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High school students' teamwork ability in project-based learning of organic waste decomposition

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ABSTRACT
Teamwork is an important skill to develop through school learning. This ability is considered to affect how a learner can learn, both independently and with a group to obtain academic achievement. This study applies project-based learning on decomposing organic waste in the Biology subject to help develop learners' teamwork skills. This study was used by one group pretest-posttest design. The data in this study were collected through the administration of Situational judgment test sheets on pretest and posttest and self-report sheet of teamwork ability. The data were analyzed descriptively quantitatively to produce a better understanding. As a result, the ability to work in teams measured has increased although the increase has not been significant (n Gain = 0.2). The implementation of project-based learning on waste decomposition generally had a good effect on teamwork ability (d = 0.5). The results in this study indicate that fostering teamwork through Project Based Learning can be optimized in the public product stage. The suggestion for the future research is to conduct pre-treatment to the research participants in the form of introduction to collaborative learning.

Introduction

Advances in science and technology in various fields have made the world seem borderless. This progress has led to greater competition in various circles. The opportunities and challenges of globalization today are characterized by stronger competition, open information systems, and communication. This of course further encourages us to be able to prepare ourselves for the challenges of globalization and build a wise attitude towards greater opportunities. Because, according to the study of Harefa (2022), the failure to act and unwise attitude towards the challenges and opportunities of globalization can lead to underdevelopment.

One of the most important preparations in facing the challenges of globalization is the preparation of future human resources. Education is considered as one of the effective means to prepare it. Education can be designed to be able to equip learners to face the demands of this century so that they are able to become quality human beings who are knowledgeable, creative, competitive, and have a positive ethic in their environments (Sulistyowati et al., 2016). Facing demands of the 21st Century, learners need to be included in developing various abilities that are important for their lives.

The abilities needed by post-school learners include various aspects of both knowledge in a discipline and skills related to life skills (soft skills). Several studies have shown that a person's ability to take on responsibility, self-confidence, team spirit, good work attitude, social and communication

skills, flexibility, self-motivation and self-management are skills that help a person to face future challenges (Lai and Viering 2012; Musa et al., 2012).

In general, the terms of reference for 21st century learning have been developed by several institutions to be used as needed. Based on the search results, Lai and Viering (2012) stated that there are at least two terms of reference, respectively prepared by the National Research Council (NRC) and the Assessment and Teaching of 21st Century Skills organization (ATC 21). Based on these two terms of reference, one of the skills needed to face the challenges of the 21st century is the ability to work in teams. The teamwork skills are included in the categories of interpersonal skills (NRC) and ways of working skills (ATC 21). Based on these two terms of reference, one of the skills needed to face the challenges of the 21st century is the ability to work in teams. The teamwork skills are included in the categories of interpersonal skills (NRC) and ways of working skills (ATC 21).

The learning process is an activity that involves learners and teachers with the support of various approaches, methods and strategies. Learning can support the development of knowledge for learners, both theoretical and practical. Learners can develop their knowledge in the learning process either individually or in groups according to their needs and the way they learn. For this reason, the ability to work in a team is an important ability to be equipped. The ability to work in teams is a person's ability when doing joint learning between two or more people by giving each other ideas and solving problems together (Lai and Viering, 2012; Musa, et al., 2012; Vhalery and Nofriansyah, 2018). The activity of working in teams, which involves exchanging ideas and solving problems, will support them to form their own knowledge (Lai and Viering, 2012; Musa, et al., 2012; Vhalery and Nofriansyah, 2018). According to this information, teamwork not only increases knowledge together, but also motivates individuals to develop their knowledge independently. Therefore, the knowledge gained from the collaborative process can be applied and applied to the next task.

