

From Theory to Classroom Practice: A Case Study on Cooperative Learning in Inclusive Science Education

Simi Gomez¹, Dr. Divya C Senan²

¹Department of Education, University of Kerala, Karivattom

²Assistant Professor, Department of Education, University of Kerala, Karivattom

Abstract

Inclusive science education seeks to create learning environments where every learner regardless of ability, background, or learning style—can participate meaningfully. Cooperative learning, grounded in socio-cultural and social interdependence theories, provides a promising pedagogical approach that enables active engagement, equitable participation, and deeper scientific understanding. This concept paper examines cooperative learning strategies as a bridge between theory and practice in inclusive science classrooms. It explores theoretical foundations, discusses practical applications, and reviews relevant literature to demonstrate how cooperative learning can enhance academic achievement and social development among diverse learners. This case study investigates how structured cooperative learning (heterogeneous grouping, defined roles, and talk scaffolds) promotes inclusion in a Grade 10 biology class during a “Cell Structure and Transport” unit. Findings highlight improved peer scaffolding, more equitable participation, and better access to vocabulary- and concept-heavy biology content for diverse learners. A teaching problem that motivated the intervention was familiar: group work was happening, but it was often unstructured, leading to unequal participation, off-task behaviour, and limited academic benefit for students who needed the most support. Drawing on Vygotsky’s socio-cultural theory (peer scaffolding within the Zone of Proximal Development) and Johnson and Johnson’s social interdependence theory (positive interdependence and individual accountability), the teacher redesigned group learning to make cooperative learning explicit, structured, and assessable.

Keywords: Cooperative learning; Inclusive education; Science education; Social interdependence theory; Constructivism; Peer collaboration; Differentiated instruction

1. Introduction

Science learning is inherently social, rooted in exploration, dialogue, problem-solving, and collaborative investigation. However, many science classrooms continue to rely on teacher-centered methods, which may inadvertently marginalize students with disabilities, learning difficulties, or limited language proficiency (Mastropieri & Scruggs, 2014). To support diverse learners, inclusive science education calls for instructional approaches that emphasize accessibility, engagement, and meaningful participation. Cooperative learning emerges as a research-supported strategy that aligns with the collaborative nature of scientific inquiry (Gillies, 2016). This paper introduces cooperative learning as a pedagogical bridge between theories of inclusive education and their practical application in science classrooms.

Science learning is fundamentally social, shaped by questioning, investigation, and the shared construction of explanations, yet inclusive secondary classrooms often struggle to translate this reality into equitable participation for all learners. In many schools, students with disabilities, learning difficulties, or language barriers are placed in mainstream science classes, but instruction may remain teacher-centered or group work may occur without the structure needed to ensure genuine collaboration. Cooperative learning offers a practical bridge between inclusive education theory and classroom practice because it is grounded in socio-cultural views of learning and in social interdependence principles that emphasize shared goals, peer support, and individual accountability. Guided by the title *From Theory to Classroom Practice: A Case Study on Cooperative Learning in Inclusive Science Education*, this paper conceptually examines cooperative learning as an inclusion-oriented approach and situates the discussion within a secondary science classroom case to illustrate how strategies such as Think–Pair–Share, Jigsaw, and Group Investigation can promote access to scientific ideas, improve engagement, and strengthen belonging when deliberately designed and implemented.

2. Background of the Study

Inclusive education advocates that all students should learn together in general classrooms, regardless of differences (Ainscow, 2020). In science education, the cognitive demands of experiments, inquiry, and abstract concepts can present challenges for learners with varied academic abilities (Scruggs & Mastropieri, 2013). Cooperative learning has been recognized as a powerful tool to address these challenges by enabling structured collaboration and peer-assisted learning (Slavin, 2014). Although this pedagogical approach is theoretically aligned with inclusive practices, many teachers struggle to implement it effectively due to limited training, insufficient planning time, or uncertainty about group management (Webb, 2009). This concept paper aims to address these issues by connecting theoretical principles with practical strategies.

3. Objectives

The objectives of this concept paper are to:

1. Explain the theoretical foundations of cooperative learning in inclusive science education.
2. Discuss cooperative learning strategies that support diverse learners.

