



Preschool children's collaboration in Steam activities: The role of teachers' guided support

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Abstract

Preschool children's collaboration is an interactive process in which children work toward shared goals, exchange and adjust ideas, coordinate their actions, and gradually share responsibility within an activity. STEAM activities, characterized by integration, hands-on experiences, exploration, and problem-solving, may provide favorable conditions for this process. However, children's participation in the same activity or their joint production of an artifact does not necessarily mean that genuine collaboration is taking place. This article employs a literature review combined with thematic analysis to clarify the relationships among STEAM activities, children's collaborative processes, and teachers' guided support. Based on the synthesis of previous studies, the article proposes a conceptual analytical framework consisting of five components: STEAM task design, opportunities for interaction among children, children's collaborative processes, increasing autonomy in joint activity, and teachers' guided support. The first four components are organized in a logical sequence, while teachers' guided support functions as a cross-cutting element that is flexibly adjusted according to the development of the activity and children's needs. The proposed framework contributes an integrated approach to examining and organizing STEAM activities by focusing not only on the products children create but also on the processes through which they learn, coordinate with one another, and develop an increasing capacity to regulate joint activity.

Keywords: STEAM education, early childhood education, collaboration, preschool children, guided support

Introduction

Early childhood education provides a foundation for children's cognitive, linguistic, emotional, and social development. Through learning experiences, children not only explore the world through action and direct experience but also gradually learn how to exchange ideas, listen, coordinate their actions, and solve problems with others. Consequently, increasing attention has been given to forms of educational activity that enable children to engage actively in experiences while participating in meaningful social interactions.

STEAM education represents one approach that is well suited to these characteristics. In early childhood education, STEAM is commonly organized around situations, problems, projects, or tasks connected to children's experiences, through which they draw on and integrate knowledge from different domains to explore, experiment, design, or create products. The review by Ng *et al.* (2022) ^[12] emphasizes that STEAM should be understood as a process of meaningful integration rather than a mechanical combination of five separate disciplines. More recent reviews also indicate that research on STEAM in early childhood education has expanded in relation to modes of implementation, learning environments, teachers' roles, and the developmental competencies targeted in children (Su *et al.*, 2025).

One notable characteristic of STEAM activities is that children are often confronted with exploratory or problem-solving tasks. When organized in groups, such tasks may create a need for children to exchange ideas, share resources, test alternative solutions, and coordinate their actions. Başaran and Bay (2023) ^[1] provide empirical evidence indicating that project-based STEAM activities are associated with the development of preschool children's

social and cognitive skills. Other studies of STEAM practice likewise suggest that integrated activities can create learning contexts in which children's participation and the ways teachers organize and support learning play important roles (Monkeviciene *et al.*, 2020; Veziroglu-Celik *et al.*, 2026) ^[9, 16]. Nevertheless, children may share the same space, manipulate the same materials, or contribute to the creation of the same product while still performing relatively independent actions. The systematic review by Burns *et al.* (2024) ^[2] shows that collaboration among young children in early educational settings is a complex process involving shared goals, communication, information exchange, coordination, and mutual support. Therefore, participating in the same activity does not necessarily indicate that a collaborative process has emerged.

Although research on STEAM in early childhood education has continued to develop, existing studies have primarily focused on methods of organizing activities, children's developmental outcomes, or teachers' competencies and readiness. Research on STEAM, collaboration among children, and teachers' guided support, however, has largely developed along separate lines. There remains a lack of direct synthesis concerning the relationships among these three components. Consequently, the relationship between the characteristics of STEAM activities, children's actual collaborative processes, and the role of teachers' guided support remains insufficiently integrated and requires more focused analysis.

Accordingly, this article aims to clarify preschool children's collaboration in STEAM activities and the role of teachers' guided support in creating the conditions for, sustaining, and gradually developing children's capacity to collaborate. In doing so, the article seeks to clarify the conditions necessary for STEAM activities to serve not only as contexts in which

children explore and solve problems but also as opportunities for them to learn how to exchange ideas, coordinate their actions, and solve problems with peers and others.

In this article, guided support refers to purposeful pedagogical support that teachers adjust on the basis of their observations of children's needs, levels of participation, and existing capabilities, either individually or as members of a group. Such support may involve organizing tasks, asking questions, providing prompts, directing children's attention to their peers' ideas, encouraging discussion, or helping children address difficulties. At the same time, it does not replace children's own thinking, decision-making, or actions. The level of support may vary and can gradually decrease as children become increasingly capable of assuming functions necessary for joint activity (van de Pol *et al.*, 2010; Wood *et al.*, 1976) ^[15, 19].

