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Classroom Students Collaborative Abilities XII SMA Negeri 5 Surakarta in Learning Biotechnology PJBL Integrated STEM Teaching Year 2023/2024

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ABSTRACT
The education sector has a large role in supporting scientific and technological progress to improve the quality of human resources. One learning model that has great potential is project-based learning or PjBL. Apart from using the PjBL model, the STEM learning approach method is also very useful for the world of education. STEM connects science with technology and mathematics so that students have a holistic understanding of the relationship between science and learning experiences. The PjBL learning model is integrated with the STEM learning model to improve collaborative skills in the 21st century. Collaboration skills are one of the important abilities of the 21st century for an effective learning process. This research aims to determine the collaborative ability of class collection techniques using quantitative descriptions. Collaborative ability is measured through questionnaires and interviews. In data analysis, a percentage descriptive approach was used. The results of the study showed that the level of collaborative ability in the classroom, and responsibility skills were 36.9%, compromise skills were 41.2%, productive work skills were 39.6%, communication skills were 41.8%, skills in using technology in working together amounted to 41.8%, and the average value of the overall indicator percentage was 40.2%. with students' collaborative abilities being in the quite good category. So it is concluded that the STEM-integrated PjBL learning model can improve the collaboration abilities of class XII IPA students at SMAN 5 Surakarta FY 2023/2024 on biotechnology material.

Keywords: *Collaboration, PjBL-STEM, 21st Century Skills, Biotechnology, Class XII Students.*

INTRODUCTION

The 21st century is marked by the industrial revolution 4.0 which leads to a century of openness and globalization. Indonesia is one of the countries that is trying to improve the quality of human resources (HR) because it is considered crucial in facing the Industrial Revolution 4.0. The education sector has a big influence in preparing to face the Industrial Revolution 4.0 (Nurfatimah, 2022). One of the approaches proposed to achieve 21st-century skills is through the 4C approach (Critical Thinking, Communication, Collaboration, Creativity) (Redhana, 2019). Fauzan (2021) also emphasized the need for 21st-century skills in the achievement process. With the Industrial Revolution 4.0, skills such as working together in teams, critical thinking, and creativity are considered essential to help students face more complex challenges.

The process of development and advancement of Science and Technology (IPTEK) is very necessary to support the process of improving human resources (HR). Biology is recognized as a branch of natural science that plays an important role in education, supporting the progress of science and technology in improving quality human resources. Biology learning provides broader knowledge about the relationships that occur in the biological world (Sayan, 2020). Biotechnology has a primary focus on solving scientific problems to develop concrete solutions in various areas of life, including health, the environment, and agriculture. Biotechnology is the science of using living things to make products (Fatma, 2021). Learning biotechnology not only provides academic knowledge but is also applied directly to help students develop life skills. These skills include the ability to solve problems, think critically, and adapt to change (Muliadi, 2021).

Lack of information, limited resources at school, and material that is considered complex are obstacles for students in studying biotechnology material (Seprianto, 2021). This is a challenge, especially if students do not have sufficient basic information or lack an understanding of scientific literacy. According to Juwita (2022), low scientific literacy skills

in biotechnology material are also associated with low reading interest and teachers' lack of knowledge about scientific literacy. This shows the importance of interesting learning models and effective teaching. The limited cognitive value of students in understanding biotechnology material can have an impact on collaboration abilities. Students may have difficulty actively participating in group activities or collaborative projects that involve solving biotechnology problems. The research results showed that students had low levels of group work, due to a lack of understanding of biotechnology concepts. A lack of self-confidence can arise in collaborative activities that involve solving complex problems (Le, 2018).

