



Implementation of Project Based Learning to Improve Students' 4C Skills in Entrepreneurship Learning

^aDesi Budiono*, ^bTiara Anggia Dewi and ^cEni Puspita

Affiliation:

^{a,b,c} Universitas
Muhammadiyah Metro

Contact:

desubudiono@ummetro.ac.id

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Abstract:

The purpose of this study was to determine differences in the 4C skills (Critical Thinking, Communication, Collaboration and Creativity and Innovation) of students before and after the implementation of the Project Based Learning (PjBL) learning model in the Entrepreneurship subject. The research conducted is Classroom Action Research (CAR), which aims to change the current real situation towards the expected state. The study followed the Kemmis and McTaggart model in two cycles with 30 eleventh-grade students (class XI Pharmacy 4) of SMK Muhammadiyah 3 Metro in the 2023/2024 academic year. In each cycle, students worked in groups on a project to make "jahemu" (an instant ginger drink) integrated with production cost material. 4C skills were scored with a structured observation sheet (16 items, maximum score 64 per student) and analyzed with quantitative descriptive analysis, supported by qualitative data from observation notes, pre-cycle interviews, and reflection. The mean 4C score rose from 55.47% (Poor) in the pre-cycle to 85.42% (Good) in Cycle 1 and 89.69% (Very Good) in Cycle 2, an overall increase of 34.22 percentage points, and the success criterion (Very Good category) was reached in Cycle 2. Because the study used no control group and no inferential test, the results are interpreted as descriptive improvement associated with the implementation of PjBL, not as proof of a statistically significant effect. The study contributes evidence on all four 4C skills together in vocational entrepreneurship learning through a real-product project; scores for each 4C dimension were not recorded separately.

Keywords: Classroom Action Research; Entrepreneurship Learning; Project-Based Learning; 4C Skills.

Introduction

The development of education worldwide cannot be separated from the ongoing industrial revolution. In the Industry 4.0 era of the 21st century, 21st-century learning combines literacy skills, knowledge, skills, behavior, and technological mastery. The 21st century itself is an information age marked by the rapid and global spread of information. (Trilling & Fadel, 2009) state that this era is supported by rapidly developing communication technology, so the competency humans must possess is

literacy. Literacy is marked by four key elements: strong comprehension, critical thinking, and collaboration and communication skills (Thornhill-Miller et al., 2023) (Nisa et al., 2025). As is widely known, the quality of an education program is influenced by many factors, including student quality,

teachers, availability of teaching materials, curriculum, facilities, and management. (Setyawan et al., 2017) state that Learning runs effectively when students feel happy, comfortable, and enjoy the learning process. (Razaq, 2012) also state that learning is a teaching-learning process that plays a role in determining students' learning success. This process creates reciprocal interaction between teacher and student toward a better goal. (Pane & Dasopang, 2017) state that learning also generates teaching-learning interaction between teacher and student, where the student is the key to learning behavior and the achievement of learning objectives, and that the learning process also aims for students to achieve the expected competencies. Project based learning itself is a learning model that involves students in problem-solving activities and gives them the opportunity to work autonomously in constructing their own learning. (Guo et al., 2020) state that this model focuses on the core principles and concepts of a discipline, involves students in problem-solving investigations and other meaningful tasks, gives students the opportunity to work autonomously in constructing their own knowledge, and culminates in producing a real product. (Sulastri & Tarto, 2022) Sulastri (2022), Prijanji et al., (2018) state that the PjBL model is highly suitable for increasing students' learning creativity so that their interest in learning increases and they do not become bored.

The problem addressed in this study is evident in the pre-cycle data. In class XI Pharmacy 4 of SMK Muhammadiyah 3 Metro, the mean 4C score was only 55.47%, and all 30 students were in the Poor category (scores of 50.00%–62.50%). Preliminary observation and interviews with the entrepreneurship teacher and five students showed that the weaknesses were spread across the four skills: students had difficulty analyzing information and evaluating arguments, generating original ideas, cooperating effectively in groups, and expressing ideas clearly. Production cost material was taught mainly through teacher explanation, case examples, question-and-answer, and individual calculation exercises, and the interviews indicated that earlier group work did not yet fully support team collaboration, with unstructured task division leaving some group members without a role.

