STEAM-based project learning: the effect to middle school’s student’s collaboration competences

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Abstract. The Purposes of this research is to investigate the student’s collaboration competence in integrated STEAM learning approach. The method that is used in this research is pre-experimental design with type one shot case study. The subject that is included in this research is students of VIII grade at one of Junior High School in Depok. The Instrument in this research to take the data is using Co-Measure rubric based on Hero’s research. The rubric has four categories, there are: 1) Students Interaction; 2) Positive Communication; 3) Multi Inquiry; and 4) Interdisciplinary Approach. The data technique sampling is used observation during the activity. Data analysis in this research is used add the score average in each category, then describe it with the description Need Work, Acceptable, and Proficient. This research results are the collaboration competence category which has higher results is transdisciplinary approach and positive communications with proficient descriptions. Arts in STEAM has influence the collaboration, communication, cross disciplinary, and curiosity in learning. This study could be concluded that student’s collaboration competence has outperformed in STEAM project activity rather than in non-STEAM project activity.

1. Introduction

Today’s challenges for students are to developed their innovative, creative, and problem-solving skills through model, method and approaches that suitable with current issues, such as following the technologies and integrate it with science, engineering, mathematics, in order able to solve the issues surround them. One of them that recently applied in some of schools is STEM. Those terms currently have already familiar with educators, students, stakeholders in several schools. Either in lower or higher education, they already applied that method, approaches, or model in their learning. STEM has an abbreviation Science, Technology, Engineering, and Mathematics. Those are combining together to make an integration in order to solve current issue in learning. Today is STEM generation and has a boarder meaning for that, it also includes environment, economic, education, medicine, and industrial [1]. Some of it is succeed to make students able to develop their thinking such as critical thinking, scientific literacy, engineering literacy, and problem-solving [2]. Although it brings a successful learning in critical thinking, scientific literacy, and STEM literacy, there are still lack in students, some of them are creativity, innovation, and collaboration. Recently, our education gives the task and learning to the students contextually and it is rarely to trigger their self-motivation, curiosity, communication, creativity, innovation, and collaboration [3].

Based on those cases, it brings the new movement to another learning strategy. STEM with Art and creativity component combining become a new strategy [4]. Some public said that science and Art cannot be combining together, because both of them has different perspective in learning [5]. Likewise,
both of them can be work together, although both of them has different characteristic, STEM provides methodological, logical, objective, analytic, and reproducible, while art has its own characteristic such as creativity, innovation, intuitive, sensual, and unique [6,7]. So, that notion could be suitable with the statement that said innovative, creative, collaborative and problem-solving skills are needed in science and mathematics leaning that using STEM and art across discipline [8,9,10]. Education that promotes creativity, collaboration, and innovation is important become a primary skill to face the real dialogue, solution, and in workplace for student’s future [11] So, that STEM with Art inside could have an abbreviation STEAM. The learning that integrates each other or promote the interdisciplinary education to solving current issues and students can face their future workplace demanding. STEAM in education usually refers to creativity, collaboration, and innovation [3,5,12,13] Art immersed in STEM could be develop the learning into more than just cognitive value that students can intake, but attitude, and psychomotor value could be reached by students. Moreover, it is needing a project in learning that promote collaboration, problem-solving, communication, creativity, and innovation skills with STEAM education.

Project learning with STEM or STEAM will be more meaningful because it requires to work in groups [14,15]. They able to work together to solve the problem without necessity to think convergent. They lead their ideas with divergent thinking. Means that think pertaining complex problem with many possible solutions. Students are able to deliver their many possible solutions based on its strength and limitations. It leads students to have their skills, for instance technology, innovation, collaboration, communication, problem-solving skills with multiple interdisciplinary approach and media tools [16,17,18]. Integrating project with STEM or STEAM could be improves more than hard skills like has been mentioned, the important one is soft skills that leads students to their future success. For instance, communication and collaboration in learning. Project immersed in STEAM learning should involve group task and collaboration between each student in group or between groups.