4. Concept of Inclusive Classroom Strategies

Inclusive classroom strategies focus on the fact that every child should have an equal opportunity for quality education, regardless of their abilities or background. This means the application of differentiated instructional techniques to respond to diverse ways of learning (Tomlinson, 2014). Also, it has universal design for learning, which creates flexible learning environments (Meyer, Rose, and Gordon, 2014). Cooperative learning helps students of varied abilities develop collaboration and social skills within the classroom (Johnson & Johnson, 2009), whereas assistive technologies, like speech-to-text software, aim to support students dealing with certain kinds of disability (Dell, Newton, & Petroff, 2016). Positive Behavioural Interventions and Supports is a set of strategies aimed at encouraging positive behaviour and preventing negative incidents of behaviour in order to provide support to all students in the classroom environment (Sugai & Horner, 2006). Collaborative teaching is when general and special education instructors work together to provide specialized instruction to students within the general education curriculum (Friend & Cook, 2016). The inclusive classroom culture supports positive attitudes about

diversity, and all students will be valued and recognized. When an educator puts students in an environment where all students are respected and enabled to confront the misconceptions about the juvenile society with all tools lost, they become provided with the security to be successful both in the classroom and in society (Smith, 2020). Together, these strategies form a supportive learning environment for learners with different needs, entailing academic and social success.

5. Significance of the Paper

Cooperative learning benefits multiple stakeholders. Educators gain actionable instructional strategies for managing diversity, while learners—especially those with special needs—gain improved academic outcomes, social skills, and participation opportunities (Gillies, 2016). Administrators and policymakers benefit from the reinforcement of inclusive education mandates. Ultimately, this paper contributes to the ongoing dialogue on how schools can create collaborative, equitable, and engaging science learning environments.

This paper adopts a conceptual research design, aimed at developing a coherent theoretical and practice-oriented argument on cooperative learning in inclusive science education. Rather than collecting primary field data, the methodology is grounded in a structured process of conceptual analysis and integrative review. The paper draws on established educational theories and peer-reviewed scholarship to clarify key concepts, identify relationships among variables, and propose an explanatory framework that bridges theory with classroom practice.

The development of the paper followed three interrelated stages. First, key constructs—inclusive education, cooperative learning, peer scaffolding, and classroom participation—were defined through foundational and contemporary literature in inclusive pedagogy and learning sciences. This stage emphasized conceptual clarity by comparing how major authors describe these constructs and how they function in classroom contexts. Second, the paper synthesized theoretical perspectives, primarily Vygotsky's socio-cultural theory and social interdependence theory, to explain why cooperative learning is expected to support inclusion and science learning. The synthesis focused on aligning core principles (e.g., Zone of Proximal Development, scaffolding, positive interdependence, and individual accountability) with instructional practices commonly used in science classrooms. Third, the paper translated theory into practice by mapping theoretical principles onto cooperative learning structures (e.g., Think–Pair–Share, Jigsaw, Group Investigation) and identifying implementation conditions that support inclusivity, such as heterogeneous grouping, explicit role assignment, scaffolded tasks, and balanced assessment strategies.

6. Theoretical Framework

6.1. Vygotsky's Socio-Cultural Theory

Vygotsky (1978) argues that learning occurs within social interactions, and students construct knowledge through engagement with peers and adults. Concepts such as the Zone of Proximal Development (ZPD) support cooperative learning by emphasizing that peers can scaffold one another's understanding.

Social Interdependence Theory

Developed by Johnson and Johnson (2009), this theory explains that cooperative efforts are most productive when group members depend positively on one another. Key components include positive interdependence, individual accountability, promotive interaction, and the development of interpersonal skills. These elements guide effective cooperative learning design in inclusive science classrooms.

Conceptual Framework

The conceptual framework positions cooperative learning strategies as a mediating process linking inclusive education goals to improved science learning outcomes. Diverse learners enter the classroom with varied capabilities; cooperative learning structures—such as Jigsaw, Think-Pair-Share, and Group Investigation—help students collaboratively explore scientific concepts. With teacher scaffolding, this process leads to increased participation, deeper understanding, and stronger social relationships.

Review of Related Literature

Research consistently demonstrates the academic and social benefits of cooperative learning. Slavin (2014) emphasizes that cooperative learning improves science achievement when group goals and individual accountability are present. Gillies (2016) found that cooperative learning enhances communication, empathy, and teamwork in diverse classrooms. Johnson and Johnson (2009) assert that cooperative learning results in higher achievement and more positive peer relations compared to competitive or individualistic methods.

