

How do professional teachers use cross-subject projects to develop students' collaboration competence?

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ABSTRACT

Collaboration is a crucial 21st-century competency that needs to be fostered through learning experiences offering students opportunities to work together to solve problems. This study aims to explore the development of students' collaboration competence through cross-subject projects. The research employs a qualitative approach with a case study design conducted at SMP Muhammadiyah 2 Yogyakarta, a Junior High School at Yogyakarta, Indonesia. Data were collected via observation, interviews, and documentation, and subsequently analyzed using the interactive analysis model developed by Miles, Huberman, and Saldana. The results indicate that collaboration competences were demonstrated at every stage of the cross-subject projects, ranging from theme selection, project planning, and scheduling to monitoring progress, assessment through project showcases, and experience evaluation. These competences were reflected in active engagement, positive communication, role distribution, responsibility, commitment to group goals, mutual assistance, and mutual respect. Project implementation was supported by teacher collaboration, integrated project modules, a conducive learning environment, and active student participation, although challenges remained regarding time constraints, limited communication, and uneven student participation. The findings imply that cross-subject projects can serve as a reference for teachers in designing integrated collaborative learning to facilitate the development of students' collaboration competence.

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1. Introduction

Modern 21st-century education requires repositioning the teacher's role from a mere conveyor of material to an architect of learning focused on developing student competencies, specifically the ability to collaborate. Ideally, the learning process should foster an environment that encourages active interaction, collaboration, and mutual respect among students (Sari, 2025). In co-curricular activities, cross-subject projects are viewed as a strategic approach because they integrate various disciplines into a single meaningful activity, enabling students not only to gain a comprehensive understanding of the material but also to develop the collaborative competencies needed to achieve shared goals (Zhou & Colomer, 2024). In cross-subject projects, teachers from various subjects collaborate to design project-based learning featuring integrated goals, clearly defined roles, and success indicators that encompass both academic achievements and the strengthening of student competencies such as the ability to collaborate (Ahlström et al., 2026). Instruction is expected to take place within heterogeneous groups where students actively discuss, share, and develop ideas, and solve problems collaboratively, all while upholding mutual respect. Consequently, cross-subject projects are intended to serve as a meaningful, mindful, and joyful

learning experience for students, fostering the strengthening of competencies, specifically the ability to collaborate (Campbell, 2024).

In reality, the situation on the ground indicates that the implementation of cross-subject projects has not yet fully aligned with those ideal conditions. The projects carried out are often merely a formality and lack an integrative design with clear objectives, particularly regarding the development of student competencies, such as the ability to collaborate (Zheng et al., 2025). Furthermore, student involvement in group work does not yet fully reflect effective collaboration, as instances of individual dominance, a lack of communication among group members, and a low level of shared responsibility for completing tasks persist. Regarding the school environment, a culture that fosters openness and cooperation has not yet been fully established, and this challenge is further compounded by time constraints and inadequate facilities that hinder the implementation of the project (Sekhar, 2024).

If this situation persists, it will lead to various consequences affecting not only the quality of learning but also the broader development of student competencies. An approach to learning that remains fragmented and lacks collaboration risks conditioning students to work individualistically, leaving them with poor communication skills and a lack of experience in collaborative problem-solving. Consequently, the capacity for teamwork, a crucial 21st-century competency, fails to develop optimally (Rafiq-Uz-Zaman, 2022). In the long term, this situation can result in students being ill-prepared to face real-life challenges that demand collaboration, adaptability, and social responsibility (Jin, 2022). Moreover, the weak implementation of collaborative learning can also hinder school efforts to build a strong culture of quality, as values such as cooperation, mutual trust, and responsibility fail to become effectively internalized within the school's daily life (Tan et al., 2022).

The development of students' collaboration competence in this study is grounded in John Dewey's concept of learning by doing, which emphasizes that learning becomes more meaningful when students acquire knowledge through direct experience in solving real-world problems (Stark et al., 2024). This concept serves as the foundation for Project-Based Learning, which offers students the opportunity to learn through activities requiring active engagement, problem-solving, communication, and group collaboration. Project-based learning is carried out in six stages: determining the project theme, project planning, scheduling, monitoring project implementation, project assessment, and evaluating the experience (Hussein, 2021). In this study, the model is implemented through a cross-subject project utilizing an interdisciplinary learning approach, an approach that integrates concepts, knowledge, and skills from various disciplines to understand and resolve issues in an integrated manner (Xu et al., 2022). Thus, the integration of the learning by doing concept, project-based learning, and interdisciplinary learning creates a learning context that enables students to construct knowledge while collaborating to complete the project together.

