Jurnal Pendidikan Kimia Indonesia
Volume 8, Issue 1, 2024, pp. 29-38
p-ISSN: 2087-9040 e-ISSN: 2613-9537
Open Access: 10.23887/jpki.v8i1.71120

The Development of Student Soft Skills through the Integration of *PJBL STEAM* Learning in The Organic Chemistry 1 Topic of Hydrocarbons

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ARTICLE INFO

Article history:
Received December 3, 2023
Revised March 24, 2024
Accepted April 25, 2024
Available online May 20, 2024

Kata Kunci:
Soft Skills, STEAM PjBL, Kimia Organik 1

Keywords:
Soft Skills, STEAM PjBL, Organic Chemistry 1

ABSTRAK

Penelitian bertujuan untuk meningkatkan soft skills mahasiswa dalam menghadapi abad 21, menjadikan pembelajaran lebih menarik dan menyenangkan sehingga kualitas SDM menjadi lebih baik. Pengembangan soft skills mahasiswa dilakukan melalui integrasi pendekatan STEAM PjBL pada mata kuliah kimia organik 1 topik hidrokarbon*. Subjek penelitian mahasiswa yang mengambil kuliah kimia organik 1 pada semester ganjil tahun akademik 2022/2023. Jenis penelitian ini adalah penelitian kualitatif dengan teknik pengumpulan data berupa wawancara, observasi lapangan, dan reflektif jurnal. Pendekatan Scince, Technology, Engineering, Art and Mathematic (STEAM) diintegrasikan dalam pembelajaran dengan sintaks menggunakan enam tahapan yaitu memberikan pertanyaan esensial, membuat perencanaan proyek, menyusun jadwal proyek, memonitor mahasiswa dan perkembangan proyek, menilai/menguji hasil, dan mengevaluasi pengalaman mahasiswa. Hasil penelitian menunjukkan bahwa mahasiswa sangat menyukai pembelajaran proyek menggunakan pendekatan STEAM dengan hasil rata-rata angket respon sebesar 89,14% dengan kriteria sangat baik. 36% mahasiswa mengalami kendala saat membuat perencanaan tugas proyek dalam menemukan ide yang menarik dan terkait dengan materi senyawa hidrokarbon dengan pendekatan STEAM. Integrasi STEAM dalam pembelajaran berbasis proyek dapat mengembangkan soft skills mahasiswa.*

ABSTRACT

This research aims to improve students' soft skills in facing the 21st century, making learning more interesting and enjoyable so that the quality of human resources becomes better. This study explores how integrating Project-Based Learning (PjBL) with the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach can improve students' soft skills in Organic Chemistry 1, specifically focusing on the topic of hydrocarbons. The research subjects were students taking Organic Chemistry 1 courses in the odd semester of the 2022/2023 academic year. This type of research is qualitative research with data collection techniques in the form of interviews, field observations, and reflective journals. The STEAM approach, encompassing Science, Technology, Engineering, Art, and Mathematics, is implemented through a six-stage learning process, namely providing essential questions, making a project plan, preparing a project schedule, monitoring students and project progress, assessing/testing results, and providing student experience. The research results show that students like project learning using the STEAM approach with an average questionnaire response result of 89.14% with very good criteria. 36% of students experienced problems when making project planning assignments in finding interesting ideas related to organic chemistry 1 material using the STEAM approach. The integration of STEAM in project-based learning can develop students' soft skills.