Previous studies have shown that PjBL is associated with improvements in 4C skills, but the evidence is uneven across contexts. (Amroni et al., 2024) and (Rati et al., 2023) reported improvements among elementary school students; (Yusuf et al., 2023) and (Waly & Ashadi, 2024) reported

improvements in vocational software engineering and foreign-language classrooms, although communication gains were less consistent in the former, and time and teacher training limited implementation in the latter. In entrepreneurship learning the evidence is narrower: (Fuldiaratman & Ekaputra, 2023) studied university students, and (Fauziah et al., 2025) examined vocational high school students' creativity only. It therefore remains insufficiently documented whether PjBL built around a real-product project can develop all four 4C skills together among vocational high school students in entrepreneurship learning, and what instructional changes between cycles accompany such improvement. The novelty of this study lies in (a) examining all four 4C skills together, (b) in entrepreneurship learning at the vocational high school (SMK) level, (c) through a real product, jahemu, integrated with production cost calculation, and (d) within an iterative CAR design that documents the changes made between cycles.

The Classroom Action Research (CAR) method was used to design and implement PjBL. As researchers, teachers are actively involved in the process of improving learning through observation, reflection, and action in the classroom. In the initial observation, it was found that students faced problems in critical thinking, creative thinking, collaboration, and communication skills. The PjBL model is expected to improve students' 4C skills, with a focus on entrepreneurship material involving the production of a product called "jahemu," an instant ginger drink or ginger powder. With this PjBL model, students can learn actively and investigate in solving problems independently or in groups. This learning model is expected to improve students' 4C skills (Critical Thinking, Communication, Collaboration, and Creativity and Innovation). Through the entrepreneurship subject, the material presented in this learning process concerns production costs, with the final outcome being a product called jahemu, produced by students through group practice. Jahemu was selected because it is a real product that can be made in class from inexpensive natural ingredients such as ginger and honey, it relates directly to the production cost material (raw material, direct labor, and overhead cost and the selling price decision), and the school's Pharmacy program already produces a ginger-based product (JaheMu), which makes the project familiar and relevant to the students. The activities are expected to support each 4C skill as follows: critical thinking when students analyze and calculate production costs; collaboration when they divide roles and work within their groups; communication when they present their products and respond to other groups; and creativity and innovation when they develop their product and its variations. These relationships are the rationale of the intervention and are examined, not assumed, in the Results and Discussion. The strategy for building 4C soft skills can be carried out through an enjoyable and non-boring project based learning method. This study aims to describe how the 4C skills (Critical Thinking, Creative Thinking,

Collaboration, and Communication) of eleventh-grade students at SMK Muhammadiyah 3 Metro change across the pre-cycle and two CAR cycles when PjBL is implemented through the jahemu project, as measured with an observation sheet (maximum score 64), and to identify the instructional changes made between cycles. The results are expected to provide insight into the benefits of PjBL in improving students' 4C skills, which can be used as a basis for developing more innovative curricula and learning methods in the future.

Literature Review

Project Based Learning (PjBL) Model

Project Based Learning (PjBL) is a learning model that places students at the center of the learning process through the completion of real projects that produce concrete products or solutions, and is designed to equip students with the skills needed in the 21st century (Bell, 2010). Through PjBL, students not only learn concepts but also practice planning, executing, and evaluating their own work collaboratively. (Yusuf et al., 2023) study of vocational high school students majoring in software engineering found that STEM-based PjBL had a significant effect on students' critical thinking, collaboration, and creativity skills, although its effect on communication skills was not yet optimal due to factors related to student motivation and learning habits. Similar findings were reported by (Waly & Ashadi, 2024), who showed that PjBL integrated with information and communication technology (ICT) was able to foster oral and written communication skills, group collaboration, and creative thinking among students in a foreign-language classroom, although implementation faced challenges such as limited time and insufficient teacher training.

PjBL is grounded in constructivist learning theory and experiential learning theory. In Vygotsky's (1978) social constructivism, knowledge is built through interaction, and teachers and more capable peers provide scaffolding that helps learners accomplish tasks they could not yet do alone. In PjBL, group work on a real product provides this social scaffolding, which is a primary driver for developing collaboration and communication skills. (Kolb, 1984) experiential learning theory describes learning as a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Planning, making, presenting, and reflecting on a project follow this cycle, and the reflection stage of CAR parallels it by turning the experience of one cycle into modified action in the next.