The teamwork skill is an ability that can be developed through collaborative learning. In a collaborative learning environment, learners can learn how to work together, support each other, and solve problems together (Ramdani & Susilo 2022). Grouping learners in groups is quite common in Indonesian schools, even since the elementary school level. However, in reality, there are several obstacles in the implementation of learning with a teamwork component. For example, the teacher's learning style when training learners' teamwork skills. The results of research conducted by Wijaya et al. (2019), stated that when teachers form groups, students experience different learning conditions. Smarter learners sometimes feel no need to share with less intelligent learners. Conversely, less intelligent learners feel inferior to ask questions, so that learners do not understand what the purpose of group formation itself is. This shows that the ability to work in teams among students is still relatively low. According to Yuningsih et al. (2017), the teamwork ability of learners still needs to be developed, even though learners have been able to be willing to deliberate, participate in groups, and play a role in completing the tasks assigned to them. Based on the findings stated above, the ability to work in teams needs to be developed by presenting meaningful learning and involving students directly in building their experience and knowledge. One of the learning models that can be done in developing the ability to work in teams is through project-based learning (Sart, 2014; Sulistyowati, et al., 2021). Based on Sart (2014) and Sulistyowati, et al. (2021), project-based learning is learning that supports group activities in planning and problem solving.

Project-based learning models should present projects that are close to and can have an impact on learners' lives both in the school environment and in the outside environment. Based on projects that are familiar to learners, it can facilitate learners to be actively involved and solve problems in their environment and can build more meaningful learning (Jagatara et al., 2014). The problems raised in project-based learning should be problems that are directly felt by learners or in other words, problems that are close to their environment. This is done with the aim that the project carried out learning can be of positive value to their lives both during the project and after the project is completed.

One of the issues that are suitable to be the focus of the project in project-based learning in the school environment is environmental issues. This is because environmental issues have a significant impact on learners' daily lives and the surrounding environment, so projects related to these issues can have a positive and valuable impact on learners (Özgür and Yilmaz, 2013; Onder and Kocaeren, 2015). Valderrama-Hernandez, et al. (2017) stated that environmental issues are issues that require more attention from current and future generations. According to him, the environmental problems that arise around us are not entirely ecological problems, but also about knowledge and education issues

(Valderrama-Hernandez et al., 2017). It is important to have a qualified education to build active participation from learners in resolving environmental problems.

By applying the project method in learning, it is expected that students can provide ideas and ideas related to creative efforts to overcome existing problems (Derevenskaia, 2014). The learning projects developed also need to focus on human values, so that with this application they also carry out their role as good members of society. This is in accordance with the framework of 21st century skills to be accomplished, one of which is how to be a good member of society and can live together in the world (living in the world).

The idea outlined above can begin to be addressed through project-based learning in Biology at school. As we all know, environmental material is one of the materials taught both in middle and high schools. In high school, the environmental material is contained in Basic Competency 3.11 and Basic Competency 4.11. In it, there is material about environmental change, environmental damage or pollution, mitigation and disasters, as well as waste and waste recycling. One of the most serious environmental problems faced by developing countries such as Indonesia is waste management. This is in accordance with the results of a study conducted by Kallas et al. (2015) which states that one of the biggest ecological crises is the increasing amount of waste produced by society, especially with today's rapid population growth. For this reason, this research will raise the issue of waste management, especially the decomposition of organic waste. The issue of organic waste management is considered appropriate to be raised as a means of building teamwork skills in students. This is because organic waste is a common problem that needs to be handled together. So that these problems can be resolved by working together in a team to tackle the waste problem around them.

Based on the explanation above, this research was conducted to measure how project-based learning can identify and improve learners' teamwork skills in learning. In this study, project-based learning on decomposing organic waste is conducted to help develop these skills. This study will provide an overview of teamwork skills and the effects of project-based learning learners' ability to solve problems through teamwork on Situational Judgement Tests (SJTs) sheet on biology subject.

Methods

The methods used in this research are descriptive quantitative research methods using a one group pretest-posttest design. In this study, researchers combined the application of the posttest and pretest by conducting a test on one group before being given treatment and after being given treatment. The pretest was conducted at the beginning of the study and the posttest was given when the study was completed. In addition, the calculation of the gain index and effect size was also carried out in order to describe the effects and changes that occurred after the treatment was given.

This study was conducted in a private high school in Bandung, using purposive sampling technique. The sample selection was based on the need to implement the project for a relatively long time and was expected to have sufficient intensity of team/group interaction. Accordingly, the schools that fulfill these requirements are boarding schools with all students considered to have the same characteristics.