Previous research pertaining STEAM and STEM has already published by the other researcher. STEM with project-based learning could leads students into their creativity [17]. STEM also could improve students’ STEM literacy [18,1]. Beside STEM literacy, it also develops students’ scientific Literacy [19]. STEM also one of the popular strategies to develop students learning [20] and science process skills, student metacognitive also able to measure after student learn with STEM strategies [21]. STEM is not only as strategies in learning, but teacher also able to create an assessment based on STEM [21]. Based on the explanation before, there are something that unrevealed pertaining students and STEM strategies. There is no research discuss pertaining STEM immersed with “A” inside becoming STEAM, would make students more innovative, creative, and collaborative. So that, this research has a notion about how STEAM can reveal student’s collaboration during learning in mathematics subject. It will figure out how art has greater influence to the student’s collaboration. Then, the teacher could consider the learning approach, STEM with art based on the student’s collaboration competence result to improve their higher order thinking skills as research contribution.

2. Method
This research used quantitative pre-experimental design, type one-shot case study, where this research has not controlled factor, there is only one class with 15 students and two different activities. The students are given the treatment as STEAM project with “Your Energy Counter” activity and the other treatment with non-STEAM project in theme “Wudu Water Wise” activity, then in the end of the treatment, students are examined by Co-Measure rubrics for figuring out their collaborative competences. Those activities are implemented in integrated leaning of Mathematics, Science, and Arts subject with STEAM approach. The subject of this research is a group of 10 students of grade VIII that include in one class at one of Junior High School in Depok. The purposive sampling is applied in this research.

The data sampling technique that is used in this research is observation during the activity. The purposes of this research are to investigate the student’s collaboration competence in integrated STEAM learning approach. Instrument that is used is Co-Measure rubrics which has Likert scale 1-3 which has four categories, namely Peer Interaction, Positive Communication, Multiple Inquiry, and
Transdisciplinary Approach [22]. Then, the data are analysed from the average of each category that described as Table 1 below.

**Table 1.** Average ranges from each category of co-measure rubrics.

| Average Range | Description       |
|---------------|-------------------|
| 0 -1.0        | Needs Work        |
| 1.1-2.0       | Acceptable        |
| 2.1-3.0       | Proficient        |

Then, the category of student’s collaboration competences in Co-Measure rubrics could described as follow Table 2 below.

**Table 2.** The category of student’s collaboration competences in co-measure rubrics.

| Category             | Attribute                                                                 |
|----------------------|---------------------------------------------------------------------------|
| Peer Interaction     | Project Comprehensive/peer activity for solving the problem               |
|                      | Negotiation role and decision for assignment among peers                 |
|                      | Gives the feedback, help, and advises to their friends                   |
| Positive Communication | Compromise/respect to other opinion                                     |
|                      | Good language and attitude                                               |
|                      | Listen each other and takes turn to speak                                |
| Multiple Inquiry     | Developing question and method for solving the problem                   |
|                      | Verify the information and sources for support the theory                |
| Transdisciplinary Approach | Discuss and use the intradisciplinary knowledge to solve the problem |
|                      | Related with scientific evidence, article, or another relevant knowledge |
|                      | Negotiate relevant method and material for solving the problem           |
|                      | Using collaborative devices to solve the task.                            |

3. Result and Discussion

This research is implemented in one class with different approach, the first project “Wudu Water Wise” used contextual project that usually used in daily learning at school. Students asked to calculate the amount of water and time that is used during wudu activity, and also make a recommendation in order students are able to save water during wudu activity. This project related with mathematics regarding three-dimensional shape measurement, volume-size conversion, and water discharge concept in VIII grade. The second project that students have already done is “Your Energy Counter” activity, which students are asked to play different role as nutrition application developer with different tasks as follow: 1) become data developer team that has to search the nutrition data in foods, 2) Program developer team whose develop application which able to count the formula of energy needs and energy intake, 3) design team who has task to create the infographic using Photoshop application and uploaded to Zapworks application, and 4) marketing team who has task to make public presentation using Google slide and Powtoon. Those are the application that is created by the students in Your Energy Counter activity as Figure 1.