4C Skills

The 4C skills critical thinking, communication, collaboration, and creativity and innovation are core 21st-century competencies that constitute one of the main objectives of implementing PjBL. Through a quasi-experimental study of elementary school students, (Amroni et al., 2024) demonstrated that the application of the PjBL model had a significant effect on improving 4C skills, with t-test results showing a significance value of 0.000 (< 0.05). This finding was reinforced by (Rati et al., 2023), who developed a Higher Order Thinking Skills (HOTS) oriented online PjBL model and found that it had a significant effect on both 4C skills and science learning outcomes among elementary school students, with a greater effect on 21st-century skills than on cognitive learning outcomes.

In an entrepreneurship project, the four skills can be described through specific indicators. Critical thinking is the ability to identify market problems, analyze the production cost structure, and evaluate efficiency. Creativity and innovation is the ability to design a new product formulation (for example, differentiating a ginger-based product) and to develop its presentation. Collaboration includes role allocation within the project team, group leadership, and resolving internal conflict. Communication is the ability to present product ideas, deliver the product to an audience, and compile the project report.

PjBL in Entrepreneurship Learning

In the context of entrepreneurship learning, several recent studies show results relevant to this research. (Fuldariatman & Ekaputra, 2023) analyzed university students' 4C skills through PjBL supported by chemo-entrepreneurship media and found a significant improvement across all 4C aspects following the implementation of the model. (Fauziah et al., 2025), using a Structural Equation Modeling-Partial Least Squares (SEM-PLS) approach involving 418 vocational high school students, demonstrated that PjBL had a positive and significant effect on students' creativity in entrepreneurship learning, in which a collaborative learning environment, engagement in real problem-solving, and self-reflection during the project strengthened divergent and innovative thinking among vocational students.

Most prior studies examined the effect of PjBL on 4C skills separately at the elementary education level (Amroni et al., 2024) (Rati et al., 2023) or within other subject contexts such as foreign languages, science, and software engineering (Waly & Ashadi, 2024) (Yusuf et al., 2023), while research within the context of entrepreneurship learning at the vocational high school (SMK) level remains relatively limited and has mostly focused on creativity as a single variable (Fauziah et al., 2025) or at the higher-education level (Fuldariatman & Ekaputra, 2023). Taken together, these studies suggest that PjBL is associated with

gains in 4C skills, that gains in communication depend on student motivation, time, and teacher preparation, and that evidence from vocational entrepreneurship classrooms is still thin. This study aims to fill that gap by describing the change in the full range of 4C skills (critical thinking, communication, collaboration, and creativity and innovation) among vocational high school students in entrepreneurship learning, through a Classroom Action Research approach involving the production of a real product. Its original contribution is a documented, cycle-by-cycle account of how PjBL with the jahemu project was adjusted through reflection and how the overall 4C score changed.

Research Methodology

This study is a Classroom Action Research (CAR), which aims to address the current real situation toward the expected condition. This uses quantitative descriptive analysis of observation scores (a comparison of mean scores across the pre-cycle, Cycle 1, and Cycle 2), supported by qualitative data from observation notes, pre-cycle interviews, and reflection sessions, and aims to improve the quality of classroom learning by solving practical problems in the interaction between teachers and students. No control group and no inferential statistical test were used; therefore, changes across cycles are interpreted as descriptive improvement. The action research model used is the Kemmis & McTaggart model, which consists of cycles of planning, action, observation, and reflection. This study used the Action Research model of (Kemmis et al., 2014), which takes the form of a spiral from one cycle to the next. Each cycle includes planning, action, observation, and reflection.

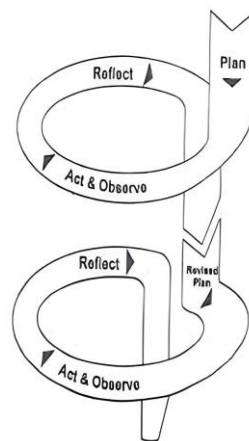


Figure 1. Classroom Action Research Cycle, Kemmis & McTaggart Model

The Classroom Action Research cycle consists of four main stages: planning, acting, observing, and reflecting. Each stage has a different focus and is interrelated with the others.

