics and Eechnology Education*, *16*(2), 114–128. https://doi.org/10.1080/14926156.2016.1166297

Falcione, S., Campbell, E., McCollum, B., Chamberlain, J., Macias, M., Morsch, L., & Pinder, C. (2019). Emergence of Different Perspectives of Success in Collaborative Learning. *The Canadian Journal for the Scholarship of Teaching and Learning*, *10*(2). https://doi.org/10.5206/cjsotl-rcacea.2019.2.8227

Fitriyani, R. V., Supeno, S., & Maryani, M. (2019). Pengaruh LKS Kolaboratif Pada Model Pembelajaran Berbasis Masalah Terhadap Keterampilan Pemecahan Masalah Fisika Siswa SMA. *Berkala Ilmiah Pendidikan Fisika*, *7*(2), 71. https://doi.org/10.20527/bipf.v7i2.6026

Gialamas, S., Grigoropoulos, J. E., Pelonis, P., & Cherif, A. H. (2020). How Can Manifesting Leadership Skills Infused with Ethos, Empathy, and Compassion Better Prepare Students to Assume Leadership Roles? *International Journal of Progressive Education*, *16*(February), 2020. https://doi.org/10.29329/ijpe.2020.

Hermawan, H., Siahaan, P., Suhendi, E., Kaniawati, I., Samsudin, A., Setyadin, A. H., & Hidayat, S. R. (2017). Desain Instrumen Rubrik Kemampuan Berkolaborasi Siswa SMP dalam Materi Pemantulan Cahaya. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *3*(2), 167–174. https://doi.org/10.21009/1.03207

Hidayat, A. (2018). Meta Analisis: Pentingnya Self Dan Peer Assesment Dalam Pembelajaran. *Jurnal Basicedu*, *2*(1), 95–101. https://doi.org/10.31004/basicedu.v2i1.127

Isharyadi, R. (2018). Pengaruh Penerapan Pendekatan Kontekstual Terhadap Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa. *AKSIOMA: Jurnal Program Studi*

Pendidikan Matematika, *7*(1), 48. https://doi.org/10.24127/ajpm.v7i1.1342

Kuswara, R., Hartuti, P., & Sinthia, R. (2018). Efektivitas Layanan Konseling Kelompok Teknik Modelling Dalam Membentuk Keterampilan Kepemimpinan Siswa. *Consilia : Jurnal Ilmiah Bimbingan Dan Konseling*, *1*(2), 39–48. https://doi.org/10.33369/consilia.1.2.39-48

Lee, D., Huh, Y., & Reigeluth, C. M. (2015). Collaboration, intragroup conflict, and social skills in project-based learning. *Instructional Science*, *43*(5), 561–590. http://www.jstor.org/stable/43575307

Listiyani, L. R. (2018). Implementasi Model Pembelajaran Inkuiri Berbasis Refleksi Kelompok pada Materi Reaksi Redoks. *Jipva*, *2*, 58. https://doi.org/10.31331/jipva.v2i1.576

Mesiono, Arsyad Junaidi, Nasution Sakholid, Susanti Eka, & Daulay Hamidah Sholihatul. (2017). Jurnal Tarbiyah. *Tarbiyah*, *24*(Juli-Desember 2017), 351–370. http://jurnaltarbiyah.uinsu.ac.id/index.php/tarbiyah/article/view/229/217

Mu'Minah, I. H., & Aripin, I. (2019). Implementasi Stem Dalam Pembelajaran Abad 21. *Prosiding Seminar Nasional Pendidikan*, *1*(2012), 1496. https://prosiding.unma.ac.id/index.php/semnasfkip/article/view/219

Norhaqikah, M. K. dan, & Kamisah Osman. (2017). STEM-21CS Module : Fostering 21st Century Skills through Integrated STEM. *K-12 STEM Education*, *3*(3), 225–233.

Primadhini, A. F. (2021). Analisis Kepercayaan Diri Siswa Kelas VIII Pada Pembelajaran Matematika di Tengah Pandemi COVID-19. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(3), 2294–2301. https://doi.org/10.31004/cendekia.v5i3.751

Prodromou, T., & Frederiksen, N. (2018). The Effects of Mathematics Anxiety on Primary Students. *Mathematics Education Research Group of Australasia*, 639–646.