![Figure 1](image-url). The application which is created by the students in your energy counter activity.
Those activities are already done to do, then teacher give the score for they collaboration competence during both activities. Thus, here the results of students regarding collaboration competences based on averages computation which shown in Figure 2.

Figure 2. The results of student’s collaborative competences averages in non-STEAM and STEAM project.

Figure 2 shows that transdisciplinary approach category has almost identical average results between STEAM (n=2.6) and non-STEAM project activity (n=2.1) with the same description, there are proficient. It is caused that students in STEAM project and non-STEAM project have already integrated the multiple disciplinary. For instance, in non-STEAM project which emphasize to contextual learning, students are asked to calculate the water discharge during the wudu and they have to relate it with volume, capacity, three-dimensional shape, and also, they should give the recommendation how to do the right way in wudu in order can save the water, which means that it is related to environment and waste management. In a line with non-STEAM project, STEAM project also definitely has already integrated all the subject including in technology and arts. All the students’ activities pertaining of creating a product, there was an art inside. So, arts could enhance student’s work, collaboration and intuition. Similar with the works of [23,24,25] that arts could enhanced students understanding in science concept, creative process as higher order thinking skills, collaboration, and fostering collaboration. STEAM approaches also able to improve mutual enhancement by simply scaffolding interdisciplinary collaboration [24].

Similar with transdisciplinary approach category, positive communication category also has identical average results between STEAM (n=2.7) and non-STEAM project activity (n=2.6) with the same description, there are proficient. It could be said that students in every single project have a discipline, respect to others, and use good attitude and language. Especially in STEAM project that has still outperformed than non-STEAM project because they play role as created by the teacher which in the environment that look alike in real life. So, they are a lot of communication among them and they have to choose the best language as in workplaces. Language is also including in arts, so good communication is really important to build among scientists with good languages [23]. The knowledges, the skills include in communication, collaboration, flexibility and adaptability, also good attitudes, student’s behaviour are acquiring from studying arts.

The results of multiple inquiry and peer interaction are contradictory with another category that has been discussed above. Both of category has different result from STEAM project and non-STEAM project. The STEAM project is in proficiency description, while non-STEAM category is in an acceptable description. In peer interaction category, students when they do non-STEAM project are less interaction than do the STEAM project. So many advise and negotiation can be done by students in STEAM project. They also more intense for discussing about divided the task with high level of difficulty in STEAM project to create an application. While the students do the non-STEAM project, they less interaction because the project has low level of difficulty. Each student is able to solve the problem by themselves. Beside peer interaction category, there are Multiple Inquiry which has different results. It is caused by in STEAM project, students used high technology as computer and internet to develop an application which can make them curious, develop the questions and method regarding to
verify the information during create the application. Students would ask a question when they have a curiosity about something they will know, it is really important because that is the key of learning [26]. STEM-based project learning also are able to improve they questioning skills [26]. While in non-STEAM project students less asking a question because they do the usual activity in learning. It means that they less curiosity in non-STEAM project activity.

Overall, the result shows that student’s collaboration competence has outperformed in STEAM project activity rather than in non-STEAM project activity. Because integrating arts in STEM obviously could balance the mind, enrich the skills, communications, multiple disciplinary, cross disciplinary collaboration, and mastery the student’s concept of the topic [24].

4. Conclusion
This study could be concluded that student’s collaboration competence has outperformed in STEAM project activity rather than in non-STEAM project activity. Arts in STEAM has influence the collaboration, communication, cross disciplinary, and curiosity in learning. The collaboration competence category which has higher results is transdisciplinary approach and positive communications with proficient descriptions.

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