1. The planning stage is the initial stage in the CAR cycle, in which the teacher plans the teaching and learning activities to be carried out in the classroom. This stage includes collecting initial data, analyzing data, formulating hypotheses, and preparing an action plan to be implemented in the classroom.
2. The acting stage is the stage in which the teacher implements the action plan prepared during the planning stage. The teacher must also record all activities and interactions that occur in the classroom during the implementation of the action plan.
3. The observing stage is the stage in which the teacher observes and records all results of the activities carried out during the acting stage. Observation includes recording data, gathering information, and analyzing the results of the activities carried out.
4. The reflecting stage is the final stage in the CAR cycle, in which the teacher reflects on all activities and outcomes achieved during the cycle. The teacher must also consider the next actions to be taken to improve the quality of classroom learning.

Research Procedure

The pre-cycle consisted of classroom observation (20 March 2023), an interview with one entrepreneurship teacher and five students (6–8 May 2023), preparation of instruments (20–25 June 2023), and preparation of teaching materials and media (26–30 June 2023); students' baseline 4C skills were also scored. Cycle 1 and Cycle 2 each consisted of two meetings of three lesson hours (3 × 25 minutes per meeting) on the topic "Production Cost of Prototype Goods/Services." At the first meeting, the teacher opened the lesson, delivered the material, formed five groups of six students, assigned the project, and guided project planning and scheduling. Groups then made the project between meetings, monitored by the teacher, and submitted a report with photo or video documentation. At the second meeting, groups presented their products, the teacher and other groups gave responses, and the teacher led an evaluation and reflection. 4C skills were scored during the presentation sessions.

In Cycle 1, all groups made the jahemu product assigned by the teacher (assigned on 29 July 2023 and made on 5 August 2023), and two observers assisted the researcher. In Cycle 2 (project assigned on 10 August 2023 and due on 12 August 2023), one observer assisted, and the modifications decided at the Cycle 1 reflection were applied; they are described in the Results. A cycle was considered successful when the class mean 4C score reached the Very Good category ($\geq 86\%$). If it did not, the study moved to a further cycle with revised actions.

The subjects of this study were all 30 students (12 male and 18 female) of class XI Pharmacy 4 at SMK Muhammadiyah 3 Metro in the 2023/2024 academic year enrolled in the entrepreneurship subject. Total sampling was used because the number of participants was fewer than 100, so the whole class was taken as the sample. The class was chosen because the pre-survey showed weak 4C skills there and because the school's Pharmacy program already produces a ginger-based product (JaheMu), which makes the jahemu project relevant for these students. Two main data collection instruments were used in this study: observation, used to observe the learning process and students' learning skills during the pre-survey stage and throughout the learning process, and relevant documents, such as records of students' 4C skills. The data obtained were analyzed based on the research problem, namely students' 4C skills. Interviews with the teacher and students before Cycle 1 and reflection discussions with the observers after each cycle provided the qualitative data. Students' skill data are expressed through the following percentage formula:

$$\text{Individual score (\%)} = (\text{obtained score} / \text{maximum score of 64}) \times 100$$

$$\text{Class mean (\%)} = (\text{sum of all students' obtained scores} / (\text{number of students} \times 64)) \times 100$$

The observation sheet had 16 items (four per 4C dimension), each scored 1–4, so the maximum score per student was 64 and the item scores can be meaningfully summed. For example, in Cycle 2 the total score of 30 students was 1,722 and the maximum total was $30 \times 64 = 1,920$, so the class mean was $1,722 / 1,920 \times 100 = 89.69\%$. Scores were converted into categories using the scale in Table 1. The interview guide was checked and declared feasible by the supervising lecturers; validity and inter-rater reliability statistics for the observation sheet were not calculated, which is acknowledged as a limitation.