Based on these considerations, the article addresses the following question: What conditions can STEAM activities create for preschool children's collaborative processes, and how can teachers provide guided support to sustain and develop these processes?

Research Method

1. Research Approach

This article employs a literature review combined with thematic analysis to synthesize findings and arguments related to three central components: STEAM activities in early childhood education, collaborative processes among children, and teachers' guided support.

This approach is appropriate to the purpose of the study because the relevant literature is distributed across several distinct lines of research. Some studies focus directly on STEAM and the organization of activities in early childhood education; others examine children's social skills or collaboration; while another group focuses on teachers' roles, competencies, and forms of support. Rather than treating these research traditions as independent domains, the present article analyzes their potential connections in order to develop a conceptual approach to children's collaboration in STEAM activities.

2. Selection and Categorization of the Literature

The literature was selected on the basis of its direct relevance to the central issue addressed in the article. The first group included studies and reviews concerning STEAM in early childhood education, the characteristics of integrated activities, the organization of STEAM projects or tasks, and children's participation. The second group included studies addressing social skills, interaction, and collaboration among children in early educational settings. The third group focused on teachers' roles, readiness, support needs, and professional capacity in implementing STEAM. The final group provided a theoretical basis for analyzing pedagogical support and the gradual fading of assistance.

Based on this selection, the literature was synthesized into four themes: the characteristics of STEAM activities in early childhood education; distinctions among interaction, co-participation, and collaborative processes; organizational conditions that may create opportunities for collaboration; and the role of teachers' guided support and the development of autonomy in joint activity.

Because the purpose of this article is to synthesize existing literature and propose a conceptual analytical framework, the relationships presented should not be interpreted as causal relationships that have been empirically established within a single study. Rather, when evidence originates from different lines of research, the arguments developed in this article are based on the integration and analysis of findings across these lines. This approach is intended to reflect both the proposed nature of the analytical framework and the limitations of the currently available evidence.

Results and Discussion

1. STEAM Activities and the Conditions for Meaningful Social Experiences

Research on STEAM in early childhood education indicates that STEAM should not be understood simply as the inclusion of content from Science, Technology, Engineering, Arts, and Mathematics within a single activity. More importantly, these domains need to be meaningfully connected through experiences, problems, or tasks that are relevant to children (Ng *et al.*, 2022^[12]; Su *et al.*, 2025).

In activities such as building, designing, experimenting, or solving a specific problem, children draw upon different forms of knowledge and skills to observe, predict, test, and revise possible solutions. Empirical studies of project-based STEAM suggest that such forms of organization may simultaneously relate to both cognitive and social dimensions of preschool children's development (Başaran & Bay, 2023) ^[1]. The study by Monkeviciene *et al.* (2020) ^[9] likewise situates children's competence development in relation to innovative STEAM practices and teachers' professional development.

However, not all STEAM activities generate the same degree of interaction among children. A task organized according to a fixed procedure or divided into entirely independent components may reduce the need for children to exchange ideas. In contrast, tasks involving a shared problem or challenge, allowing multiple possible solutions, and requiring children to experiment and revise may create more opportunities for children to attend and respond to one another's ideas. This relationship is proposed on the basis of the synthesis of research on the characteristics of STEAM activities and collaboration and therefore requires direct examination in specific empirical contexts.

Thus, rather than assuming that STEAM inherently promotes collaboration, this article adopts a more cautious position: STEAM activities may provide an environment for meaningful social experiences when the design and organization of tasks create a genuine need for children to exchange ideas and coordinate their actions.

2. Distinguishing Interaction, Co-participation, Collaborative Processes, Collaborative Competence, and Autonomy in Joint Activity

To analyze children's collaboration in STEAM activities accurately, several related but distinct concepts need to be differentiated.

Interaction among children

Interaction among children refers to reciprocal exchanges or responses between two or more children. Such interaction may occur through verbal communication, gestures, actions, or attention to one another's activities. Interaction is an important condition for joint activity, but the mere presence of interaction is not sufficient to conclude that children are collaborating.

