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The Effect of Project Based Learning (PjBL) Integrated by STEM on Students' Generik Science Abilities

Bung Ashabul Qahfi[1*], Aris Doyan[2], Muh. Makhrus[3]

[1] Department of Physics Education, University of Mataram, Mataram, Indonesia

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Corresponding Author:
Bung Ashabul Qahfi
bungmukh95@gmail.com

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Abstract: This research aims to determine the effect of the integrated STEM project-based learning (PjBL) model in static fluid material on the generic science abilities of students at SMAN 1 Donggo. The type of research is quasi-experimental research with a pretest and posttest design with non-equivalent control groups. The sample used was class XI where MIA 1 was the experimental class and class MIA 2 was the control class. The instrument used in collecting data is a test instrument in the form of multiple-choice questions. The data analysis technique used is the n-gain test. The research results show that the average n-gain value for critical thinking skills for both classes is an n-gain value of 53.43%, a minimum value of 11.67, and a maximum value of 85.11 for the experimental class. while the average n-gain value for the control class was 44.46%, the minimum value was 17.81 and the maximum value was 72.34. Based on these values, it is concluded that the STEM integrated project-based learning (PjBL) model has an effect on students' generic science abilities.

Keywords: Project based learning; STEM; Science Generic

Introduction

The level of education and ability of the people to follow contemporary developments in science and technology are indicators of a country's progress (Doyan et al., 2022). Education has the aim of creating knowledgeable humans. Humans with this knowledge are expected to be able to change their thinking structures and skills for the better. Education is also expected to be able to shape people to apply their knowledge (Susilawati et al., 2021; Arifah et al., 2021). Changing times and the character of Generation Z are challenges that must be faced in the education sector in accordance with its development (Hernandez-de-Mendendez et al., 2020). Therefore, education in Indonesia is expected to mutate following changes in the technological era (Keshav et al., 2022). But in reality, compared to other Southeast Asian countries, Indonesia is still far behind (Fenanlampir et al., 2019). The results of the 2018 Program for International Student Assessment (PISA) survey, of the 79 participating countries, Indonesia was ranked 71st, which means it is still far behind (Hewi & Saleh, 2020). This situation makes Indonesian students still strive to be at a better level.

Increasing this level, namely by increasing students' generic science abilities (Pujani et al., 2022; Supena et al., 2021; Zulyusri et al., 2023). These abilities are basic and general abilities that are oriented towards higher knowledge, and can be applied to a fairly broad field of work. Generic abilities are not discipline-specific, these generic abilities include: problem solving, critical thinking, communicative analysis, technological skills, and collaboration (Taofiq et al., 2018; Ni Putu et al., 2023). Another advantage of generic science abilities is that they can be applied in studying and interpreting concepts and solving problems in science and can also be developed through learning (Doyan et al., 2021). Generic scientific abilities are not acquired suddenly but require continuous training so they can develop (Agustina et al., 2016). In essence, knowledge, attitudes and generic science skills are expected to be positively improved through the implementation of learning (Doyan et al., 2021).

In Indonesia, one of the important subjects to study is physics as a branch of science. Physics subjects prepare students to improve their skills at a higher level of education. Mastery of physics subjects makes it easier for students to analyze processes related to contemporary technological developments (Anggraeni

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et al., 2015). Therefore, generic science abilities are very necessary in learning physics. Learning can be said to be successful if students have understood the material both in the realm of knowledge, skills, and attitudes (Susilawati et al., 2015).

One effort to improve generic science abilities is with the project based learning (PjBL) model. The project based learning (PjBL) model is one of the model choices to make it easier for students to understand the subject matter being discussed because students carry out direct practice so that they can analyze problems found, provide critical responses, and find solutions and are able to improve or enrich learning skills. and students' understanding of physics concepts (Dywan and Airlanda, 2020; Novianto et al., 2018). Through project-based learning, students can develop their creativity, by investigating problems, finding solutions, and producing products based on the concepts they learn (Saputri et al., 2020; Natty et al., 2019). Apart from that, the PjBL model can also provide innovation skills and contextual experience to students (Mustika et al., 2020; Wicaksana et al., 2022; Yusika et al., 2021).

The project based learning (PjBL) model can be combined with an approach that integrates four scientific disciplines, namely STEM (Science, Technology, Engineering and Mathematics). These aspects are really needed in working on a project so that a comprehensive and active learning atmosphere is created (Mawarni et al., 2020). The STEM approach has the potential to improve students' generic science abilities (Setiawan et al., 2022; Widiastuti et al., 2019). Based on this description, this research aims to determine the effect of the STEM integrated project based learning (PjBL) model in static fluid material on the generic science abilities of students at SMAN 1 Donggo.