One project-based learning model that links a problem with a real-world context has great potential, namely project-based learning or PjBL. In the 2013 curriculum, it is one of the highly recommended learning models. This model is considered effective for achieving levels of student activity, creativity, and learning outcomes (Salybekova, 2021). A comparison of the learning process with the PjBL model and the conventional model (lecture method) shows that PjBL learning outcomes influence effectiveness in the biology learning process in the classroom and have significantly positive results of 0.035 out of 0.05 (Jamil, 2021). Several other studies show that the collaboration ability using project-based learning models is significantly higher than the collaboration ability of students using conventional learning, which is 92.95% and 53.6% (Sulfiani, 2021). In the PjBL model learning environment, students often work in groups, solve problems together, share ideas, and understand roles in a team to achieve an effective learning process, and these collaboration skills are very important both in the world of work and education (Saenab, 2019).

Another learning model in the 21st century that is related to the development of soft skills is STEM (Science, Technology, engineering, and mathematics) which links the fields of science (science) with technology, and mathematics so that students have a holistic understanding of the relationship between the fields of science and experience. 21st-century learning (Sartono, 2020). STEM learning focuses more on the educational process by solving real problems in everyday life and can make students more active so that the learning

process is more meaningful (Anggraeni, 2021). Implementation of the STEM-based PjBL model has the advantage of increasing students' mastery of concepts and analytical thinking abilities (Tipani, 2019). Integration between PjBL and STEM learning models can be carried out because of their interconnectedness in education. STEM Includes science and technology literacy, which can be improved in the activities involved in PjBL. One of the science materials that can be delivered with PjBL-STEM learning is biotechnology subjects.

In Indonesia, the implementation of PjBL-integrated STEM has not been widely applied in the learning process. This can be seen in the results of STEM research in the last four years, from 2019 to 2022 (Yatin, 2022). The relatively low level of implementation of STEM-integrated PjBL learning in the educational context is due to several factors, such as a curriculum that is still centered on standardized tests, limited resources, limited teacher training, and a lack of awareness and understanding of the benefits of implementation. SMA Negeri 5 Surakarta is one of the state high schools in Central Java Province, Indonesia, which is one of the leading schools that has not implemented the STEM-integrated PjBL learning model based on the results of initial observations carried out on Thursday, 22 September 2023.

PjBL-STEM learning is a new learning model used by several high schools in the city of Solo. The PjBL-STEM learning system has an orientation to enable students to develop potential through projects. The main principle in this learning process is the involvement of all components owned by students so that students' understanding of analyzing and solving problems in learning can run well so that the learning outcomes obtained can improve. Based on the explanation above, researchers are interested in researching "Classroom Students' Collaborative Abilities XII SMA Negeri 5 Surakarta in PJBL Learning Integrated Stem Biotechnology Material 2023/2024 "which is expected to make a good contribution in increasing the ability of student collaboration to biotechnology material.

RESEARCH METHOD

The type of research used is quantitative descriptive research. This is because researchers want to know the extent of students' 21st-century skills in learning Biology, especially in biotechnology material. The population in this study was all class The research instrument used interviews and questionnaires. The questionnaire was used to measure students' collaboration skills and was strengthened by interviews with the main data source, namely several class XII students at SMA Negeri 5 Surakarta, Even Semester for the 2023/2024 academic year. The questionnaire instrument consists of 6 questions with a scale and observation sheet analysis technique using the following formula:

Table 1. Answer Scoring Scale

Scale	**1**	**2**	**3**	**4**	5
Information	strongly disagree (STS)	Disagree (TS)	Disagree (KS)	Agree (S)	Strongly Agree (SS)

Table 2. Score Categorization

No.	Score Interval	Category
1	81 – 100 %	Very Good
2	61 – 80 %	Good
3	41 – 60 %	Fair
4	21 – 40 %	Poor
5	0 – 20 %	Very poor

Sumber : Nudriani (2019)

DISCUSSION

The data obtained from filling out the questionnaire was analyzed using descriptive analysis. The skills in the 21st century possessed by students in this research are aspects of collaboration skills in 6 indicators, namely: (1) Responsibility skills, (2) Flexibility skills, (3) Productive work skills, (4) Compromise skills, (5) Communication skills, and (6) skills in using technology to work together.