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1. INTRODUCTION

Indonesia is part of the Southeast Asian countries which have become part of the ASEAN Economic Community *(MEA).* In the AEC era, the thing that is of concern is developing the quality of Human Resources (HR). Currently, limited employment opportunities mean that human resources must be truly qualified so they can compete on the international stage (Wibowo, 2015). The quality of good human resources of course cannot be separated from the skills to do the work (hard skills) and soft skills. Soft skills concern the development of students' character in the family, community and educational environment. Soft skills are knowledge or skills in non-academic or subjective fields including character, understanding of values, art, encouragement (motivation), adaptation, communication, teamwork, problem-solving, stress management and leadership from within humans to actualize their abilities (Firdaus, 2017). Research conducted by (Latifah et al., 2020) states that in the industrial era 4.0 soft skill abilities influence a person's work readiness. The soft skills needed include the ability to communicate, the ability to work in a team, leadership and the ability to solve problems (Setiawati & Mayasari, 2021; Fauzan, 2020; Gunawan et al., 2019; Aziz, 2020). Soft skills are knowledge or skills in non-academic fields, including etiquette, understanding values, art, motivation, adaptation, communication, teamwork, problem-solving, stress management and leadership from within humans actualizing their abilities (Firdaus, 2017). The importance of soft skills for the quality of human resources makes character education a must in learning. Therefore, in this research, the main focus is the development of students' soft skills as an effort to improve character in building good human resources quality in line with the demands of the times. Based on observations, the organic chemistry course still focuses on improving student academics and has not yet developed students' soft skills in class. The development of these soft skills becomes an indicator for students in carrying out their work. Success in work depends on 75% of soft skills and the rest is hard skills (Abbas et al., 2013). Other research also states that 85% of a person's success comes from soft skills and the rest from various things (Ramlall, 2014). So, to form an educator or prospective teacher who can understand the situation to achieve success, there needs to be learning by developing soft skills. Efforts are being made to improve students' soft skills by using a learning approach that can integrate several scientific disciplines (Apriliana et al., 2018).

Learning that integrates several scientific disciplines is called Science, Technology, Engineering and Mathematics (STEM) learning. In some studies, elements of art or art are added to become STEAM. These integrated scientific disciplines are connected, meaningful and relevant to each other so that they can foster students' interest and motivation to learn (Cheng et al., 2020; Dasgupta et al., 2019)

In STEM learning, cognitive abilities, personal motivation, conceptual knowledge, social skills, problem-solving competencies, scientific discoveries, technological innovation and mathematical calculations can develop according to the demands of 21st-century skills. The STEAM approach is an approach that integrates Science, Technology, Engineering, Arts and Mathematics, by focusing the educational process on problem-solving. STEM can integrate concepts, principles of science, technology, engineering and mathematics in the development of products, processes and systems that provide benefits to human life and apply the knowledge gained about phenomena that occur in real life (Handayani et al., 2022; Ariyatun, 2021). STEM (Science, Technology, Engineering, and Mathematics) is a learning approach that emphasizes the importance of developing problem-solving skills in students and honing collaborative skills so they can compete in the global era and be ready to face future challenges (Yakman & Lee, 2012; Wei et al., 2022). The approach that is often used in STEM learning is the Project Based Learning (PjBL) approach.

Project Based Learning (PjBL) is a learning model that emphasizes contextual learning through complex activities, guiding students to be able to ask questions, design, solve problems, carry out investigations, make decisions, work independently or in groups so that later the resulting project becomes a real product (Trianto, 2014; Wena, 2014; Herowati, 2023; Jauhariyyah et al., 2017). Learning in the PjBL model focuses on students solving problems, integrating various knowledge concepts from various scientific disciplines as student learning experiences (Han et al., 2016; Bell, 2010). In PjBL, several phases are determining project assignments, developing project plans, preparing schedules for lecturers and students in the form of an agreement on collecting assignments, monitoring project assignments, assessing the results of assignments given and final evaluation (Handayani, 2021).

This research will develop the soft skills of students taking organic chemistry courses, specifically focusing on the topic of hydrocarbons which are integrated into STEAM learning using the PjBL approach. The soft skills that will be analyzed include communication skills, teamwork, critical thinking skills, caring for the environment, responsibility, creative thinking, leadership and honesty. This research is important because apart from aiming to create student-centred learning-based learning, it is also to improve students' soft skills through STEAM-based project assignments. By developing these soft skills, students are expected to excel in communication and teamwork. The project fosters a sense of care for others and the

environment, alongside honesty, critical thinking, creativity, and increased responsibility towards assigned tasks.