In this study, collaboration competence is understood as students' ability to work effectively with others to achieve shared goals through active participation, positive communication, responsibility, role allocation, commitment to group objectives, mutual assistance, and mutual respect. This definition aligns with the views of Xiang et al. (2024) and Johnson (2014), who explain that effective collaboration is built upon positive interdependence, individual accountability, supportive interaction, interpersonal skills, and the ability to work within a group. Based on this conceptual framework, the study posits that collaboration competence is reflected not only in the project's outcome but also throughout every stage of the cross-subject project, ranging from theme selection, planning, scheduling, monitoring, and assessment to the evaluation of the experience. Consequently, the cross-subject project serves as a learning context that enables students to continuously practice various indicators of collaboration competence throughout the learning process.

Various prior studies, such as those by Parwati & Suastra (2024), Eswaran (2024), Owens & Hite (2022), Parwoto et al. (2024), Ibrahim & Rashid (2022), Crawford et al. (2024) and Vaithianathan et al. (2024) demonstrate that the implementation of project-based learning, including within the project to strengthen the Indonesian student profile framework, provides students with opportunities to develop various 21st-century competencies and character values. These studies generally focus on project-based learning implementation within the P5 context, the strengthening of student character, the improvement of learning outcomes, or the general development of 21st-

century competencies. Despite their significant contributions, these studies have not extensively examined how student collaboration competence is manifested across the various stages of cross-subject projects, ranging from planning to evaluation. Furthermore, research regarding cross-subject projects as a form of interdisciplinary learning involving teacher collaboration in project design and implementation remains relatively limited. This gap highlights the need for research that offers a deeper understanding of the process by which student collaboration competence is developed through cross-subject projects.

Stemming from this research gap, the novelty of this study lies in its focus on cross-subject projects that integrate various disciplines into a single project-based learning activity. Unlike previous studies that largely examined project-based learning within the context of the project to strengthen the Indonesian student profile, this research highlights how collaboration is fostered through the integration of multiple subjects, thereby involving cooperation not only among students but also among teachers in the design and implementation of learning projects (Kolm et al., 2022). Furthermore, the study focuses on students' collaborative competence as demonstrated across the various stages of cross-subject projects, ranging from planning to evaluation. Based on this focus, the research aims to explore how students' collaborative competence develops at each stage of these projects and to describe the factors that facilitate or hinder this development. Consequently, this study offers empirical insights into the development of collaborative competence through cross-subject projects within an interdisciplinary learning context at SMP Muhammadiyah 2 Yogyakarta, while also serving as a reference for teachers and schools in designing integrated collaborative learning to support the development of students' 21st-century competencies.

2. Method

2.1. Research design

This study employs a qualitative approach with a case study design. The case study design was selected because it enables the researcher to examine a phenomenon in depth and within its natural context. This approach is used to explore how students' collaboration competence is demonstrated at each stage of the cross-subject project and to describe the conditions that facilitate or hinder its development. Through a qualitative approach, researchers can gain a more comprehensive understanding of the cross-subject project implementation process and the various experiences students undergo while participating in the project activities.

2.2. Participants of the research

The study participants consisted of the school principal, teachers, and students from SMP Muhammadiyah 2 Yogyakarta. The research was conducted at this school because it had implemented a cross-subject project involving the integration of multiple subjects into learning activities. Participants were selected using purposive sampling, choosing individuals with direct experience who could provide information relevant to the research focus (Campbell et al., 2020). Specifically, the principal was selected because of their role in policy-making and school program development, while two teachers were chosen because they served as both coordinators and primary implementers of the cross-subject project. Two students were selected because they had participated in every stage of the project, from planning to evaluation, thereby providing comprehensive insights into the development of collaboration competence during the project's implementation. The number of participants was determined based on the criterion of information sufficiency, the extent to which the data provided a deep understanding of the phenomenon under study rather than on the need for statistical population representation. Consequently, the selected participants were expected to provide rich, in-depth information regarding the development of students' collaboration competence through the cross-subject project.