Method

This research was conducted at SMAN 1 Donggo with the type of research, namely quasi-experimental research with a pretest and posttest design with non-equivalent control groups. The sample used was class XI where MIA 1 was the experimental class and class MIA 2 was the control class. The instrument used in collecting data is a test instrument in the form of multiple choice questions. The data analysis technique used to test the hypothesis is the n-gain percent test. Before the hypothesis test is carried out, the analysis prerequisite tests are first carried out, namely the data normality test and homogeneity test.

Table 1. Research design

Class	Pretest	Treatment	Posttest
Experimental	P_1	X_1	P_2
Control	P_1	X_1	P_2

Result and Discussion

Project Based Learning Model (PjBL) Model

The project-based learning (PjBL) learning model according to the George Lucas Educational Foundation (in Kettler et al., 2018) has 6 syntaxes in its application, namely:

Table 2. Syntaxes of Project-based Learning (PjBL) Learning Model according to the George Lucas Educational Foundation

syntaxes	information
Create basic questions	At this stage, as an opening the teacher asks a logical question related to students' interests and material, involves students and provides apperception during project work.
Design a project plan	At this stage the teacher explains the project to be worked on, arranges activities that facilitate students to improve the skills needed to work on the project.
Formulate a schedule	This stage is the stage where the teacher determines the time needed, hands over tools and materials to students, and students are expected to be able to utilize the time they have been given with maximum work.
Providing and monitoring student work	This stage is the stage where the teacher explains the material briefly and asks each group about the progress of the project.
Provide an assessment	This stage is the stage where the teacher describes the assessment guidelines both relating to students' abilities when working on projects and the overall (final) assessment.
Evaluate the experience	This stage is the stage where students are invited to review the material they have studied and carry out individual evaluations about the projects they will work on next.

Generic Science

Generics are one of the skills that are very important in efforts to improve human resources in the 21st century. Therefore, the science education and learning curriculum makes generic skills a skill that needs to be developed. Generic skills in scientific knowledge are known as generic science skills (Zulfani and Octafiani, 2015). Generic science skills are basic skills used to understand concepts, solve various problems in science, and make decisions in everyday life (Agustina et al., 2016; Aryani et al., 2016).

According to Brotosiswoyo, generic science skills have several indicators, namely (Rohman, 2018): (1) Observation is a skill for using the senses in conducting experiments, finding facts from experimental results, and finding differences and similarities. This observation is divided into two observation models, namely direct observation and indirect observation; (2) Awareness of scale is sensitivity to scale, both macroscopic and microscopic; (3) Symbolic language is knowledge of symbols, terms, codes and symbols; know the meaning of units and quantities of equations quantitatively; solve problems using equations; and the ability to understand graphs and tables; (4) Basic logical framework, Principled logical ability is the ability to link relationships between two situations logically; (5) Logical consistency/logical inference is the ability to convey arguments, solve problems, and make conclusions based on understood rules and existing laws; (6) The law of cause and effect is the ability to predict the basis for the occurrence of natural phenomena and the ability to link existing variables; (7) Mathematical modeling is the ability to formulate problems, provide alternative solutions based on the problem, as well as the ability to compile graphs and images based on the problem; and (8) Concept building is the ability to formulate or add new concepts.

N-gain Percent of Students' Generic Science Ability

The generic science abilities of students who are given the integrated STEM project based learning (PjBL) model treatment are as shown in Figure 1.

