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2026 Volume 4, Issue 3
Educational Innovation Research
ISSN: 3029-1852 (Online)
ISSN: 3029-1844 (Print)

From Scaffolding to Shared Regulation:An Interactional Pathway Protocol for Preschool Cps in Project-Based Learning

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Abstract: Early childhood project-based learning (PBL) is often claimed to improve cooperation and problem-solving, yet the interactional mechanisms that connect these competencies remain under-specified. Derived from a doctoral dissertation on the coordinated development of preschool children's cooperation and problem-solving ability, this manuscript develops a qualitative companion protocol for a QUAN → QUAL mixed-methods program. It conceptualizes coordinated development as collaborative problem solving (CPS) and proposes an interactional pathway model linking teacher scaffolding (contingency, fading, and functional focus) to children's shared regulation moves (joint planning, shared monitoring, and repair) and to CPS mechanisms (shared understanding, coordinated action, and team organization). The protocol specifies connected episode selection based on quantitative gain profiles, prioritizing critical moments such as disagreement, prototype failure, role negotiation, and revision. Data sources include classroom video, teacher interviews, child stimulated recall, and artifact traces (plans, drawings, prototypes). The contribution is an operational coding architecture and a set of scaffolding-sensitive indicators that make CPS-in-interaction visible and support joint displays for integrated meta-inferences.

Keywords: Project-based learning; scaffolding; socially shared regulation; interaction analysis; collaborative problem solving; preschool education

Online publication: March 26, 2026

1. Introduction

Preschool project work is rich in interaction: children coordinate talk, gesture, gaze, and objects while negotiating goals and participation. Yet research evidence often reduces this complexity to broad ratings of 'cooperation' or 'problem solving', which can obscure whether children are developing the integrated capacity to solve problems collaboratively. When coordination is not analyzed, it is possible to overestimate cooperation by counting participation, or to overestimate problem solving by focusing on products that may have been achieved through adult direction or unequal division of labor [1].

This manuscript provides a qualitative companion protocol that explains how coordinated development emerges as CPS during preschool PBL. It is designed to connect directly to a sequential explanatory mixed-methods design (QUAN → QUAL): quantitative change patterns guide the selection of contrasting cases and high-information episodes, and qualitative analysis traces scaffolding and regulation pathways that explain variation in outcomes [2].

2. Purpose & objectives

The purpose of this study is to develop an interactional explanation of how teacher scaffolding supports the emergence of shared regulation and CPS during preschool PBL, and to provide a transparent, reusable analytic protocol for connected qualitative follow-up in a QUAN → QUAL design.

The specific objectives are to:

(1) To specify an interactional pathway model linking scaffolding moves to shared regulation moves and CPS mechanisms during project work.

(2) To define connected episode selection principles aligned to quantitative gain profiles and contrasting-case logic.

(3) To provide a coding architecture and observable indicators for CPS-in-interaction, including artifact-mediated coordination and repair.

(4) To derive practice-oriented implications for scaffolding that supports autonomy, inclusion, and iterative revision without over-directing children's solutions.

3. Literature review and theoretical background

The dissertation's theoretical base integrates sociocultural theory and scaffolding research with social interdependence accounts of cooperation. Sociocultural perspectives emphasize mediated activity: talk and artifacts function as tools for coordinating attention and meaning, and adult guidance can temporarily structure participation until children gain greater control [3]. In project work, artifacts (plans, drawings, prototypes, criteria lists) are not merely products; they anchor joint attention, make goals visible, and stabilize shared understanding during disagreement and revision.

Regulation in collaboration is increasingly conceptualized as distributed. Beyond individual self-regulation, learners may co-regulate one another and engage in socially shared regulation of learning when they jointly plan, monitor, and repair task activity [4]. Although SSRL research often focuses on older learners, the conceptual distinction is valuable for preschool projects because regulation moves are visible in interaction (e.g., 'Let's try again', 'We need it stronger', 'You hold it and I test'). When these moves become shared rather than individual, cooperation and problem solving can develop synergistically as CPS.

Teacher scaffolding provides a bridge between adult support and child-led shared regulation. Research syntheses highlight contingency and fading as defining features: effective scaffolding is responsive to children's current state and gradually transfers responsibility [5]. In preschool CPS episodes, scaffolding is also social-regulatory: supporting turn-taking, inclusion, and repair during conflict, conditions that enable cognitive strategy to become shared rather than dominated.