2.3. Data collection tools

In this qualitative study, the researcher serves as the primary instrument responsible for collecting, analyzing, and interpreting data. To facilitate data collection, the researcher employs interview guides, observation sheets, and documentation. The interview guides were developed based on the research focus and are used to explore the implementation of the cross-subject project, the collaborative competence demonstrated by students during the project, and the factors that either support or hinder the development of this competence. Additionally, observation sheets are used to

monitor student activities, interactions, and engagement throughout the project. Documentation techniques involve gathering relevant materials, such as project modules, activity photographs, and other supporting documents. The use of these three techniques aims to yield richer, more in-depth data regarding the development of students' collaborative competence through the cross-subject project. Data validity is ensured through source triangulation and technique triangulation. Source triangulation involves comparing information obtained from the school principal, teachers, and students, while technique triangulation is achieved through the use of interviews, observations, and documentation. Furthermore, interview findings are verified with participants (member checking) to ensure that the researcher's interpretations align with the experiences shared by the participants.

2.4. Research procedure

The research procedure was carried out in several stages. The first stage involved selecting participants comprising the school principal, teachers, and students who were directly involved in the implementation of the cross-subject project. The subsequent stage involved data collection through in-depth interviews, observations, and documentation. Interviews were conducted to gather information regarding the project's implementation and the students' collaboration competence, while observations focused on student activities, interactions, and engagement during the project. Documentation was used to supplement the data obtained from interviews and observations. All collected data were documented in the form of field notes, interview recordings, and other supporting documents. Subsequently, the data were transcribed and analyzed using the interactive analysis model developed by Miles, Huberman, and Saldana, comprising data reduction, data display, and conclusion drawing or verification to gain an in-depth understanding of how students' collaboration competence was developed through the cross-subject project. All interview results were recorded, transcribed verbatim, and then integrated with the findings from observations and documentation. Finally, the data were organized before the coding stage, which utilized Atlas.ti 9 software.

2.5. Data analysis technique

The data were analyzed using the interactive analysis model proposed by Miles, Huberman, and Saldana, which encompasses data condensation, data display, and conclusion drawing or verification. All interview transcripts were first prepared verbatim, followed by an open coding process using Atlas.ti 9 software to identify units of meaning relevant to the research focus. Codes sharing similar meanings were subsequently grouped into categories and themes representing the stages of the cross-subject project, students' collaborative competence, and the factors supporting or hindering its implementation. Data were presented using a network view to illustrate the interrelationships among categories, thereby enabling a systematic understanding of the connections among themes. The final stage involved drawing conclusions and verification, conducted iteratively by comparing analysis results across various data sources until credible findings were obtained. Overall, the procedure of this research is shown in Figure 1.

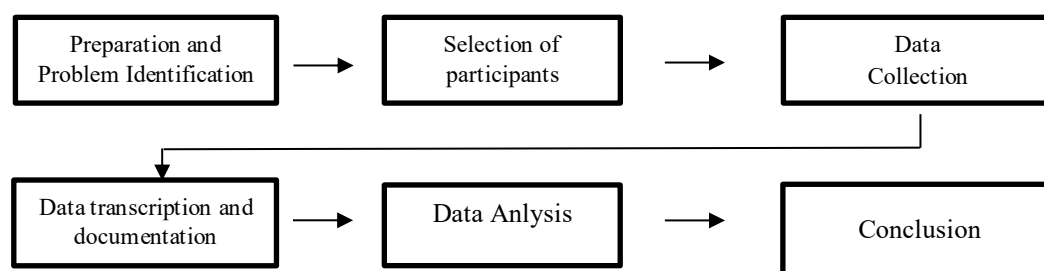


Fig. 1. Research flow

3. Results and Discussion

Based on observations, interviews, and documentation, cross-subject projects provide students with opportunities to practice collaboration competence throughout the learning process. The findings indicate that student involvement in each stage of the project encourages them to share roles, communicate positively, and assist one another in completing group tasks. Students also demonstrate responsibility for tasks agreed upon collectively, indicating that collaborative competence develops through active participation across the different stages of the project.

3.1. Cross-subject project to develop students' collaboration competence

Cross-subject projects provide opportunities for students to develop collaborative competence throughout the learning process. Various indicators of collaborative competence emerged during the implementation of the projects. These indicators are presented in Figure 2, which illustrates the dimensions of students' collaborative competence observed during the project activities.