This research was conducted by implementing project-based learning with participants totaling 44 students of class X SMA. Data collection conducted in this study includes quantitative data collected before and after treatment, and qualitative data during treatment in learning. This learning was conducted for three meetings. The implementation time of learning and projects is for 15 days. The project carried out in project-based learning in this study is an organic waste decomposition project.

The first instrument is the Situational Judgement Tests (SJTs) sheet. The Situational Judgement Tests (SJTs) sheet was given before and after the project-based learning on organic waste decomposition. The Situational Judgement Tests (SJTs) sheet used consists of 7 situations adapted based on the SJTs in the research of Zhuang et al. (2008). These seven situations consist of the aspects of managing tasks in the team (found in situations 1 and 4), conveying ideas in the team (found in situations 2 and 3), solving problems in the team (found in situation 5) and guiding (found in situations 6 and 7).

While the second instrument is a self-report questionnaire that is filled based on the learning stages. This questionnaire is used to identify the ability to work in teams based on the stages of project-based learning. This questionnaire was scored using a 1-6 rating scale. The self-report compiled in this study is divided into group discussion self-report, class discussion self-report, project making self-report, product making self-report, and self-report during learning (which is given after the learning is done entirely).

Results and Discussion

The project-based learning implemented is adapted from the design developed by Larmer and Mergendoller (2010) and then adapted to the implementation of learning in the classroom. The learning is organized into 8 essential designs of gold standard project-based learning. The process of assessing the ability to work in teams uses Situational Judgement Tests (SJTs) instruments given during pretest and posttest and Self Report questionnaires consisting of 5 Self Reports according to the learning stages.

The data obtained is a total of 44 data in two classes that participate in learning activities as a whole, each of which consists of pretest and posttest data through the Situational Judgement Tests (SJTs) instrument. Learning is carried out for three meetings accompanied by a project management process carried out for approximately 15 days.

Table 2 below shows the lowest score, the highest score, and the average score of the learners' pretest and posttest. The average pretest score obtained was 70.1 while the average posttest score of learners was 73.9. The increase in the average score of learners from the pretest score to the posttest score is 3.8 points. This average value is then calculated by calculating the Gain index.

Table 2. Gain index calculation results

Aspects	*Pretest*	*Posttest*	Improvement
Lowest Score	60,7	59,3	
Highest Score	84,3	96,4	
Average	70,1	73,9	3,8
Standard Deviation	5,5	8,5	7,2
Gain Index			0,2

Based on the calculation of the Gain index in table 2, the average Gain index obtained is 0.2 so that it falls into the low category. There are 29 learners who get higher scores on the posttest than the pretest with a range of different scores. There are 14 learners with posttest scores that are lower than their pre-tests and one learner with the same score between pretest and posttest. This shows that most learners (66%) experienced an increase between pretest and posttest scores.

The improvement in teamwork skills can also be seen in each category of situations tested. Each situation (question item) has a score range of 1-5. The following is the distribution of the ability to work in teams based on the answers to each situation on the SJTs sheet.

The distribution of the acquisition of each indicator of teamwork ability according to the STJs situation is shown in Figure 1.

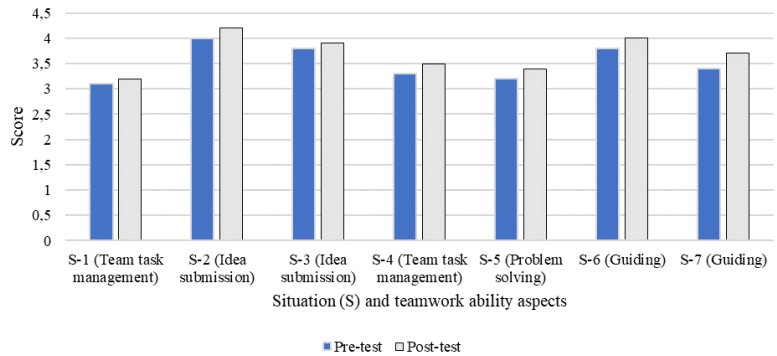

Figure 1. Distribution of teamwork ability based on situations in SJTs questions

Based on this distribution, the ability to work in teams is grouped based on their ability categories. Each situation is divided into four categories consisting of categories of less, enough, good, and very good.