Methodologically, interaction analysis treats episodes as units where mechanisms become visible through coordinated multimodal action [6]. Sequential explanatory mixed methods design provide a principled way to select episodes that explain quantitative variation and strengthen credibility of inferences through integration.

4. Materials and methods

Design approach. The manuscript specifies a qualitative process-explanation protocol embedded within a QUAN → QUAL mixed-methods program. In line with an educational design research stance, the protocol makes conjectures explicit (how scaffolding supports shared regulation and CPS) and proposes evidence-proportionate sampling and coding procedures that are feasible in naturalistic preschool settings [7].

Materials (data corpus). The qualitative corpus includes:

(1) Classroom video recordings of project sessions with attention to planning, testing, disagreement, and revision phases;

(2) Teacher interviews focused on project intentions and scaffolding decisions;

(3) Child stimulated recall using selected video clips to elicit child perspectives on goals, choices, and peer interaction; and
(4) Artifact traces such as plans, drawings, prototypes, and criteria posters that mediate coordination.

Connected episode selection. Episodes are sampled through a two-stage procedure. Stage 1 selects contrasting cases based on quantitative gain profiles (e.g., triads with high CPS gain vs. low CPS gain; classrooms with stronger vs. weaker scaffolding profiles). Stage 2 identifies critical moments that require coordination and therefore reveal mechanisms: disagreement over criteria or roles, prototype failure that triggers revision, drift into parallel participation, and repair of exclusion or dominance patterns.

Coding and analysis. Analysis proceeds in three passes. (Pass A) Segment episodes by project phase and identify artifacts-in-use (what artifact is referenced and how). (Pass B) Code shared regulation moves (joint planning, shared monitoring, repair) and participation structure (turn-taking, inclusion, dominance/withdrawal). (Pass C) Code teacher scaffolding moves with attention to contingency and fading and to functional focus (cognitive, metacognitive, social-regulatory). The analytic output is a chain-of-evidence narrative for each episode that links scaffolding → regulation → CPS mechanisms, supported by transcript excerpts and artifact photographs where permissible.

Trustworthiness and ethics. Credibility is supported through triangulation across video, interviews, recall data, and artifacts, and through connected integration via joint displays. Dependability is strengthened through codebook documentation and periodic coder calibration; confirmability is supported through analytic memos. Ethical safeguards include guardian consent, child assent, anonymization of video data, controlled access, and the right to withdraw. See **Figure 1, Table 1, 2** and **3**.

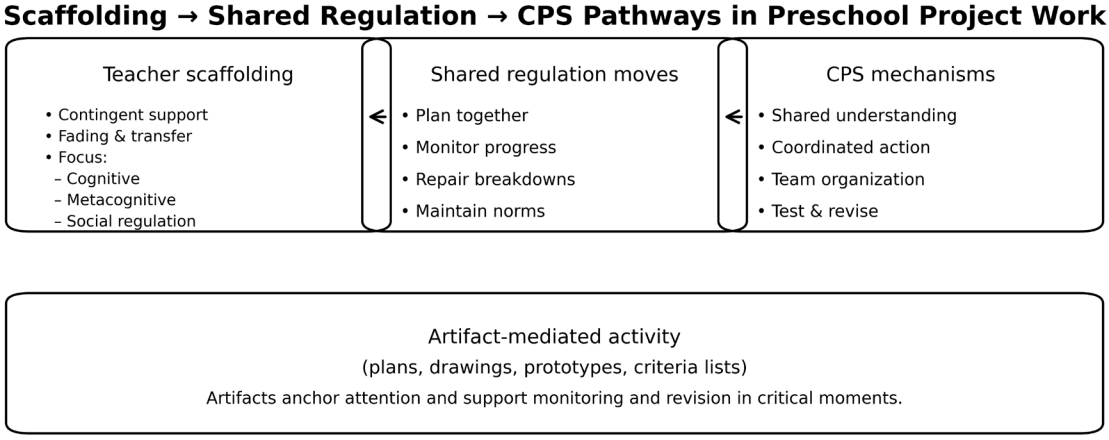

Figure 1. Scaffolding → shared regulation → CPS pathways in preschool project work.