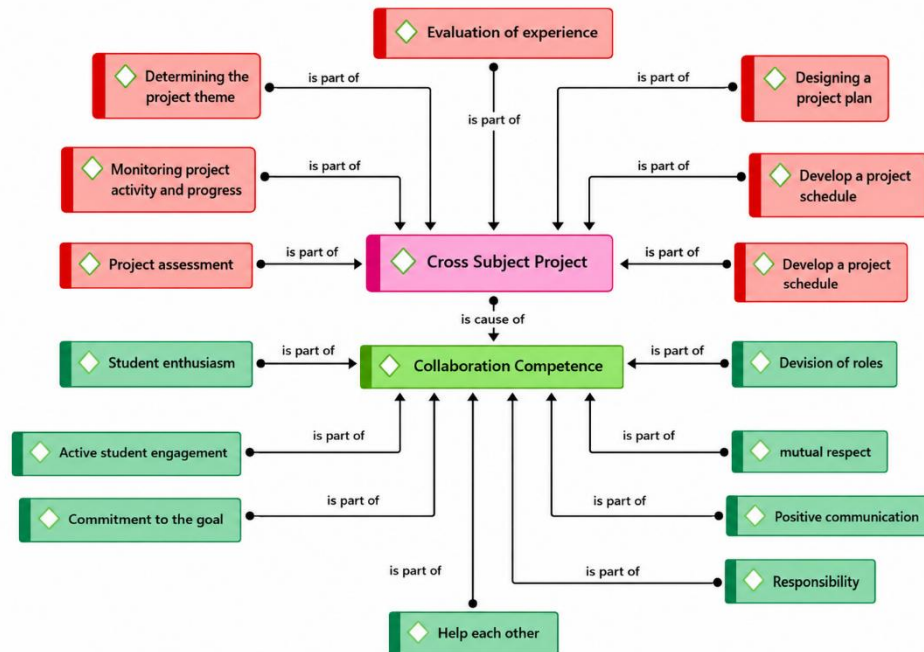


Fig. 2. Cross-subject project to develop collaboration competence

The coding analysis results presented in Figure 2 demonstrate the link between the implementation of cross-subject projects and students' collaboration competence. Cross-subject projects comprise six stages: determining the project theme, designing the project plan, developing the project schedule, monitoring project progress, assessing the project, and evaluating the overall experience. Students' collaboration competence is reflected in eight indicators, namely student enthusiasm, active engagement, commitment to group goals, mutual assistance, responsibility, positive communication, mutual respect, and effective role distribution. The coding results indicate that these various collaboration competence indicators are evident at every stage of the cross-subject projects, thereby providing students with opportunities to practice and develop collaboration competence throughout the learning process.

The research results show that determining a project theme is the initial stage in implementing a cross-subject project. At this stage, the principal and teachers coordinate to determine a project theme that aligns with the students' mastery of the material and to determine the subjects to be integrated into the project. In the project with the theme of technological engineering, the integrated subjects include science, mathematics, Indonesian, and civics. As stated by Teacher B, "... to determine the project theme, we typically coordinate with the school principal, the deputy principal for curriculum affairs, and the subject teachers involved, tailoring the choice to the students' grade level and their mastery of the material. ...For the Engineering and Technology theme, the integrated subjects are Sciences, Mathematics, Indonesian Language, and Civics."

Once the theme was established, the teacher allowed students to discuss and decide on the product each group would develop. Research findings indicate that during this stage, students engaged in sharing ideas, exchanging opinions, and making collective decisions. These activities demonstrated enthusiasm, active participation, positive communication, and mutual respect within the groups, as reflected in the statement made by Student B, "... first, we received an explanation from the teacher. Then, we decided on the type of building miniature to create, whether a house or a commercial building, through a discussion that involved polling. We ultimately chose a house,

respecting the group's collective decision; ideas that weren't selected were set aside without issue, as the priority was choosing the best option for the group. We then looked for design references on Pinterest and Google to find a suitable style, finally settling on a design that was both the best choice and feasible to construct"

Research findings indicate that the project planning and design phase is carried out collaboratively by teachers across different subjects, as stated by the school principal, *"... since the theme has already been set and the team determined and given that the project theme is integrated across, say, three subjects, those three subjects must collaborate. They need to discuss and plan the project, including creating the necessary instruments and project modules, to ensure the students' work is optimized and results in a final product"*

During the project planning and design stage, students discuss to determine the product sketch, the division of tasks, and the steps for project implementation, such as in Student B's statement, which is, *"... We started by creating a sketch that seemed suitable for our group, involving all members in the process. Then, we listed the necessary materials such as what to use for the roof and determined the dimensions. Finally, we worked together as a group to build the miniature house."* Research results indicate that at this stage, students actively engage in sharing ideas, providing input, and collaboratively formulating project plans. Furthermore, the division of roles agreed upon within the groups enables each member to understand their respective tasks and responsibilities. The planning process also demonstrates positive communication, commitment to group goals, and mutual respect in reaching a consensus. These findings suggest that the students' collaborative competence is evident through their involvement in the project planning process, which is conducted collaboratively.