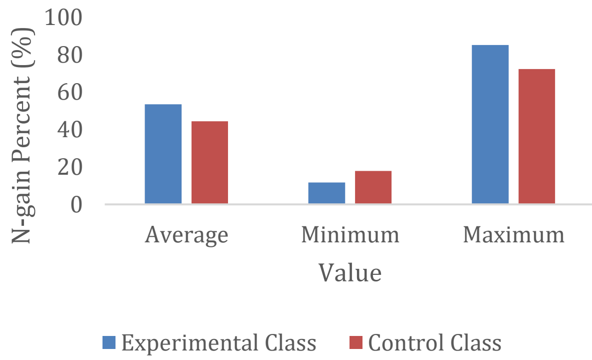

Figure 1. N-gain Percent Generic Science Ability

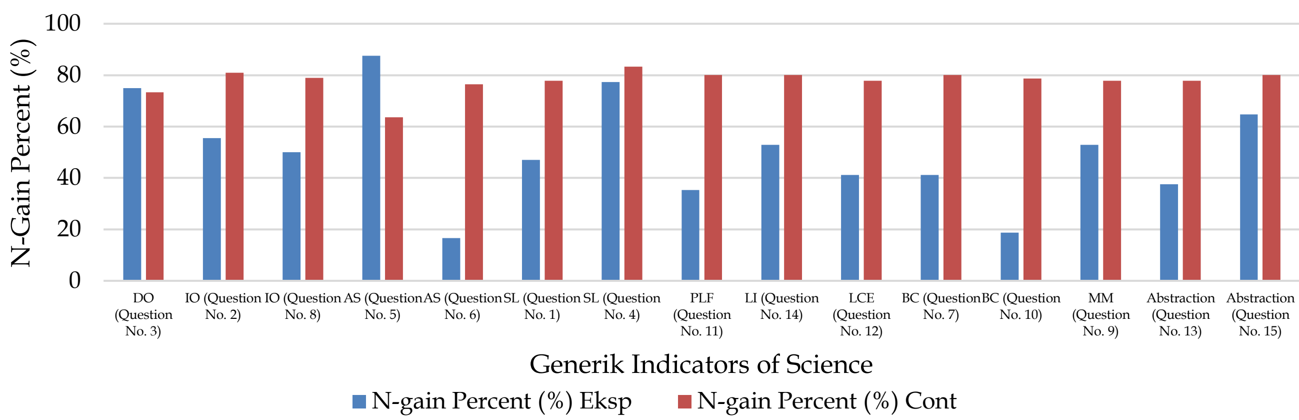

Figure 2. N-gain Percent Per Science Generic Indicator

Figure 1 shows that the average n-gain value for the experimental class is 53.43%, the minimum value is 11.67 and the maximum value is 85.11 which is categorized as quite effective, which means that the integrated STEM project based (PjBL) model has an effect on students' generic science abilities. Meanwhile, the average n-gain value for the control class was 44.46% with a minimum value of 17.81 and a maximum value of 72.34. This means that the generic science abilities of the control class are categorized as less effective. Then the n-gain percent value per generic science ability indicator can be seen in Figure 2..

Based on Figure 2 above, the results obtained show that generic science abilities per indicator. (1) Direct observation (DO) indicator for question 3. Both classes obtained an n-gain percent score of 75% for the experimental class and 73% for the control class, which means that both classes have effective criteria. (2) Indirect observation (IO) question 2 and 8. In question no. 2, The experimental class obtained an n-gain value of

56% with quite effective criteria and the control class was 81% with effective criteria.

Then in question number 8, the experimental class obtained an n-gain value of 50% in the effective category and the control class was 79% in the effective category. (3) Awareness of the scale (AS) of questions 5 and 6. In question 5 the experimental class obtained an n-gain percent score of 88% with effective criteria and the control class was 64% with quite effective criteria. Then in question 6, the experimental class obtained an n-gain value of 17% with ineffective criteria and the control class was 76% with effective criteria. (4) Symbolic language (SL) questions 1 and 4. In question 1, the experimental class obtained an n-gain percent score of 47% with less effective criteria and the control class was 78% with effective criteria. Then in question 4, the experimental class obtained an n-gain value of 77% with effective criteria and the control class was 83% with effective criteria. (5) Principled logical framework (PLF) question 11. In question 11 the experimental class obtained an n-gain percent value of 35% with less effective criteria and the control class was 80% with effective criteria. (6) Logical inference (LI) question 14. In question 14, the experimental class obtained an n-gain percent score of 53% with quite effective criteria and the control class was 80% with effective criteria. (7) Law of cause and effect (LCE) question 12. In question 12, the experimental class obtained an n-gain percent score of 41% with less effective criteria and the control class was 78% with effective criteria. (8) Building concepts (BC) for questions 7 and 10. In question 7 the experimental class obtained an n-gain percent score of 41% with less effective criteria and the control class was 80% with effective criteria. Then in question 10, the experimental class obtained an n-gain value of 9% with ineffective criteria and the control class was 79% with effective criteria. (9) Mathematical modeling (MM), question 9. In question 9 the experimental class obtained an n-gain percent score of 53% with quite effective criteria and the control class was 78% with effective criteria. (10) Abstraction, questions 13 and 15. In question 13, the experimental class obtained an n-gain percent score of 38% with less effective criteria and the control class was 78% with effective criteria. Then in question 15, the experimental class obtained an n-gain score of 65% with the criteria being quite effective and the control class 80% with the criteria being effective.

Conclusion

The STEM integrated project based learning (PjBL) model can improve students' overall science generic abilities. This can be seen from the average n-gain percent value, minimum value and maximum value for both classes. However, there are several indicators of the generic science abilities of students who are given project-based learning treatment that show ineffective results.

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Conflicts of Interest
This research was carried out immediately with the aim of producing scientific papers for the field of education.

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