2. METHOD

This research is a type of descriptive qualitative research. Descriptive qualitative research is conducted to produce data in the form of words that are as they are and not manipulated so that the data obtained is appropriate to existing conditions or phenomena both individually and in groups (Sukmadinata, 2009). Data collection techniques include interviews, field observations, response questionnaires and reflective journals. The research was carried out on 25 students taking organic chemistry courses in the odd semester of the 2022/2023 academic year. Data analysis in qualitative research is carried out during data collection and after data collection is complete. Qualitative data analysis is carried out interactively and continues to reach completion so that the data used is saturated. Activities in data analysis are data reduction, data display, and conclusion drawing/verification. Research instruments include interviews, questionnaires, and reflective journals. This student response questionnaire uses a Likert scale whose measurements are the same as those seen in Table 1 to calculate the percentage using the following formula:

$$\text{Score}(\%) = \frac{\text{Total Student Score}}{\text{Maximum Total Score}} \text{x}100\%$$

Student response results are considered good if they get a percentage of >70%. Data for closed questions were analyzed using descriptive techniques. Student response criteria can be seen in Table 1.

Table 1. Student Response Criteria

Interval	Criteria
0 - 20%	Very Bad
21% - 40%	Bad
41% - 60%	Sufficient
61% - 80%	Good
81% - 100%	Very Good

3. RESULT AND DISCUSSION

Result

STEAM Integration in Project-Based Learning

The integration of STEAM in project-based learning is carried out by implementing 6 stages in project-based learning. The PjBL learning model with the STEAM approach aims to strengthen students' concepts (Pratiwi & Effendi, 2023). The six stages can be seen in Figure 1.

In stage 1, providing essential questions, students are given basic questions about the topic of organic compounds being studied, especially hydrocarbon material. Some examples of questions given are what do you know about organic compounds? Why is organic chemistry often called carbon chemistry? Give examples of organic compounds in everyday life? and Explain the classification of organic compounds? The questions given can stimulate students to think critically. The second stage is planning the project, which includes planning topic selection, making predictions and investigation design (Titu, 2015). At this stage, discussions are held between students and lecturers and between students, namely about the project design plan that will be made, the tools and materials needed, and the place for completing the project tasks that will be made. The discussions that occur will give rise to empathy, good communication, and mutual respect for fellow group members. At this stage, student leadership attitudes will usually emerge, for example group members taking the initiative to express their opinions to each other. The results of the student discussion resulted in an idea, namely creating a chemistry LUDO game board on the topic of Hydrocarbons, starting from design planning, chemical materials that will be included in the game board and questions. Table 2 is an example of STEAM integration on the Hydrocarbon topic.