During the project scheduling phase, the school principal and teachers from various subjects coordinate to determine the schedule and sequence of project activities to be carried out by the students. Teacher A states, *"...We collaborate through joint coordination and discussion, starting from the planning stage—such as when we determined the project theme and the activity schedule. Since our project schedule operates on a block system, the students carry out the project over the course of about a week, and we create a daily itinerary for their activities"*. Based on the established schedule, students organized the allocation of time for carrying out group tasks in alignment with the required targets. Research findings indicate that, at this stage, students engaged in discussions to agree upon the division of tasks and the project timeline. This process demonstrated active involvement, positive communication, a sense of responsibility, and commitment to group goals, ensuring the project could be completed according to the predetermined schedule.

The results of the study indicate that during the monitoring and development phase of the project, the teacher acted as a facilitator who accompanied and monitored the implementation of activities without dominating the group work process. The teacher provided direction, feedback, and assistance when students encountered difficulties in completing the project assignments. Meanwhile, students demonstrated active involvement in completing the assigned tasks, helping each other when group members encountered difficulties, and maintaining positive communication throughout the project process. In addition, students also demonstrated responsibility for their respective roles and remained committed to achieving group goals, as conveyed by student B, *"...We are all actively involved in this; after all, we each have our own specific areas. For instance, I handle the electrical work, while others take care of cutting or other tasks so everyone has their own distinct role and responsibilities. We also help each other out if anyone runs into difficulties. It isn't dominated by just one person."* The interactions observed during the monitoring phase demonstrate mutual respect and effective cooperation among the students, allowing the project to progress according to the mutually agreed-upon plan.

Research findings indicate that during the project assessment stage, teachers evaluate not only the quality of the products created by students but also the development of competencies demonstrated throughout the project's execution, such as collaboration, creativity, and critical reasoning. Teacher B stated, *"... The assessment covers both the students' final work and the learning process, aligned with the graduate profile dimensions we aim to foster, creativity, collaboration, and critical reasoning."* At this stage, each group presents its project outcomes during a "work showcase" event held in the school hall. Through this event, students explain the collaborative process and results of their projects, as well as the division of roles within their groups. Furthermore, students

interact with teachers and visitors throughout the event. These findings demonstrate that the showcase provides students with opportunities to practice collaborative skills through communication, responsibility, role allocation, and active engagement in presenting their group's work

Research findings indicate that the experience evaluation phase is conducted through a collective reflection session following the completion of the project. During this stage, students are allowed to share their experiences, the challenges they faced, and the lessons learned while working in groups. Through this reflection, students demonstrate an ability to appreciate their group members' contributions, evaluate individual responsibilities, and identify the forms of collaboration established throughout the project. The reflection activity also allows students to revisit the importance of communication, mutual assistance, and commitment to achieving shared goals key aspects of the collaborative competence demonstrated during the project. This evaluation phase also involves teachers and the school principal as part of continuous improvement efforts; as Teacher A noted, "...naturally, an evaluation takes place to share insights regarding shortcomings and obstacles, allowing us to assess whether to implement this theme again next year or modify it to better resonate with the students. We also conduct joint reflections with students regarding their feelings during the project that made them happy, what they found difficult, and so on." These findings demonstrate that the evaluation of the experience serves not only as a space for student reflection but also as an integral part of the review and development process for cross-subject projects in future periods

3.2. Factors of the development of students' collaboration competence

In addition to revealing the stages involved in developing students' collaboration competence through cross-subject projects, the findings identify various supporting and hindering factors that emerged during project implementation. These factors represent important dynamics in implementing cross-subject projects to foster students' collaborative competence. The overall relationship between these factors and the implementation process is illustrated in Figure 3.