Co-participation in an activity

Co-participation in an activity refers to a situation in which multiple children are present and participate in the same task, space, or activity. Children may use the same materials and work toward the same product while still carrying out separate or relatively independent actions. Therefore, co-participation represents a form of activity organization rather than collaboration itself.

Collaborative process

In this article, a collaborative process is understood as a process in which children work toward a shared task or goal, exchange and respond to ideas, coordinate and adjust their actions, and gradually share responsibility for the joint activity. This conceptualization is consistent with the review by Burns *et al.* (2024) ^[2], in which collaboration is described as a multidimensional phenomenon involving communication, information sharing, shared goals, and coordinated behavior.

Collaborative competence

Collaborative competence differs from the collaborative process itself. Whereas the collaborative process concerns what is occurring among children within a particular situation, collaborative competence refers to an individual child's capacity to participate in, sustain, and regulate collaboration across different situations. In other words, the collaborative process constitutes the direct focus of analysis in this article, whereas collaborative competence may be regarded as a capacity that develops through repeated collaborative experiences.

Autonomy in joint activity

Autonomy in joint activity also requires clarification. Within the proposed analytical framework, this concept does not refer simply to an individual child's independence in completing a personal task, nor does it mean that a group works entirely without the teacher. Rather, autonomy in joint activity refers to the extent to which children and groups of children can independently perform functions necessary for joint activity, such as exchanging ideas, making decisions, allocating or coordinating actions, resolving certain differences, and maintaining engagement with the task without frequent direct intervention from the teacher. Autonomy may therefore be understood as the gradual transfer of certain coordinating functions from the teacher to individual children and the group.

These distinctions help prevent the equation of children merely sitting or working together with genuine collaboration, or the interpretation of a single successful collaborative experience as evidence that children have developed stable collaborative competence.

3. From STEAM Task Design to Opportunities for Interaction and Collaborative Processes

The synthesis of the literature suggests that organizing children into groups is only an initial condition. To create opportunities for collaborative processes, STEAM tasks need to possess characteristics that give children a reason to attend to one another's ideas and actions.

First, the task should involve a shared problem or challenge. When children confront a question or task that the group needs to address collectively, the actions of individual members are more likely to become connected to a shared

goal. Project-based STEAM activities provide one example of how tasks can be organized to sustain children's engagement throughout processes of exploration and product creation (Başaran & Bay, 2023) ^[1].

Second, the task should allow an appropriate degree of openness. Tasks that enable children to propose, test, and revise multiple solutions may create opportunities for different ideas to emerge. However, the existence of multiple ideas does not automatically result in collaboration. The relationship between task openness and collaboration depends on whether children are genuinely encouraged to exchange ideas, respond to one another, and jointly consider alternative solutions.

Third, the activity should create a need for coordination or a degree of interdependence among participants. This does not necessarily mean that teachers need to assign children to rigid roles. More importantly, the organization of the activity should ensure that one child's contribution is meaningfully connected to the actions of others, for example through shared goals, shared resources, or requirements for joint experimentation and revision.

Studies directly examining STEAM and social skills provide some evidence that project-based STEAM approaches may be associated with children's social development (Başaran & Bay, 2023) ^[1]. However, these studies vary in how they define, measure, or observe collaborative processes specifically. Therefore, based on the currently available evidence, it cannot yet be concluded that a particular characteristic of a STEAM task will directly produce a specific form of collaborative behavior.

It may therefore be proposed that task design provides initial conditions; these conditions create opportunities for interaction; and whether such opportunities develop into collaborative processes depends on how children participate and on the forms of support available during the activity. This represents a conceptual analytical framework developed through the integration of different lines of research and requires further empirical examination.

4. The Role of Teachers' Guided Support in Collaborative Processes

In research on STEAM in early childhood education, teachers' roles are not limited to the transmission of content. They also include designing learning environments, organizing experiences, observing children's participation, and adjusting activities in response to children's actual needs. Studies of Vietnamese preschool teachers' readiness suggest that STEAM implementation is influenced by multiple factors related to knowledge, preparation, and conditions of implementation (Bui *et al.*, 2023; Nguyen *et al.*, 2025) ^[3, 11]. Research on professional development likewise emphasizes the need to equip teachers with appropriate competencies and support to implement STEAM effectively (Leoste *et al.*, 2022; Walshe *et al.*, 2025) ^[8, 18].