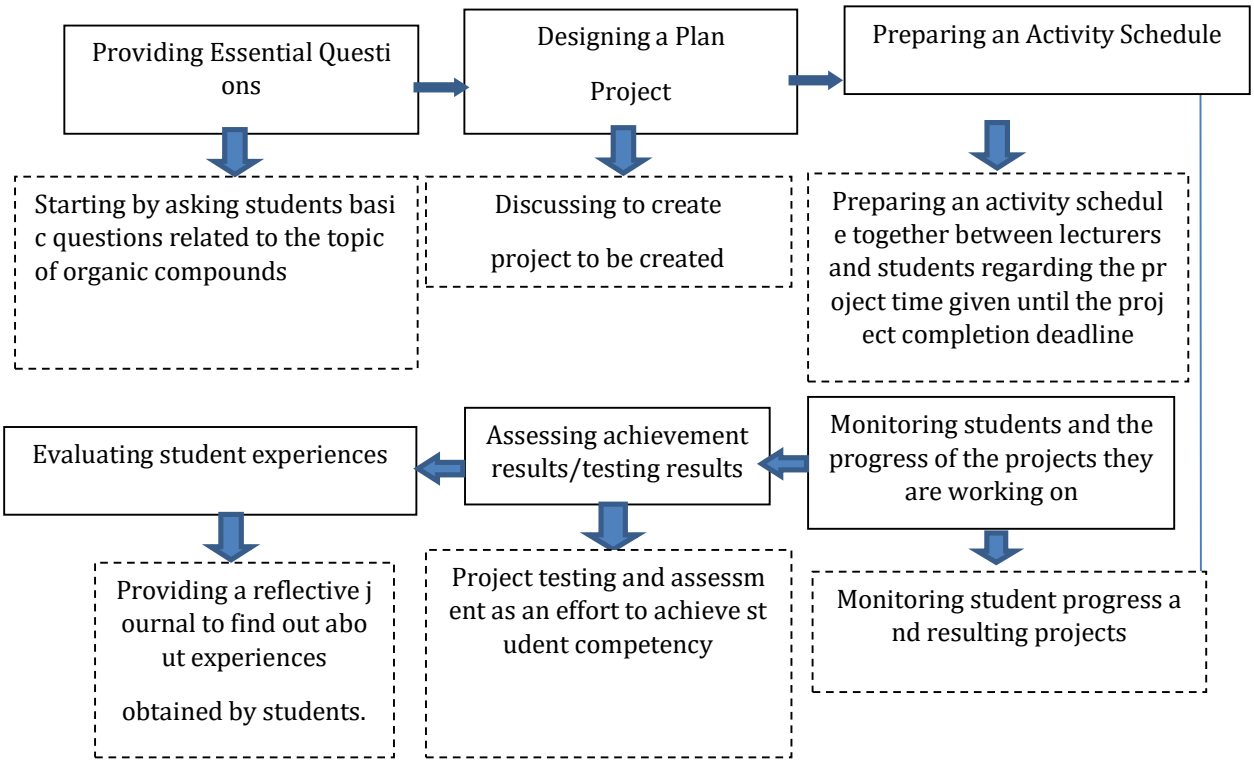

Figure 1. Six Stages in Project-Based Learning

Table 2. STEAM Integration in Group 1 Project Organic Chemistry Topic Hydrocarbons

No.	Aspects	Information
1.	Science	• Theory of alkanes, alkenes, and alkynes • Nomenclature of alkanes, alkenes, and alkynes. • Molecular formulas of alkanes, alkenes, alkynes. • Uses of alkanes in daily life. • Physical properties and chemical properties of alkanes, alkenes, and alkynes. • Write down the structural formulas of several compounds in alkanes, alkenes, and alkynes. • Name several compounds according to IUPAC rules from alkanes, alkenes, and alkynes. • Grouping several compounds into alkanes, alkenes, and alkynes. • Determination of isomers of alkanes, alkenes, and alkynes. • Reactions that occur with alkanes, alkenes, and alkynes.
2.	Technology	• Use of stopwatches on cellphones to count students' time in answering questions and writing the material on chemistry ludo cards. • Print chemistry ludo board designs and rules in banner form.
3.	Engineering	• Making a chemical ludo game design with an overall size of around 77.5 cm × 62 cm. • Pawns were drawn and formed laboratory tools such as test tubes, funnels, dropper pipettes and distilled water bottles using origami paper. • Pasting pictures related to chemistry in the chemistry Ludo deviation box
4.	Arts	• Determination of colour composition in the chemistry ludo game
5.	Mathematics	• Measure and calculate the overall length and width of the chemistry ludo game board.

The third stage is preparing a project schedule. The group team creates a schedule of activities in the LUDO chemistry game project on the topic of hydrocarbons. At this stage, lecturers and students jointly set a deadline for completing project assignments carried out by students. At this stage, cooperation and responsibility between students is needed. After discussion, students create a timeline for completing the project. The timeline functions as a guide for students to start and complete a given project. According to (Nurfitriyanti, 2016), project work takes quite a long time for students to understand a concept based on the results of their investigation of a problem.

Table 3. Project Work Schedule

No	Date	Activities	Time allocation
1	September 6, 2022	Make chemical LUDO	60 minutes
		Do Activity Worksheets	20 minutes
		Discussion of Hydrocarbon material	40 minutes
		Making game pieces and creating colours (Art)	30 minutes
2.	September 13, 2022	Try playing LUDO chemistry game in class	30 minutes
		Make questions related to hydrocarbons	60 minutes
		Test the game with other groups	40 minutes
		Doing Activity Worksheets	20 minutes
3.	September 20, 2022	Present project assignments and work on activity worksheets	40 minutes

The fourth stage is monitoring students and project progress. Student monitoring activities are carried out at each meeting. While monitoring students and project progress, lecturers must teach students to work together to complete the specified project (Lucas, 2003). Monitoring students at this stage is the most important stage to be able to observe the development of students' soft skills. One of the soft skills that develops during project completion at this stage is collaboration. This follows what was stated by (Djamarah, S. B., & Zain, 2014; Musa et al., 2012; Moursund, 2003), that project-based learning can develop cooperation. Apart from cooperation, at this stage, you can also develop several other soft skills, namely communication empathy, caring for the environment, hard work, adaptation skills and creative thinking.