Based on the grouping of these categories, the ability to work in a team has increased, especially with the results of SJTs item number two, namely the aspect of conveying ideas in the team. The score on item number two increased from the good category to very good. Achievements in each aspect of teamwork displayed in table 2 show that in general, some students can complete their understanding and skills. The category of the ability to work in a team of learners can be seen in the following table.

Table 3. Categories of teamwork skills in each situation

Question item (situation-)	*Average of scores*		*Categories*	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Team task management	3,1	3,2	Good	Good
Idea submission	4	4,2	Good	Very Good
Idea submission	3,8	3,9	Good	Good
Team task management	3,3	3,5	Good	Good
Problem solving	3,2	3,4	Good	Good
Guiding	3,8	4	Good	Good
Guiding	3,4	3,7	Good	Good

Effect size is a measure of the magnitude of the difference or effect of a variable on another variable (Santoso, 2010). Effect size calculations show the significance of the research results obtained. One of the effect size calculations used is the calculation of the standardized mean difference. Based on the results of data collection on the ability to work in teams using Situational Judgement Test questions, an effect size test was conducted to see the effect of project-based learning treatment of decomposing organic waste on the ability to work in teams. The following are the results of the effect size calculation of the results of this study.

Table 4. Effect size calculation results

Aspect	***Pretest***	***Posttest***	Improvement
Lowest Score	60,7	59,3	
Highest Score	84,3	96,4	
Average	70,1	73,9	3,8
Standard Deviation	5,5	8,5	
Effect size (Cohen's d)	(701 - 739)/71.59 = 0.53		Medium

Based on the effect size calculation, the result is 0.5. The Cohen's d value obtained in this calculation shows that the effect of project-based learning on decomposing organic waste falls into the medium effect category.

The ability to work in teams at each stage of project-based learning is also described in this study. The data showed that there were two categories of the level of ability to work in teams that emerged, namely good and sufficient (Figure 2). There are five self-reports that are used based on the stages of learning, namely group discussions, class discussions, project making, product making, and self-reporting during learning. On the self report sheet, there are several statements divided into 4 aspects of teamwork, namely cooperation, advocacy, negotiation, and guiding. The following is data on the percentage of students' ability to work in teams at each stage of learning (Figure 2). Based on the data, teamwork activities during the implementation of project-based learning for decomposing organic waste generally went well. The activity of working in a team that gets the highest percentage response is during product manufacturing. While the smallest percentage of learner responses occurred in class discussion activities.

At the stages of group discussion, class discussion, and project creation, the ability to work in a team of students falls into the moderate category. While at the stages of making products and during learning, it falls into the good category. The overall average percentage of learner responses is 70.6%, which means that the average learner response is categorized as a good response. Learners' responses also look diverse when viewed from the aspects assessed in the self report. The ability to work in teams

is seen to get the best response in the aspect of cooperation for product manufacturing activities and learning in general (4.8 from the highest score of 6). While the less favorable response is on the guiding aspect of group discussion activities (3.0 from the highest score of 6).

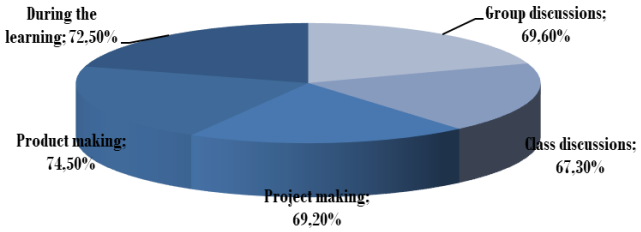

Figure 2. Percentage of ability to work in a team of learners

Project-based learning can help the positive growth of interpersonal skills, such as teamwork (Sulistyowati et al., 2021). This is because in its application, learners are supported to experience a process of thinking in small groups, discussing, and planning to solve certain problems. In project-based learning, learners are not only evaluated in terms of cognitive outcomes but also in terms of affective development. This is in line with Efstratia's (2014) opinion that project-based learning will enable the evaluation of cognitive and social skills. According to him, through project-based learning, learners will cooperate, communicate, and use their thinking to do the project guided by the reflection process.