From the perspective of collaboration among children, guided support should be understood as a continuous process rather than something that occurs only when children are unable to complete a task. Teachers first need to observe how children are participating: who is taking an active role, who has limited opportunities to participate, whether the group is exchanging ideas or merely performing parallel actions, and how differences in ideas are being addressed. Based on these observations, teachers may

provide support by prompting children to explain their ideas, directing their attention to peers' opinions or actions, encouraging them to respond to one another rather than simply express individual ideas, creating opportunities for different solutions to be tested, helping the group identify problems when the activity is disrupted, and encouraging children who participate less frequently to contribute.

A key principle is that teachers should not replace children's own choices, negotiations, or problem-solving. This principle is consistent with the concept of scaffolding, according to which support should be responsive to learners' current needs and adjusted as their capabilities develop (van de Pol *et al.*, 2010; Wood *et al.*, 1976) ^[15, 19].

Recent research on STEAM also suggests that teachers need support in moving beyond simply "conducting a STEAM activity" toward the capacity to observe and adjust the processes that unfold during the activity, including children's participation and experiences (Veziroglu-Celik *et al.*, 2026; Walshe *et al.*, 2025) ^[16, 18]. Notably, some studies have begun to indicate relationships between STEAM participation and children's social outcomes. Başaran and Bay (2023) ^[1], for example, examined project-based STEAM activities with 57 preschool children in a six-week program. Their findings indicated positive effects on several outcomes, including social product, teamwork, presentation, and technical skills.

A study conducted in Vietnam also investigated the education of collaborative skills among children aged 4–5 years through STEAM activities. The findings suggested that although the children generally demonstrated relatively good social skills, a proportion of them still experienced difficulties in collaborating effectively when participating in STEAM activities (Dinh Lan Anh *et al.*, 2024) ^[6].

However, within the body of literature synthesized in this article, direct evidence concerning the effects of specific support strategies on children's collaborative processes in STEAM activities remains limited. This suggests that teachers' support should be flexibly adjusted in accordance with the evolving circumstances and needs that arise during the activity (van de Pol *et al.*, 2010) ^[15]. On this basis, the article proposes a conceptual analytical framework in which teachers' guided support is viewed as a cross-cutting factor in the relationship between STEAM activities and children's collaborative processes.

5. The Gradual Fading of Support and Autonomy in Joint Activity

An important principle of guided support is that its level should not remain constant. When children do not yet know how to connect ideas, coordinate their actions, or address differences, teachers may need to provide more explicit support. As children and groups become increasingly capable of performing these functions independently, direct support may gradually be reduced (van de Pol *et al.*, 2010) ^[15].

In this article, autonomy in joint activity is not regarded as a final state that every group of children will necessarily achieve. Rather, it is understood as a process that may vary depending on the nature of the task, the complexity of the problem, and the characteristics of individual groups. A group may be able to exchange ideas and make decisions independently when completing a familiar task but still require support when confronted with a new problem.

Therefore, the gradual fading of support should be understood as a flexible process involving the progressive transfer of certain coordinating functions from the teacher to individual children and groups of children, rather than as the complete withdrawal of the teacher from the activity.

Post-activity reflection may also be used as an opportunity to help children become aware of how the group worked together. Teachers may prompt reflection through questions such as: How did the group decide what to do? Which ideas did you try? What did you do when you had different opinions? Organizing reflection on the process of working together is a pedagogical proposal derived from the conceptual analytical framework presented in this article and requires further research regarding its practical effectiveness.

A Proposed Conceptual Analytical Framework for Children's Collaboration in STEAM Activities

Based on the synthesis and analysis of relevant studies, this article proposes a conceptual analytical framework for preschool children's collaboration in STEAM activities. This framework should not be interpreted as a causal model established through empirical evidence. Rather, it is intended as an analytical structure for systematizing the major components involved and clarifying theoretically meaningful relationships among them in children's collaborative processes.

The components initially identified are not entirely equivalent in terms of analytical level or function. Therefore, to ensure the logical coherence and consistency of the framework, they are organized according to different positions and roles within the analytical structure, as follows:

1. STEAM task design as an input condition. The task may involve a shared problem or challenge, an appropriate degree of openness, a common goal, and a certain need for coordination among participants.
2. Opportunities for interaction as a proposed mediating mechanism. As a result of task design, children may have opportunities to exchange and share ideas, use common resources, respond to one another, and adjust their actions.
3. The collaborative process as the central phenomenon to be observed and analyzed. This process is evident when children actually use opportunities for interaction to work toward a shared goal, exchange and connect ideas, coordinate their actions, and share responsibility.
4. Autonomy in joint activity as a possible developmental direction. Autonomy may emerge as children and groups of children become increasingly able to assume functions that previously required direct support from the teacher.
5. Teachers' guided support as a cross-cutting component. Guided support does not occur after or outside the preceding stages. Teachers may contribute to task design, create conditions for interaction, observe the development of collaboration, and adjust the level of support according to children's needs. However, direct support may gradually decrease as children and groups become increasingly capable of regulating joint activity independently.