Figure 2. The Examples of LUDO Projects Produced by Students

The fifth stage is assessing or testing the results. Assessment is a systematic process of collecting information on students' learning processes and outcomes based on certain considerations from parents, peers, and students' attitudes so that they can decide on the final results in a certain period (Destiana et al.,

2020; Nuriyah, 2014; Panjaitan et al., 2020). The assessment of this project assignment is to look at the effectiveness of the media that has been created, the practicality and ease of playing and the achievement of the desired hydrocarbon concept in the learning outcomes of the organic Chemistry 1 course.

The sixth stage is evaluating experience. Evaluation is carried out on the entire process carried out from the beginning to the end of the learning activity. At this stage, students are given a self-assessment and a reflective journal in the form of a questionnaire on student responses to the project assignments that have been carried out. The student response questionnaire was also distributed to 25 students taking the Organic Chemistry 1 course. The percentage of responses can be seen in Table 3.

Table 3. Student Response Questionnaire

No	Statements	Percentage (%)
1	I didn't experience any significant obstacles in making plans	64
2	I didn't have difficulty collecting data for my project assignments	96
3	I didn't have difficulty organizing my project assignment data	96
4	I didn't encounter any problems in presenting my project assignment data	84
5	Through learning with project assignments, I understand more about organic chemistry	92
6	I am happy with the implementation of the project assessment	100
7	I am interested in taking part in further project-based learning.	92
	Average	89.14
	Criteria	Very good

In Table 3, it can be seen that in general students like project learning with an average of 89.14% with very good criteria. Students (9 people) only experienced problems when planning their project assignments for the first time. Find interesting ideas related to organic chemistry 1 with the STEAM approach. In the response column, students wrote that integrating the STEAM approach into project-based learning can make learning more interesting, exciting and fun.

Discussion

STEM is a new approach to teaching that meets the needs and increases students' interest in science, technology, and mathematics. STEM is an important breakthrough that is in line with the development of 21st-century skills based on an interdisciplinary approach that studies academic concepts connected to the real world and applies the principles of science, mathematics, engineering and technology (Kanematsu, 2016; Salame & Nazir, 2019). Learning that uses a STEM approach is usually integrated with project assignments where the implementation is carried out by students with the help of a lecturer. In this case, students gain understanding through questions that can answer their curiosity. Project-based learning can help students in the process of building individual knowledge based on each student's abilities. Skills in collecting and using data to guide and interrogate the results of scientific and engineering research in STEM activities can also be used to develop student's scientific knowledge, especially the practice of science, namely asking questions, planning and collecting data, representing, analyzing and interpreting data, and reaching conclusions. In field applications, STEM elements are often added to make it STEAM. With the Art element, it is hoped that through STEAM students will get used to solving problems creatively.

STEAM-based learning can also be linked to the need to develop 21st-century skills for students, namely critical thinking skills, creativity, collaboration and communication. This is in line with previous research which states that STEM skills include students' metacognitive skills, such as critical thinking and creativity; and non-cognitive (soft) skills, such as collaboration and communication (Hu et al., 2020; Xie et al., 2015). With this in mind, STEAM-based learning also requires students to identify problems, create something to solve problems, work together with classmates to solve problems, communicate effectively, and respond to other people's opinions. The integration of STEAM in project-based learning can develop students' soft skills, namely: cooperation, critical thinking, environmental care, responsibility, adaptability

skills, creative thinking, leadership and honesty. This can be seen in the self-assessment rubrics, peers and reflective journals that students have filled out.

In the self-assessment rubric, students assess themselves and the results obtained are 100% stating that they have submitted assignments on time, according to a mutually agreed method and made reports independently, meaning that students are fully responsible for the assignments given by the lecturer. Only 80% of students record all the project data obtained and are willing to ask questions and discuss with colleagues or lecturers. As many as 92% of students looked for information related to project assignments given through reference books and the internet and understood the concept of chemical compounds/reactions in learning. In general, there are no significant obstacles to the project tasks given.