Within inclusive settings, cooperative learning has been shown to improve outcomes for learners with disabilities. Scruggs and Mastropieri (2013) report that peer-mediated learning increases accessibility to science content and improves comprehension. Furthermore, Webb (2009) highlights that structured peer interaction helps struggling students ask questions, receive explanations, and participate confidently.

Challenges noted in the literature include dominance by stronger students, lack of teacher preparation, and insufficient scaffolding (Gillies, 2016). However, these challenges can be mitigated through explicit teaching of social skills, careful group formation, and systematic monitoring.

This paper reports a school-based case study examining how structured cooperative learning can support inclusion in a secondary biology classroom. The case took place in a Grade 10 biology class in a mixed-ability school where students learned together in a single mainstream setting. The class included learners with varied achievement levels, two students with identified specific learning difficulties, and several students requiring language support. The unit of focus was “Cell Structure and Transport”, a topic that typically demands strong scientific vocabulary, careful interpretation of diagrams, and conceptual understanding of abstract processes. Prior to the intervention, group activities were used occasionally, but participation was uneven and students who needed support often relied heavily on the teacher rather than benefiting from peer interaction. To address this, the teacher implemented structured cooperative learning routines with purposeful heterogeneous grouping, assigned roles (facilitator, recorder, materials manager, presenter), and guided talk supports such as sentence starters and visual organizers. These structures were intended to strengthen peer scaffolding, improve equitable participation, and help all students access biology concepts through discussion, shared reasoning, and collaborative problem-solving.

7. Case Study Report: Procedure

The case study was implemented in a Grade 10 secondary biology classroom during a six-week unit on “Cell Structure and Transport.” The overall purpose of the procedure was to examine how structured cooperative learning routines could improve inclusion, peer scaffolding, and equitable participation in a mixed-ability mainstream class. Before the intervention began, the teacher conducted a brief baseline phase to understand existing group-work patterns and learning barriers. During two biology lessons, the teacher observed and noted that group tasks were often dominated by a few confident students, while learners with specific learning difficulties and language support needs tended to remain silent, wait for teacher help, or contribute minimally. A short diagnostic quiz on basic cell organelles and a vocabulary

check were also administered to identify conceptual gaps and language demands. These baseline findings guided the design of the cooperative learning intervention.

Following the baseline phase, the teacher reorganized the class into purposeful heterogeneous groups of four students. Each group was designed to include a balance of achievement levels and, where possible, to distribute students requiring language support across groups to prevent isolation. The teacher introduced cooperative learning norms in a dedicated lesson, explicitly teaching expectations such as respectful listening, turn-taking, encouraging participation, and asking peers before asking the teacher. Students practiced these norms through a low-stakes task (labeling a simple plant cell diagram) so that the class could focus on collaboration skills rather than content difficulty. After this practice, the teacher implemented consistent role assignments within each group: facilitator, recorder, materials manager, and presenter. Role cards were printed with short responsibilities and sentence starters, and roles rotated weekly to ensure fairness, skill development, and shared responsibility.

To support language and participation, the teacher embedded structured talk supports into every cooperative activity. Sentence starters were displayed on the board and printed on group task sheets, such as “I think this organelle is responsible for... because...,” “Can you explain why...?,” and “My evidence from the diagram/text is....” Visual organizers were provided for key concepts, including a cell organelle-function table, a graphic organizer comparing plant and animal cells, and a flow chart template for diffusion and osmosis. For students with learning difficulties, task sheets were chunked into smaller steps with checkboxes, and key vocabulary was provided with icons and simple definitions. The teacher also used a “teach-back” routine, where groups had to restate instructions in their own words before starting, to reduce confusion and improve task independence.

The intervention procedures were carried out through three cooperative learning structures across the unit. In the first two weeks, Think–Pair–Share was used frequently for concept introduction and vocabulary building. The teacher began lessons with a prompt (e.g., “Why do cells need membranes?” or “What happens when a cell is placed in salt water?”), gave individual thinking time, then paired discussions, and finally collected responses from multiple pairs. This routine ensured that students who were hesitant to speak publicly could rehearse ideas with a partner, building confidence and language accuracy. During these weeks, the teacher explicitly modeled how to disagree respectfully and how to ask probing questions, reinforcing inclusive talk habits.