The project-based learning applied in this study revealed several things about the ability to work in teams that exist in learners. The ability to work in a team was found after collecting data on the ability to work in a team of learners by using the Situational Judgement Test (SJTs) sheet and Self Report questionnaire in each phase of project-based learning that supports teamwork activities. Based on the research results, the ability to work in a team of students before project-based learning is still relatively low. Based on observations in the field, this happens because the collaboration skills of students are still lacking, for example the lack of optimizing the job description of each member so that the potential of each member in managing teamwork is still lacking. In addition, the lack of understanding of learners in problem-solving-based activities makes teamwork less. The level of text reading ability of learners in the target schools was found to be inadequate. This shows that there is a relationship between reading ability and students' thinking ability in solving problems. Muttaqin and Sopandi (2015) said in their research that the better the ability of learners to read and criticize reading, the better the learners will be in solving problems in story problems and concluding reading.

After the project-based learning of organic waste decomposition was conducted, the results showed an increase in the ability to work in teams in learners. Learners obtained an average score of 73.9 during the posttest using the SJTs sheet. Although the average obtained by learners has increased, the number of learners who scored below the average is getting bigger. The range between the scores obtained during the pretest and posttest became farther, while the distribution of students' scores was still below the average point of the scores obtained.

Based on these conditions, students' ability to assess alternative problem solving related to teamwork activities has not improved significantly. This is indicated by their achievement which did not experience a significant increase between the pretest and posttest. This can occur, due to the ability to read and understand the situation in the context of teamwork problems is still not qualified. In addition, to be able to determine the effectiveness of a problem solving in a team situation requires a correct view and a critical attitude. According to van Knippenberg & Van Ginkel (2022), if critical attitudes are not developed, learners will find it difficult to overcome differences of opinion and problems that may occur in teamwork situations. This is an important thing for teachers to consider when conducting activities that require team learning. In addition, learners' critical attitude can be trained through project-based learning to help learners construct their knowledge in complex learning, one of which is when working in teams (Astuti, et al., 2022).

On the SJTs sheet, there are several situations related to working in teams. In each situation, there are statements and learners are asked to rate the effectiveness of the options given to solve the problem. The results showed that some learners (66%) became better at solving problems in teamwork situations.

These findings are in line with Wena's (2013) statement that learners' activities in groups while completing the project will develop learners' abilities in cooperation and problem solving through learners' higher order thinking activities.

In the SJTs filling results grouped by aspect, the aspect that improved the most after project-based learning was the aspect of conveying ideas. As we know before that idea delivery is one of the things that can be facilitated through project activities (Splichal et al., 2018). In Splichal et al.'s research (2018), it is mentioned that the development of the quality of idea delivery project activities will affect the development of their thought regulation while learning. This can be seen when students undergo a waste decomposition project which is used as a learning tool in this study. During the waste decomposition project using BSF larvae, learners often expressed ideas that were intended as their efforts to do the waste decomposition project correctly. In the discussion session, several people also expressed their opinions on why decomposing organic waste needs to be done by utilizing natural methods such as utilizing the life cycle of BSF larvae.

On the other hand, there are aspects of working in teams that still need to be developed in this project-based learning. The aspects that still need to be improved are task management and problem solving. These two aspects are two of the important teamwork components to form a good team. According to Stevens and Campion (1994), teamwork can be built by involving knowledge, abilities and skills. These actually include conflict resolution, collaborative problem solving, communication, goal setting and performance management, and task planning and coordination. However, it is unfortunate when these aspects of task management and problem solving are not well developed. Several things were detected as causes for this, including some children not having the courage to handle the larvae, which they referred to as "maggots". On the other hand, the lengthy observations in this project compared to their learning habits that do not involve diligence in the observation made some of them delegate the task management to only a few group members.

The ability to work in teams did improve, but the improvement was relatively low. One of the important findings in this study is that to measure learners' abilities using the SJTs instrument, additional time needs to be allocated and the basic abilities of learners needed to be able to do this SJTs sheet well. Learners' basic skills in critical reading and reading summarization need to be identified first. This is because students' reading interest and reading ability play an important role in the ability to solve problems in the form of story problems (Muttaqin and Sopandi, 2015; Kumalasari et al., 2021).