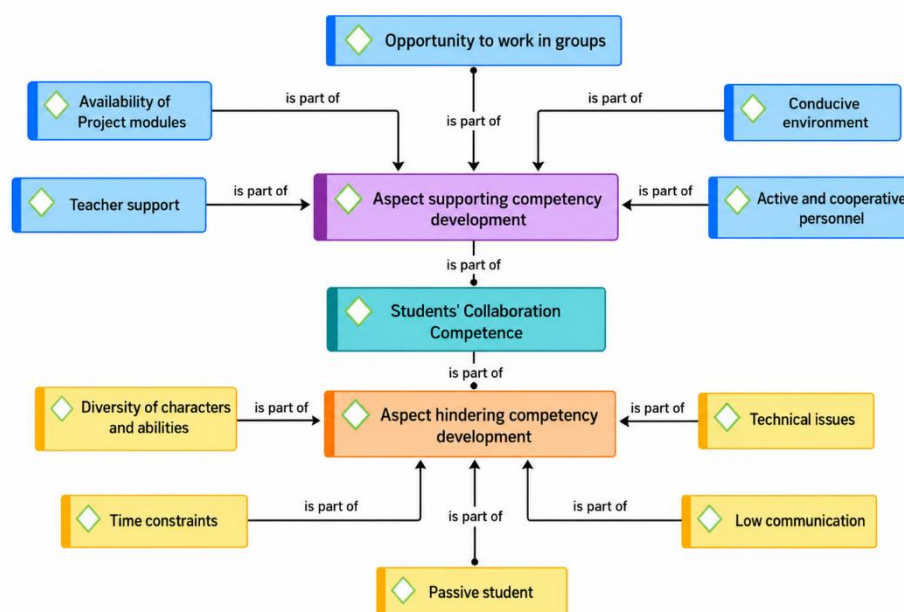


Fig. 3. Factors supporting and hindering the development of collaboration competence

Research findings indicate that several factors supported the development of students' collaborative competence during the implementation of cross-subject projects. These factors included the availability of a project module to guide activities, teacher support in a facilitator role, opportunities for group work, a conducive learning environment, and students who were active and cooperative in completing shared tasks. These conditions enabled students to participate actively, communicate effectively with group members, and complete the project collaboratively. As Student A noted, "...A key factor supporting our group's collaboration was the support from the teacher,

which helped us finish the project on time; we were constantly reminded, and while it sometimes felt like we were being chased to meet deadlines, it was actually better because it kept us from just slacking off. There was also support from equally active classmates; we helped each other whenever a member faced difficulties. Plus, we had the project module to use as a guide while working on the project. Oh, and thankfully, the school environment was comfortable for us to work on the project."

The study also identified several obstacles that arose during the implementation of the cross-subject project. These obstacles included the diversity of students' competencies and abilities, limited time for project execution, poor group communication, the presence of passive students, and technical issues encountered during the project work. These conditions posed challenges for group collaboration, as not all members were able to participate and contribute optimally. Student A remarked, *"What holds us back is when some of us slack off being passive and unwilling to work and sometimes our communication breaks down; though, once the teachers step in, they usually start helping out. Also, the time constraints are an issue."*

Research findings indicate that the implementation of cross-subject projects at SMP Muhammadiyah 2 Yogyakarta provides students with opportunities to engage in various collaborative activities that demonstrate indicators of collaboration competence such as active participation, positive communication, responsibility, mutual assistance, commitment to group goals, role allocation, and mutual respect. During the project theme selection phase, students actively participate in discussions to determine the product to be collaboratively developed in alignment with the chosen theme. These findings reveal that collaboration competence begins to develop at the project's inception through a shared decision-making process. Student engagement in sharing ideas, considering alternatives, and reaching a consensus demonstrates that collaboration is not limited to the product completion stage but evolves from the project planning phase. Thus, the theme selection stage serves as a foundation for fostering interaction and a sense of ownership regarding group goals.

Cross-subject projects essentially implement the concept of interdisciplinary learning, an approach that integrates concepts, knowledge, and skills from various subjects to explore a theme or solve a problem in an integrated manner (Cassidy & Puttick, 2022). In this study, such integration was realized through the subjects of Science, Mathematics, Indonesian Language, and Civics. Integrating these diverse disciplines not only enriched students' learning experiences but also fostered interdependence among group members as they completed the project. Students were required to connect concepts from different subjects, making collaboration a necessity throughout the learning process rather than merely a strategy for task completion. These findings reinforce the view that interdisciplinary learning creates more contextual learning experiences while providing opportunities for students to develop collaborative competence through the integration of knowledge, communication, and collective problem-solving. Thus, collaborative competence in this study emerged as a result of students' engagement in integrated learning activities, rather than simply because they were working in groups.