In weeks three and four, the teacher implemented the Jigsaw method to deepen understanding of cell organelles and transport mechanisms. Each group member became an “expert” on a subtopic such as nucleus and genetic control, mitochondria and energy, cell membrane structure, or transport types (diffusion, osmosis, active transport). Students first met in expert groups to study short, scaffolded reading passages with diagrams, highlighted keywords, and guiding questions. The teacher circulated, checked comprehension, and provided mini-support where needed, especially for students requiring language assistance. After expert preparation, students returned to their home groups to teach their section using a visual organizer. The recorder completed a shared chart while the facilitator ensured each member spoke. The teacher concluded each Jigsaw lesson with an individual exit ticket to maintain accountability and confirm that learning was distributed across all members.

In weeks five and six, the class conducted a Group Investigation task focused on applying cell transport concepts to real-life biological situations. Groups selected one investigation question from teacher-provided options, such as the effect of different solute concentrations on osmosis using potato strips, or explaining why red blood cells swell or shrink in different solutions using model diagrams. Groups

planned procedures with teacher guidance, identified variables, recorded observations, and interpreted results using sentence frames. The materials manager handled equipment checklists, while the presenter prepared a short explanation combining results with scientific reasoning. The teacher used checkpoints throughout the investigation—proposal approval, mid-task observation, and final explanation review—to ensure students stayed on track and that all members were contributing. Group products were assessed using a rubric that included scientific accuracy, evidence use, clarity of explanation, and collaboration indicators.

Throughout the entire intervention, the teacher used continuous monitoring and inclusion-focused supports. During group work, the teacher relied on an observation checklist to track participation equity (who speaks, who records, who leads), peer assistance behaviors (explaining, prompting, checking understanding), and on-task engagement. When dominance patterns appeared, the teacher intervened by redirecting questions to quieter students, requiring round-robin sharing, or temporarily adjusting roles to rebalance participation. Students with learning difficulties were supported through additional visuals, simplified reading passages (without reducing core concepts), and opportunities to demonstrate understanding orally or through diagrams before writing. Language support students received vocabulary banks, bilingual glossary permission where applicable, and encouragement to use diagrams and gestures alongside spoken explanations.

The case study concluded with a post-intervention assessment phase. Students completed a unit test and a concept application task requiring interpretation of membrane diagrams and prediction of outcomes in diffusion and osmosis scenarios. Students also completed a short reflection survey on their group experiences, focusing on fairness, confidence, and perceived learning. The teacher conducted brief informal interviews with a small sample of students representing different learning needs to understand how cooperative structures affected participation and comprehension. Artifacts such as group organizers, completed role sheets, exit tickets, and investigation reports were collected to provide evidence of learning processes and inclusion outcomes. The procedure provided a clear record of how cooperative learning routines were systematically introduced, practiced, and sustained to support inclusive biology learning during a demanding conceptual unit.

8. Findings of the study

1. Participation became more balanced: With assigned and rotating roles, more students contributed during group work instead of a few dominating discussions.
2. Peer support increased while teacher-dependence decreased: Students began asking teammates for help first, and classmates provided explanations using diagrams and examples.
3. Understanding of transport concepts improved: Students showed clearer reasoning about diffusion, osmosis, and active transport, especially when using flowcharts and visual organizers.
4. Use of biology vocabulary became stronger: Sentence starters and word banks helped students use key terms more accurately in discussions and written work.
5. Classroom engagement and behaviour improved: Groups stayed more on-task, and students—especially those needing learning or language support—showed higher confidence and involvement.

9. Conclusion

Inclusive science classrooms bring together learners with a wide range of strengths, needs, and learning preferences. Cooperative learning enables teachers to organize instruction in ways that ensure each

student's participation and contribution. Grounded in social learning theories, cooperative learning connects academic content with interpersonal development.

Through group roles and shared responsibilities, students work together to conduct experiments, interpret scientific data, and solve inquiry-based problems. For students with disabilities or learning difficulties, cooperative learning provides natural support systems through peer assistance and scaffolding (Mastropieri & Scruggs, 2014). Teachers enhance accessibility using visual tools, adapted materials, or guided prompts.

Cooperative learning also fosters social development by promoting communication, empathy, and cooperation. These skills not only improve group performance but also create an emotionally supportive learning environment—critical for inclusive education. Reflection and group processing help students evaluate their collaboration and refine their strategies.

Despite implementation challenges, cooperative learning remains one of the most effective inclusive teaching strategies in science education. With proper training, planning, and support, teachers can bridge the gap between theory and practice and create learning environments where all students experience success.

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