Learners' involvement in learning is sometimes not directly proportional to how they assess cooperation. Practical activities or the like in which there are teamwork activities are usually addressed by dividing tasks together, but in the process they seem to work together instead of working together. Raes et al. (2015) in their research have shown that a team that is only involved in joint work may not involve the exchange of their ideas and knowledge. Therefore, each member in the team activity should make an active contribution to solving problems together by bringing their ideas together. For this reason, the role of the teacher is important to be able to help learners achieve awareness in active contribution in a team.

Based on the results of learners' responses in each activity phase, the tendency of learners in team activities can be identified. The results of learners' responses in the Self Report distributed during learning show that learners' involvement in teamwork activities is more in product making activities than other activities. This result shows that fostering an attitude of teamwork through Project-Based Learning can be optimized in the stage of making a product (public product).

Gold Design Project-Based Learning developed by Larmer and Mergendoller (2010) is considered to provide opportunities for students to develop the ability to work in teams, especially through public product activities. However, other aspects besides cooperation can also be developed. For example, the negotiation aspect can be developed through group discussion activities and class discussions. Meanwhile, the guiding aspect can be developed through the preparation of a group project that involves their participation as project actors (Student choice and voice, stage).

In addition, the advocacy process as part of the indicators of teamwork is still not really accommodated. It needs to be emphasized that influencing others through support and encouragement is part of the activities that are important to do when building quality teamwork. According to Dekker et al. (2006), factors from the environment (including support and encouragement from others) are instrumental in shaping learners' collaboration in teams. Therefore, a teacher needs to encourage the teamwork process while monitoring the quality of the process.

The ability to work in a team that continues to develop will actually have a wider impact than what is seen in students. The ability to work in a team that is well stimulated can eventually have an impact on their mindset before acting. One of the impacts of developing the ability to work in teams is the development of their ability to manage their thoughts. As in many findings in the research that has been done, the ability to work in teams turns out to be interconnected with the metacognitive abilities of learners. Both support each other (Kuhn and Dean, 2004; Dekker, et al., 2006; Saab, et al., 2012; Sukaisih and Muhalih, 2014). The results of this study are also reinforced by the statements of Kramarski and Mevarech (2003) and Setiana et al. (2020), which states that with teamwork activities, learners who interact with each other will continue to contribute to building their metacognitive abilities.

Based on the explanation and findings of this study, the improvement of teamwork skills through project-based learning of waste decomposition has not been significant. This is one of the challenges for teachers or other educators in senior high schools. Although the development of technology and the fulfillment of facilities at the school are adequate and allow learners to do everything themselves independently. However, the ability of learners to work in teams is one of the things that need to be developed. With lessons that are touching, meaningful, close, and felt by learners, it might make them understand and want to open themselves to be able to work in teams well. Providing good, directed and planned feedback can also help strengthen teamwork activities carried out by learners. This is because providing feedback on the teamwork process and project planning can be useful and help learners reflect on their learning process (Soller et al., 2005; Jermann and Dillenbourg, 2008; Du et al., 2022). Thus, while learners are working on the project, their teamwork activities not only enable them to complete the project well, but also develop their skills in various aspects of cooperation and communication.

Conclusion

Based on the findings and discussion in this study, it can be concluded that the ability to work in a team of students can be developed through project-based learning of waste decomposition. The ability to work in a team of students after the implementation of project-based learning to decompose organic waste has increased, although not significantly. The results of the calculation of the Gain index value obtained show the significance of the difference in results before and after the implementation of project-based learning is still low (N gain = 0.2). Nevertheless, most learners (68%) can solve problems related to the ability to work in teams well. The results of the effect size test of the ability to work in teams show that project-based learning to decompose organic waste has a moderate effect as an effort to improve the ability to work in teams with students. Recommendation for further research is to conduct pre-treatment on research participants in the form of introduction to collaborative learning such as introduction to the job description division so that the potential of each member of the team can be maximized.

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Conflict of interest statement

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