Table 1. Operationalization of 4C skills, scoring, and score categories

4C dimension	Indicators observed	Items / max. score	Assessment procedure
Critical thinking	Identifies relevant arguments; evaluates strengths and weaknesses of arguments	4 items / 16	Observed during discussion, project planning, and presentation
Collaboration	Actively participates in discussion; able to cooperate in the group	4 items / 16	Observed during group work and project making
Communication	Able to convey ideas; able to listen and respond well	4 items / 16	Observed during presentation and question-and-answer

Creativity and innovation	Generates new and original ideas; combines different concepts	4 items / 16	Observed during project design and presentation
Total		16 items / 64	Scored by the researcher with observers
Score category	Poor: 50–69.99; Fair: 70–75.99; Good: 76–85.99; Very Good: 86–100 (percentage of maximum score)		Success criterion: class mean in Very Good

Results and Discussions

Result

Changes in 4C Skills across the Cycles

This study was conducted through learning activities using the PjBL model to determine the level of 4C skills (critical thinking, communication, collaborative, creativity and innovation) of eleventh-grade Pharmacy 4 students at SMK Muhammadiyah 3 Metro in the 2023/2024 academic year, both before and after using this learning model. The results of the study, after processing, are presented in Table 2. The observation sheet was scored as a total of 16 items; scores for each 4C dimension were not tabulated separately in the research records, so the results are reported as an overall 4C score. Total scores were recalculated from the individual scores in Appendix 1.

Table 2. Data Processing on the Use of the PjBL Model on 4C Skills

Implementation Stage	Number of Students	Total Score	Maximum Total Score	Average (%)	Category
Pre-Cycle	30	1.065	1.920	55.47%	Poor
Cycle 1	30	1.640	1.920	85.42%	Good
Cycle 2	30	1.722	1.920	89.69%	Very Good

Based on the data presented in Table 1, it can be seen that the mean score of students' 4C skills (critical thinking, communication, collaborative, creativity and innovation) of eleventh-grade Pharmacy 4 students at SMK Muhammadiyah 3 Metro in the 2023/2024 academic year increased across the cycles in which the PjBL model was applied. This is consistent with the research problem, with the results showing a descriptive improvement in students' 4C skills that is associated with the implementation of the PjBL model. The average value of students' 4C skills before participating in learning using the PjBL model was 55.47%, while the average value after participating in two cycles of learning using the PjBL model was 89.69%, an increase of 34.22 percentage points. Thus, the success criterion (Very Good category) was not

reached in Cycle 1 (85.42%, Good) but was reached in Cycle 2. This improvement is descriptive: no inferential test was applied, so it is not claimed to be statistically significant.

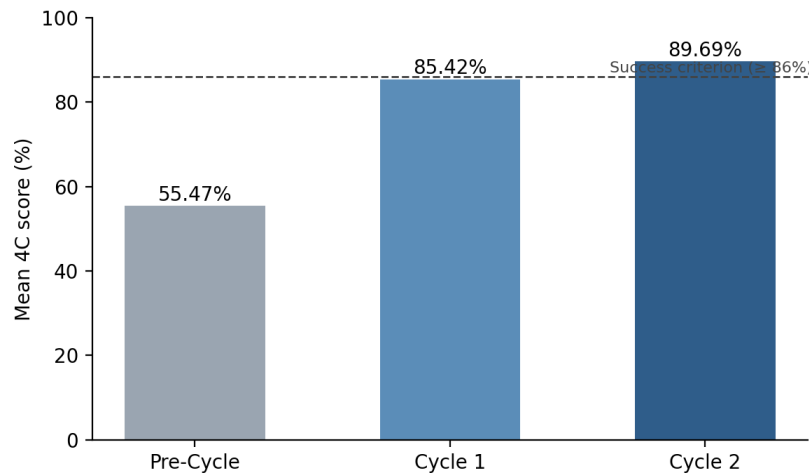


Figure 2. Chart of Students' 4C Skills

Based on Figure 1, it can be concluded that there was a clear increase in the mean 4C score from the pre-cycle to Cycle 2. The results of these three stages are detailed as follows:

Results in the Pre-Cycle

In the pre-cycle stage, it was found that the average assessment score for students' 4C skills only reached 55.47%. This indicates a need to further develop these skills. Under these conditions, students were not yet fully able to apply effective communication, productive collaboration, critical thinking, and creativity in learning. In the pre-cycle student assessment aspect, individual scores ranged from 50.00% to 62.50%, and all 30 students were in the Poor category (Appendix 1). The class mean was 55.47% (1,065 / 1,920). This result became an important consideration in preparing for Cycles 1 and 2. These 4C skills cover important aspects such as critical thinking, communication, collaboration, and creativity, and this result provides an initial picture of the extent to which students had mastered these skills before the learning model was applied.