Cooperation carried out in groups is by dividing tasks among group members. Each student is **responsible** for the assignments given with full awareness. Tasks are divided evenly so that all students are directly involved in the project assignments given by the lecturer and students can **adapt** well to fellow members in their group**.** All students have the same opportunity to convey their ideas in groups. **Students' critical and creative thinking skills** are required in this activity. So that it produces good, useful and interesting project assignments. These critical and creative thinking skills are related to each other, namely creative thinking which is correlated with the ability to solve problems in critical thinking (Gafour & Gafour, 2021). The STEAM project assignment given uses the concept of green chemistry by utilizing used goods that can be recycled so that they become more useful and train students' attitudes to **care more about the environment**. Students' **leadership** attitudes and **honesty** are trained when they communicate and present the project results obtained in front of the class. Students present their respective project assignments according to the results they have obtained while carrying out their assignments. Students' **creative thinking abilities** are seen when students include art elements in the STEAM projects they design Students with *NPM* 15 stated that:

"*I am very happy with the STEAM project assignment given. It made me think about what project I would make for organic chemistry. At first, I had difficulty, but in the process, there were no significant obstacles. Our group made a Ludo Chemistry board game based on hydrocarbon material, we gave it lots of colours so that the game was interesting and not boring. We have previously discussed the questions that were designed in groups with the guidance of the lecturer*".

Based on the analysis of media development created by students, the advantage of the Chemistry Ludo Game is that it can help students to be more active in thinking critically because this game requires precision in playing, and by playing students have a high sense of responsibility in completing the tasks given. Apart from that, this game is easy to play and simple to play anywhere and anytime because the chemical ludo board is in the form of a banner, and increases the level of student solidarity. Meanwhile, the disadvantage of the chemical ludo game is that the number of players must be determined and determined because there are 4 boxes which means only 4 people can play. Then, if the division into groups to play is not directed by the lecturer, students will choose to group with their close friends. To avoid this, lecturers must be fair in dividing group members to avoid choosing friends. And if the class is not managed well, the classroom atmosphere will become busy and noisy.

The STEAM approach carried out on students is based on observations made by researchers in the field, namely: (1). Students are increasingly thinking critically, as indicated by the many questions asked when expressing ideas for making projects. (2). Learners focus more on processes that help lead to innovation. (3). Learning becomes more fun and useful for students. (4). Increasing students' creativity in applying learning materials and solving problems. (5). Increase collaboration between students so that they are more productive. Some of the benefits obtained are closely related to students' soft skills. This means that the STEAM approach applied in learning supports the development of students' soft skills. The STEAM approach also supports 21st-century learning in welcoming the era of society 5.0 (Mu'minah, 2021).

The STEAM approach in hydrocarbon learning cultivates critical and creative thinking as students generate ideas for project tasks. Teamwork is honed through collaboration, fostering leadership skills within the team. Communication and cooperation are emphasized throughout group work. Additionally, a sense of care for peers and the environment is nurtured, alongside self-confidence and honesty in presenting project outcomes. Research supports these observations (Rohma et al., 2023) and found the STEM approach encourages creative problem-solving, leading to tangible results. Mulder et al (2023) suggest that web-based learning media, coupled with STEAM, effectively improves students' creative thinking. Furthermore, Raudatul Jannah & Abdul Syukur (2022) highlight STEM as an interdisciplinary approach that fosters knowledge and skills across these subjects, while also promoting scientific attitudes like openness, objectivity, curiosity, and responsibility.

4. CONCLUSION

Based on the research conducted, it can be concluded that students stated that the integration of the STEAM approach in project-based learning was interesting, exciting and fun learning. From the questionnaire distributed to 25 students, an average of 89.14% was obtained with very good criteria. The integration of STEAM in project-based learning on organic compound material can develop students' *soft skills*, namely cooperation, critical thinking, environmental care, responsibility, adaptability skills, creative thinking, leadership and honesty.

ACKNOWLEDGEMENT

We would like to express our gratitude to the Faculty of Teacher Training and Education, University of Bengkulu as a financial supporter for this PPKP research with contract number 3176/ UN.30.7/PP/2022 in June, 06st 2021.

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