Qomaria, N., & Wulandari, A. Y. R. (2022). Pengembangan Keterampilan Kolaboratif Siswa Melalui Pembelajaran Dengan Pendekatan Ethno-Steam Project Konteks Pesapean. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1306. https://doi.org/10.24127/ajpm.v11i2.4586

Rizkiyah, Z. R., Hariyadi, S., & Novenda, I. (2020). The Influence of Project Based Learning Models on Science Technology, Engineering and Mathematics Approach to Collaborative Skills and Learning Results of Student. *ScienceEdu*, *3*(2), 1–6. https://jurnal.unej.ac.id/index.php/S%0Acedu/article/view/16589

Saenab, S., Yunus, S. R., & Husain, H. (2019). Pengaruh Penggunaan Model Project Based

Learning Terhadap Keterampilan Kolaborasi Mahasiswa Pendidikan IPA. *Biosel: Biology Science and Education*, *8*(1), 29. https://doi.org/10.33477/bs.v8i1.844

Safarini, D. (2019). Developing students' collaboration skills through project-based learning in statistics. *Journal of Physics: Conference Series*, *1265*(1). https://doi.org/10.1088/1742-6596/1265/1/012011

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

Triana, D., Anggraito, Y. U., & Ridlo, S. (2020). Effectiveness of Environmental Change Learning Tools Based on STEM-PjBL Towards 4C Skills of Students. *Jise*, *9*(2), 181–187. http://journal.unnes.ac.id/sju/index.php/jise

Ulhusna, M., Putri, S. D., & Zakirman, Z. (2020). Permainan Ludo untuk Meningkatkan Keterampilan Kolaborasi Siswa dalam Pembelajaran Matematika. *International Journal of Elementary Education*, *4*(2), 130. https://doi.org/10.23887/ijee.v4i2.23050

Ummah, S. K., Inam, A., & Azmi, R. D. (2019). Creating manipulatives: Improving students' creativity through project-based learning. *Journal on Mathematics Education*, *10*(1), 93–102. https://doi.org/10.22342/jme.10.1.5093.93-102

Uziak, J. (2016). A project-based learning approach in an engineering curriculum. *Global Journal of Engineering Education*, *18*(2), 119–123.

Widarwati, D., Utaminingsih, S., & Murtono. (2021). STEAM (Science Technology Egineering Art Mathematic) Based Module for Building Student Soft Skill. *Journal of Physics: Conference Series*, *1823*(1). https://doi.org/10.1088/1742-6596/1823/1/012106

Yakman, G., & Lee, H. (2012). Exploring the Exemplary STEAM Education in the U.S. as a Practical Educational Framework for Korea. *Journal of The Korean Association For Science Education*, *32*(6), 1072–1086. https://doi.org/10.14697/jkase.2012.32.6.1072

Yaqin, M. A., Indriwati, S. E., & Susilo, H. (2018). Think-pair-square learning: Improving student's collaborative skills and cognitive learning outcome on animal diversity course. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *4*(2), 135–142. https://doi.org/10.22219/jpbi.v4i2.5514

Yuntiaji, D. A., Lukman, H. S., & Imswatama, A. (2020). Digital Worksheet Design Based of STEAM to Develop Students' Problem Solving Skill. *Mathematics Education Journal*, *4*(2), 137–146. https://doi.org/10.22219/mej.v4i2.13313

Yusuff, K. B. (2015). Does self-reflection and peer-assessment improve Saudi pharmacy

students' academic performance and metacognitive skills? *Saudi Pharmaceutical Journal*, *23*(3), 266–275. https://doi.org/10.1016/j.jsps.2014.11.018

Zubaidah, S. (2019). STEAM (science, technology, engineering, arts, and mathematics): Pembelajaran untuk memberdayakan keterampilan abad ke-21 [STEAM (Science, Technology, Engineering, Arts, and Mathematics): Learning to Empower 21st Century Skills]. *Seminar Nasional Matematika Dan Sains*, *September*, 1–18.