The relationships among these components can be represented conceptually as follows:

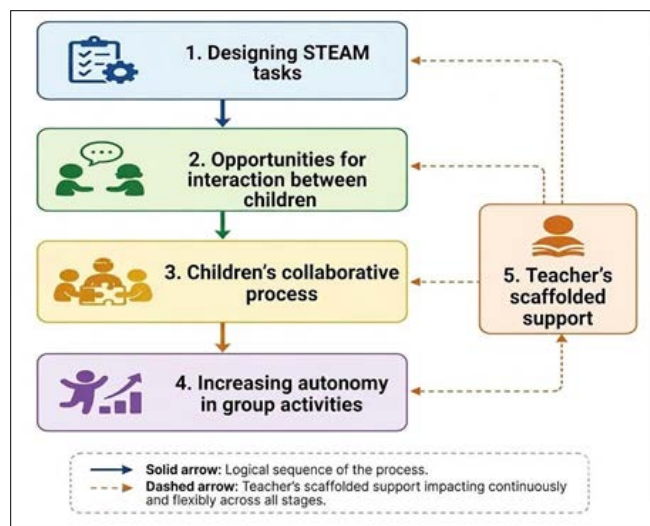


Fig 1: Relationships among the components

It should be noted that these five components do not imply a proven linear causal relationship. Rather, they represent conceptual relationships proposed on the basis of the literature synthesis. In practice, collaborative processes may also operate in the opposite direction: previous experiences of collaboration may influence how children make use of opportunities for interaction in subsequent tasks. Similarly, teachers may increase the level of support when tasks become more complex or when groups encounter new difficulties.

Therefore, the proposed framework is intended as a conceptual analytical framework for guiding the observation and investigation of relationships among STEAM tasks, interaction, collaboration, and pedagogical support in early childhood education. It should not yet be regarded as an empirically validated model.

Conclusion

This article synthesizes research on STEAM in early childhood education, collaboration among children, and pedagogical support in order to clarify an issue that has received limited integrated attention: the relationship among STEAM activities, children's collaborative processes, and teachers' guided support.

The synthesis suggests that STEAM activities may create conditions for meaningful social experiences, particularly when tasks involve shared problems or challenges, create opportunities for exchange, and require children to attend to one another's ideas or actions. However, co-participation does not necessarily constitute collaboration. Collaborative processes need to be identified through the ways in which children work toward shared goals, exchange and respond to ideas, coordinate their actions, and gradually share responsibility.

The main contribution of this article is the proposal of a conceptual analytical framework in which STEAM task design is considered an input condition, opportunities for interaction represent a proposed mediating mechanism, the collaborative process constitutes the central focus of analysis, autonomy in joint activity represents a possible developmental direction, and teachers' guided support functions as a cross-cutting component. The framework also clarifies that support is not intended solely to help children

complete tasks but may also serve to sustain and develop the forms of interaction necessary for joint activity.

From a practical perspective, teachers should attend not only to the products of STEAM activities but also to the ways in which children work together to complete tasks. Task design, observation of participation, prompting discussion, and adjusting the level of support may therefore represent important areas of pedagogical attention. At the same time, teachers should not replace children's own thinking and decision-making; support should be flexibly adjusted and may gradually decrease as children become increasingly capable of regulating joint activity.

This article also has several limitations. First, it is a literature-based study with a limited scope of sources, and the studies included vary in their objectives, methods, and approaches to STEAM. Second, some of the relationships within the proposed framework were developed by synthesizing evidence from different lines of research, while direct evidence concerning collaboration among children in STEAM activities remains limited. Third, the proposed conceptual analytical framework has not yet been empirically tested.

Future research could directly observe children's collaborative processes across different types of STEAM tasks, analyze specific forms of teacher support, and examine the suitability of the proposed conceptual analytical framework in different early childhood education contexts.

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