Results in Cycle 1

After the application of the PjBL model in Cycle 1, there was clear increase in the development of 4C skills. The average assessment score for 4C skills increased to 85.42%. This illustrates that the PjBL model was accompanied by better students' communication, collaboration, critical thinking, and creativity skills. The experience of working on projects and facing real challenges helped students participate more actively,

interact with group members, and practice critical and solution-oriented thinking. In the Cycle 1 student assessment aspect, students achieved an average score that was considerably higher compared to the pre-cycle assessment. The level of students' 4C skills in Cycle 1 reached 85.42%, in the good category. Individual scores ranged from 73.44% to 92.19%: 15 students were in the Very Good category, 14 in Good, and 1 in Fair (Appendix 1). This result shows that most students had performed quite well in applying 4C skills (Communication, Collaboration, Critical Thinking, and Creativity) at the Cycle 1 stage, with a clear increase compared to the pre-cycle condition (55.47%).

Cycle 1 did not reach the success criterion. The reflection with the observers identified the following problems: some students were passive and did not ask questions because they were shy, and some did not understand the assignment because they had not followed the explanation of the material; cooperation within groups was hindered, partly because task division was unstructured; project monitoring needed to be improved; the project schedule had been set by the teacher; not all groups were involved in the presentation and evaluation; and the teaching media were incomplete. These problems led to the changes applied in Cycle 2 (Table 3).

Table 3. Problems identified in Cycle 1 and modifications introduced in Cycle 2

Problem identified in Cycle 1	Modification in Cycle 2	Intended support for 4C skills
Passive students; shy to ask questions; some did not understand the assignment	Teacher identified passive students and their reasons, and gave more attention to them; questions were invited from every group representative	Communication; critical thinking
Hindered cooperation; unstructured task division	Same groups kept to strengthen communication and cooperation; teacher facilitated discussion to resolve conflicts and made sure all members had a role	Collaboration
Schedule set by the teacher; weak monitoring	Students took part in determining the project schedule through discussion; the teacher acted as facilitator and increased guidance during project making	Collaboration; critical thinking (planning)
Project fixed as jahemu	Groups chose their own project, as long as it related to production cost (a jahemu product innovation)	Creativity and innovation
Not all groups engaged in presentation	Open presentation in random order (roulette), 5 minutes per group, and each group responded to one assigned group	Communication; critical thinking
Incomplete teaching media	Learning media supporting the material were completed	All dimensions

Results in Cycle 2

In the Cycle 2 stage, the improvement became more apparent more apparent. The average assessment score for 4C skills reached a very satisfying level of 89.69%. This shows that students not only learned the learning concepts but were also able to apply them effectively in a more complex context, achieving the very good category. Individual scores ranged from 84.38% to 93.75%: 27 students were in the Very Good category and 3 in the Good category (Appendix 1). Most students therefore performed very well in applying 4C skills (Communication, Collaboration, Critical Thinking, and Creativity) at the Cycle 2 stage, with a very satisfying increase compared to Cycle 1. The observers noted that all group representatives asked or responded to questions, cooperation between group members began to develop well, and the presentations were livelier. One group still had a member who left the group task to others, and the teacher redirected this student to take part.

Discussion

The mean 4C score moved from the Poor category before the intervention to Good after Cycle 1 and Very Good after Cycle 2, which met the success criterion and justified ending the cycles. The discussion below interprets this change through the 4C dimensions and the stages of the jahemu project. Because scores for each dimension were not recorded separately, the dimension-level statements rely on observation notes, the pre-cycle interviews, and students' responses after learning, and should be read as plausible explanations rather than measured results.

Critical thinking

Critical thinking was exercised mainly when groups analyzed the structure of production cost (raw materials, direct labor, and overhead) and calculated the cost of the jahemu prototype. After learning, students reported that they were better able to identify relevant arguments and to evaluate the strengths and weaknesses of an argument, and the teacher judged PjBL effective for critical thinking. This agrees with Yusuf et al. (2023), who found a significant effect of PjBL on critical thinking in vocational education, and with Amroni et al. (2024). Because these reports are self-reported and not scored separately, they support but do not confirm the improvement.