Table 1. CPS components and observable indicators for episode-level analysis

CPS component	Preschool-adaptive description	Observable indicators (interaction + artifacts)
Shared understanding	Children align interpretations and goals using talk, gesture, and shared representations.	Clarification questions; referencing plans/drawings; summarising joint decisions; negotiating criteria.
Coordinated action	Children sequence and distribute actions to test ideas and build a joint artifact, adjusting roles as needed.	Role negotiation; synchronised material work; collective decision points; iterative testing and revision.
Team organization	Children sustain norms that enable collaboration and repair breakdowns during conflict or drift.	Turn-taking; invitations; conflict repair; addressing exclusion/dominance; returning to shared goals.

Table 2. Scaffolding moves (functional focus) and expected regulatory uptake

Scaffolding focus	Illustrative teacher moves	Expected child/shared regulation uptake
Cognitive	Prompt strategy generation; highlight constraints; model testing	Children propose strategies; link actions to constraints; generate alternatives
Metacognitive	Ask 'What is our plan?' 'How do we know it works?'; request monitoring statements	Children articulate plans; monitor progress; initiate revisions after feedback
Social-regulatory	Support turn-taking; invite quiet peers; reframe conflict; assign rotating roles	More equitable participation; repair sequences; shared responsibility for coordination

Table 3. Critical moments and analytic targets for mechanism tracing

Critical moment type	Why it is explanatory	Analytic targets
Disagreement (criteria/roles)	Makes shared understanding and participation norms visible under tension	Justification; revoicing; inclusion moves; resolution type; artifact referencing
Prototype failure (test breakdown)	Triggers monitoring, strategy switching, and revision, key for shared regulation	Monitoring talk; repair sequences; changes to plan/ prototype; responsibility transfer
Parallel drift / dominance–withdrawal	Reveals whether cooperation is equitable and whether cognition becomes shared	Participation structure; scaffolding focus; re-engagement strategies
Fading moment	Shows transfer of regulation from teacher to children	Contingency; decreased directiveness; sustained child-led monitoring and repair

5. Results

The "results" of this qualitative companion protocol are the operational pathway model and the coding architecture that make CPS-in-interaction visible and explainable. **Figure 1** specifies the proposed scaffolding → shared regulation → CPS pathways and foregrounds artifact-mediated activity as a central coordination resource. **Tables 1–3** operationalize what counts as evidence and where to look: CPS components are translated into preschool-adaptive indicators, scaffolding moves are linked to expected regulatory uptake, and critical moments are mapped to analytic targets.

To minimize the risk of 'framework-only' reporting, the protocol also specifies admissible evidence for the final empirical article:

(1) Episode chains that demonstrate planning → monitoring → repair around a shared artifact;
(2) Triangulation across video, interview accounts, and artifact traces; and
(3) Joint displays that align these qualitative chains with the quantitative change profile of the same triad or classroom.

These decision rules ensure that the qualitative component functions as an explanation of QUAN results rather than as a separate narrative. In the full dissertation-linked reporting, these protocol outputs enable joint displays that align quantitative change indicators (e.g., CPS task gains, SRL routines) with qualitative process evidence (episode chains showing planning → monitoring → repair). This supports meta-inferences about why PBL effects vary across classrooms—for example, differences in scaffolding contingency, participation norms, or artifact use—rather than treating variability as unexplained noise.

6. Discussion

The protocol reframes 'cooperation' and 'problem solving' as intertwined processes constructed through shared regulation in activity. For practice, it implies that effective project teaching is not primarily about giving solutions, but about scaffolding conditions for child-led coordination: making goals and criteria visible, supporting inclusion and turn-taking,

and prompting monitoring and repair while progressively transferring responsibility. Overly directive guidance can reduce opportunities for shared regulation, whereas insufficient guidance can allow unproductive conflict or disengagement to persist.

For research, the framework strengthens mixed-methods integration. Connected episode selection ensures that qualitative explanation targets the most informative contrasts, and the coding architecture supports transparent links from evidence to inference. This contributes to theory-building about early CPS and provides a reusable analytic template for future preschool PBL studies.

Limitations include the context sensitivity of interactional patterns and the labor demands of video analysis. The protocol therefore emphasizes evidence-proportionate sampling: focusing on a manageable number of high-information episodes linked to quantitative patterns, rather than attempting exhaustive coding of all sessions.

7. Conclusion

This qualitative companion protocol provides a scaffolding-sensitive pathway model and an operational coding architecture for explaining coordinated development as preschool CPS in PBL. By specifying where mechanisms are visible (critical moments) and how teacher support may enable shared regulation without undermining autonomy, the framework supports both rigorous explanation and actionable instructional design.

Disclosure statement

The authors declare no conflict of interest.

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