The implementation of cross-subject projects also demonstrates teacher collaboration in instructional design. Teachers of Science, Mathematics, Indonesian Language, and Civics coordinated to integrate subject matter, develop project modules, and reach a consensus on objectives and assessment methods. Such teacher collaboration is a crucial prerequisite for creating an integrated learning experience. When planning is conducted collaboratively, students gain a holistic learning experience in which each project stage is interconnected and fosters the development of collaborative competence. In other words, students' collaborative competence is shaped not only by group activities but also by the instructional design collaboratively crafted by the teachers. These findings align with the characteristics of project-based learning, which positions the teacher as a facilitator and the student as the center of the learning process (Kokotsaki et al., 2016). The findings broaden the understanding of project-based learning by demonstrating that the successful development of students' collaborative competence depends not only on collaboration among students but also on collaboration among teachers in designing integrated learning experiences.

During the project planning phase, students collaboratively drafted house sketches, outlined work procedures, and allocated tasks based on group consensus. The results indicate that students actively engaged in discussions, defined their respective roles, and demonstrated a commitment to completing tasks as agreed upon. These findings suggest that project planning is not merely a technical precursor to implementation but a process of role negotiation that enables each member to

understand their responsibility regarding the group's success. The collaborative allocation of roles reflects positive interdependence among group members, where the project's success hinges on each individual's contribution. This aligns with the work of Johnson (2014), who explains that effective collaboration is built upon individual accountability and positive interdependence in the pursuit of shared goals. The study demonstrates that the project planning process serves as a crucial stage for fostering these aspects, allowing collaborative competence to develop even before the project is actually carried out.

During the project scheduling phase, students discuss and determine activity timelines, task completion targets, and the allocation of time for each group member. Research results indicate that the scheduling process involves communication among students to reach a consensus on the project's implementation stages. These findings suggest that scheduling serves not only to organize the project timeline but also acts as a negotiation process that trains students to align individual interests with group goals. Through this process, students learn to build shared commitment and understand that project success depends on each member's willingness to adhere to the agreed-upon plan. These findings align with Zhang & Ma (2023), who state that coordination and the organization of joint activities are crucial components of group work. By collaboratively creating a schedule, students have the opportunity to agree on time allocation, manage responsibilities, and demonstrate commitment to the agreements made within the group for the sake of a shared objective.

During the project monitoring and development phase, the teacher acts as a facilitator, providing guidance, support, and feedback to students as they work on the project. Meanwhile, students actively engage in completing group tasks, assisting one another when facing challenges, and demonstrating responsibility for agreed-upon duties. Interactions during this monitoring phase reveal that collaborative competence develops through mutual support and joint problem-solving, rather than merely through the division of tasks. The teacher's role as a facilitator also creates space for students to make decisions and independently resolve obstacles, allowing collaboration to flourish through authentic learning experiences. These findings align with the characteristics of project-based learning outlined, where the teacher serves as a facilitator guiding students through the project, while students participate actively in the learning process (Markula & Aksela, 2022). The study demonstrates that students' collaborative competence develops through continuous interaction throughout the project's execution. These findings reinforce the nature of project-based learning, which positions authentic learning experiences as a means to foster 21st-century competencies.

During the project assessment phase, evaluation focuses not only on the final product created by the students but also on the collaborative process demonstrated throughout the project's execution. Furthermore, students present their project outcomes during a showcase event held in the school hall. These findings indicate that the assessment process serves not merely to measure learning outcomes but also as a means for students to demonstrate accountability for their individual contributions within the group. This demonstrates that collaborative competence extends beyond the project execution phase and is also reflected in the students' ability to take collective responsibility for the work produced. These findings align with Crespi et al. (2022), who state that project-based learning assesses not only academic aspects but also the development of social competencies during the learning process. Thus, this study illustrates that project assessment plays a role in strengthening collaborative competence, rather than serving solely as an evaluation of learning outcomes.