Creativity and innovation

The clearest change in creativity was the Cycle 2 modification in which each group developed its own jahemu product innovation. Students said that the model pushed them to think creatively and to combine

different concepts in their projects. This is in line with Fauziah et al. (2025), who found that real problem-solving, a collaborative environment, and self-reflection strengthened creativity among vocational students in entrepreneurship learning, and with Fuldjaratman and Ekaputra (2023), who reported improvement across all 4C aspects in a project-based entrepreneurship setting.

Collaboration

Collaboration was the weakest point in Cycle 1: both the teacher and students said that PjBL had not yet fully supported cooperation, and unstructured task division left some members without a role. In Cycle 2 the groups were kept the same, the teacher facilitated conflict resolution and made sure every member had a role, and the schedule was agreed with students. Cooperation was then observed to develop better, although one group still had a member who relied on others. This pattern fits Vygotsky's (1978) idea of scaffolding by teachers and peers and the positive effect of PjBL on collaboration reported by Yusuf et al. (2023) and Waly and Ashadi (2024).

Communication

In the pre-cycle and Cycle 1, only some students asked questions because others were shy. In Cycle 2, presentations were held openly, each group responded to another group, and all group representatives asked or answered questions. Students also said that speaking first in a small group made them more confident to speak before the class. Yusuf et al. (2023) found the effect of PjBL on communication less optimal because of student motivation and learning habits, whereas in this study the required presentation and response activities coincided with more active communication. Waly and Ashadi (2024) similarly noted limited time as a challenge; here the 75-minute meeting made the response rule (one group per group) necessary. Without separate communication scores, this remains an interpretation.

Why Cycle 1 stopped at 85.42% and what changed

Cycle 1 reached the Good category but not the success criterion because of the obstacles listed in Table 3: passive students, hindered group cooperation, weak monitoring, a teacher-set schedule, and a presentation format that did not involve all groups. The Cycle 2 modifications addressed each of these, and the mean score rose by 4.27 percentage points to 89.69%. This iterative adjustment is the core of CAR and gives a plausible explanation for the improvement. In terms of Kolb's (1984) cycle, the reflection after Cycle 1 turned concrete experience into modified action in Cycle 2.

Alternative explanations

Several other factors may also have contributed to the observed change and cannot be separated in this design. The same 30 students were scored three times with the same instrument, so familiarity with the project and the assessment (repeated practice) may have raised scores. The groups were unchanged between cycles, so group members became more used to working together. Teacher guidance and monitoring were increased in Cycle 2. The researcher acted as the main rater, which may introduce rater bias, and inter-rater reliability was not calculated. The class is also regarded as one of the stronger classes of the school. Finally, there was no control group and no inferential test. For these reasons, the findings are interpreted as descriptive improvement associated with PjBL, in line with the studies cited above but without claiming a statistically significant effect.

Conclusion

Based on the research and analysis conducted, it can be concluded that the Project Based Learning (PjBL) model was associated with improvement in the 4C skills (Critical Thinking, Creative Thinking, Collaboration, and Communication) of eleventh-grade students at SMK Muhammadiyah 3 Metro. The application of the PjBL model in the learning process produced an improvement in the development of students' 4C skills. The mean 4C score increased from a low baseline in the pre-cycle (55.47%, Poor) to 85.42% (Good) in Cycle 1 and 89.69% (Very Good) in Cycle 2, an overall increase of 34.22 percentage points, which suggests that PjBL may be an effective approach to fostering students' 4C skills through active and collaborative learning. For vocational entrepreneurship teachers, a project-based model built around a tangible product such as jahemu can bridge production cost theory with 21st-century skills, particularly when group roles, monitoring, and presentations with peer responses are structured, as these were the main changes between cycles. The study has limitations: it involved one class in one school (30 students), used no control group or inferential test, relied on the researcher as the main rater, and did not record scores for each 4C dimension. Future research is recommended to test the approach on a larger scale and in other vocational disciplines, to use comparison groups, and to assess each 4C skill separately with reliability checks.

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