Table 3. Descriptive Percentage of Student Collaboration Skills in Biology Learning Biotechnology Material

No	Indicator	Percentage	Category
1.	Responsibility skills	36,9 %	Not good
2.	Flexibility skills	40,3 %	Fairly good
3.	Skills to work productively	39,6 %	Not good
4.	Compromise skills	41,2 %	Fairly good
5.	Communication skill	41,8 %	Fairly good
6.	Skills in using technology in working together	41,8 %	Fairly good
	Average	40,2 %	Fairly good

Based on Table 3 above, it is known that the collaboration skills possessed by the class to work together, with percentages respectively 36.9% (not good), 40.3% (fairly good), 39.6% (not good), 41.2% (fairly good), 41.8% (quite good), 41.8% (fairly good), and 40.2% (fairly good).

CONCLUSION

In the learning implementation plan or RPP activity, the teacher provides an introduction to learning to convey the learning objectives and then tells about core competencies, basic competencies, indicators, and Minimum Completion Criteria (KKM).

Then the teacher gives instructions to students to divide into several groups consisting of 4-5 people per group. The teacher shows a video of large-scale compost making, both traditional and modern (without sound and text). Students ask various questions related to the video and the teacher provides directions so that classical discussions occur so that each group can work together with each member to answer the questions so that each group member can have the ability to solve problems and understand material concepts such as tools, materials, and processes. compost making. Next, the teacher gives directions to each group to create a detailed compost project design starting from determining goals, writing down the reasons for choosing tools and materials, calculating the capacity of the compost reservoir, and choosing the technology used in the composting process.

Most students demonstrate active contribution skills when discussing, expressing their ideas or opinions, and respecting each other's opinions. Actively discussing in groups can increase knowledge in deepening the material that has been given. Students share ideas and design concepts for making compost on flipchart paper in the form of mind maps, diagrams, or other forms according to the group's creativity. The teacher monitors the design activities carried out by students so that they are by the goals that are useful and effective. Group representatives briefly presented the results of planning and designing the composter. Students started working on making compost in groups, followed by a test model testing the composter by adding composting materials in the form of household waste and starter (EM4 liquid negative microbes). The composter is stored in a safe place and away from outside interference. Students reflect on the results of the composter design trial. The teacher gives each group the task of observing the compost, especially calculating the time until the compost is ready to be used. After that, students in the class were given a questionnaire containing questions related to indicators of collaboration skills, such as I act respectfully whether as a leader or member, I work with all team members, I share ideas and information with the group, I respect other people's opinions, I solve problems. that the group faces, and I know how to use technology in working on projects.

The results of the questionnaire percentage analysis were strengthened by the results of interviews with 6 Class In interviews with 6 students, a total of 6 students stated that this learning made students more active and understanding in discussing and expressing their opinions in working on the final project. However, there needs to be improvements in the time involved in project work, and material that has not been practiced must be deepened and explored again before taking the test. Based on the analysis of the six indicators of collaborative skills in the 21st century, the percentage values arranged from the highest to the lowest percentage values are shown, namely the indicators of responsible skills, productive work skills, flexibility skills, compromise skills, communication skills and skills in using technology. There are 2 of the 6 indicators that are in the poor category and this is confirmed by the results of interviews where students show interest in STEM integrated PjBL learning. This shows that the 21st-century skills in the collaborative skills of class The relationship between STEAM model learning and projects with the ability to think creatively and collaborative skills in Muhammadiyah 2 Batu students and the PjBL-based STEM learning model can improve critical thinking and collaboration skills (Nurwidodo, 2020). This is in line with Fitriyani's (2021) research where the results of collaboration skills by applying scientific learning received a score of 63.410, while the class that applied STEM learning received a score of 70.996. According to (Saenab, 2019) collaboration skills are very important to achieve an effective learning process, and these collaboration skills are very important both in the world of work and education. Limited cognitive values will impact a lack of confidence in participating in collaborative activities that involve problem-solving (Le, 2018).

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