The final stage, evaluating the experience, provides students with the opportunity to reflect on the learning experiences gained during the project. At this stage, students discuss their experiences, the obstacles encountered, and the individual contributions of group members toward completing the project. Reflection activities allow students to evaluate not only the project's success but also the quality of interactions established while working in groups. Such reflection helps students realize that communication, responsibility, and mutual assistance are processes requiring continuous improvement to enhance collaboration in future activities. These findings align with the views of Dewey cited in Quay et al., (2022), who emphasizes the importance of experience and reflection as integral parts of the learning process. In the context of this study, reflection serves not merely as a means to evaluate project outcomes but also as a process that helps students understand the strengths and weaknesses of their collaborative efforts. Thus, the study demonstrates that the experience evaluation stage plays a role in reinforcing students' awareness of the importance of communication, responsibility, mutual assistance, and commitment in developing collaborative competence for future learning activities.

Beyond the project implementation stages, the development of students' collaborative competence is supported by several aspects identified during the execution of cross-subject projects. These aspects include the availability of integrated project modules, teacher support as facilitators, opportunities for group work, a conducive learning environment, and the presence of active, cooperative students. Fundamentally, cross-subject projects apply the concept of interdisciplinary learning, integrating various subjects into a single learning activity. This creates a space for students to interact, exchange ideas, and collaborate on completing shared tasks. These findings indicate that the development of students' collaborative competence is influenced not only by the project activities themselves but also by a supportive learning ecosystem. The availability of modules, teacher guidance, and a conducive learning environment fosters conditions that enable more intensive student interaction, allowing the collaboration process to be sustained throughout the project. These findings align with the characteristics of project-based learning, which positions the teacher as a facilitator and the student as the center of learning within collaborative activities that encourage active engagement and cooperation among students (Markula & Aksela, 2022).

On the other hand, research findings indicate several obstacles to developing students' collaboration competence during the implementation of cross-subject projects. These conditions pose a challenge to fostering teamwork, as not all group members are able to participate and contribute optimally. The findings suggest that collaboration competence does not develop automatically simply because students work in groups; differences in character, ability, and communication quality among students influence group dynamics, necessitating teacher facilitation to ensure every member has a balanced opportunity to participate. These findings align with López (2022), who asserts that effective collaboration requires positive interaction, individual accountability, good communication, and the active involvement of every group member. Nevertheless, efforts were made to overcome these obstacles through teacher guidance as a facilitator, providing direction to less active students, clarifying task distribution based on individual responsibilities, and strengthening communication throughout the project. The findings demonstrate that developing collaboration competence is a dynamic process requiring ongoing instructional support to ensure every student has an equal opportunity to participate and contribute within the group. Thus, the teacher's role as a facilitator is crucial not only for guiding project implementation but also for ensuring that the collaboration process is inclusive and provides learning opportunities for all students.

Overall, this study demonstrates that collaboration competence develops gradually across the various stages of a cross-subject project, rather than solely when students are working in groups. Each stage offers distinct learning experiences that foster communication, responsibility, role allocation, commitment, and mutual respect. These findings reinforce Dewey's concept of learning by doing and the characteristics of Project-Based Learning, which position authentic experiences as a means to develop 21st-century competencies. Furthermore, the study provides empirical evidence that integrating multiple subjects into a single project creates a learning context that supports the gradual and sustained development of collaboration competence.

4. Conclusion

Based on the research findings and discussion, it can be concluded that the cross-subject project integrating Science, Mathematics, Indonesian Language, and Civics provided students with opportunities to develop collaboration competence throughout every stage of the project: theme selection, planning, scheduling, monitoring progress, product assessment (via a project showcase), and experience evaluation. The collaboration competence demonstrated by students included active engagement, positive communication, responsibility, mutual assistance, commitment to group goals, role distribution, and mutual respect. This development was supported by teacher collaboration, the availability of project modules, a conducive learning environment, and active student participation, despite challenges such as varying student personalities and abilities, time constraints, and limited communication or participation from some students. This study offers an empirical contribution by demonstrating that collaboration competence develops incrementally across the stages of a cross-subject project, thereby enriching the understanding of project-based learning implementation within an interdisciplinary context at the junior high school level. Practically, these findings can serve as a reference for schools and teachers in designing more integrated cross-subject projects, strengthening teacher collaboration, and creating learning experiences that foster student collaboration competence. However, as this was a case study conducted at a single school with a limited number of participants,

the findings are contextual and not intended for generalization across all school settings. Therefore, future research should involve a larger number of schools with diverse characteristics to gain a more comprehensive understanding of cross-subject project implementation across various educational contexts.

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Declarations

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- Conflict of interest** : The authors declare no conflict of interest.
- Additional information** : No additional information is available for this paper.

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