CPM EDUCATIONAL PROGRAM

CPM's 2023 Research Base
Executive Summary
Collaborative Learning

This is a summary of CPM's 2023 research base on Collaborative Learning. For more information and for references, please see the full report, available from https://cpm.org/research-base/.

What is Collaborative Learning?

Collaboration is distinct from cooperation; collaboration implies a joint production of ideas and cooperation implies sharing of ideas (Staples, 2007). While sharing ideas and strategies is important, it falls short of collaboration because it can amount to a distribution of labor in which students take on different parts of the task to accomplish a task as a team but do not build on each other's ideas for problem-solving. When students collaborate, they jointly produce ideas by making their ideas public to their peers, responding to each other's ideas, and over time, generating shared understandings. When we center collaborative mathematics learning, effort must be recast from an individual attribute to an attribute of group dynamics, where, for example, effort is viewed as learners representing their ideas to their teammates, considering their teammates' explanations, or monitoring their team's problem solving (CCSI, 2010; Schoenfeld, 1985; Sengupta-Irving & Agarwal, 2017).

CPM's Pillar of Collaborative Learning refers to:

A. students jointly constructing mathematical ideas as they problem-solve together; and
B. engaging in productive struggle by relying on each other as essential resources for problem solving.

In Collaborative Learning, teachers facilitate mathematics learning by positioning and equipping students to make sense of and build on each other's ideas.

Overview

In classrooms that feature Collaborative Learning, students rely on each other to solve mathematical problems such that all students learn from each other — a quality scholars have coined "interdependence" (Cohen & Lotan, 2014; Horn, 2012). Collaborative Learning affords teachers opportunities to create more inclusive classroom environments where students from many social groups and with various mathematical strengths can bring their full selves to the learning process (Joseph, 2021; Jasien & Hayes, 2021).

CPM infers from this research that…

Collaborative Learning is a humanizing way to support students to engage in mathematical practices (i.e., the skills and dispositions necessary to participate in disciplinary discourse) for the production of mathematical knowledge and skills. Humanizing instructional practices occur when teachers see their students as whole people with natural and cultural needs (including to be social and playful), challenge the status quo of participation normed by whiteness (such as by foregrounding students' physical and emotional well-being), and more generally affirm students' full selves.

Why is Collaborative Learning important for learning mathematics?

Students in collaborative classrooms engage in quantitatively more mathematical thinking than students in cooperative classrooms (Wood, Williams, & McNeal, 2006). The different qualities of student discourse across collaborative and cooperative classrooms have implications for students' mathematical reasoning: students in collaborative classrooms spend more of their time analyzing and synthesizing (higher-level discourse), while students in cooperative classrooms spend most of their time comprehending and applying (lower-level discourse).

In classrooms that foster collaborative learning, students have been shown to progress over time from being oriented only to mathematical content (i.e., the technical skills and knowledge of the discipline) to being more fully engaged in mathematical practices (i.e., the skills and dispositions necessary to participate in disciplinary discourse; Gresalfi & Cobb, 2006; Lampert, 1990).

CPM infers from this research that…

Collaborative Learning supports rigorous engagement in mathematics by requiring students to analyze their solution strategies and synthesize across strategies, focusing not only on how to solve problems but also on why some methods make more sense than others in particular situations. Thus, collaborative learning leads to sophisticated mathematical reasoning, where students engage in authentic mathematical practices in ways that allow them to develop a sense of mathematical efficiency and elegance.

If Collaborative Learning is important for mathematics learning, why is it not more widespread?

Many curricula are meant to provide teachers with opportunities to grow their teaching practices. As CPM has seen over the years and as evidenced in classroom research, teachers often modify curricula so that they can continue to teach in ways that are familiar to them—in ways that align with their teaching philosophy and allow them to use their stores of practical knowledge about how to teach and learn (Cobb et al., 2003; Gresalfi, Martin, Hand, & Greeno, 2009). At the same time, research has shown that the curricula teachers use has a considerable impact on how teachers teach and what students learn (Kloosterman & Walkcott, 2010).

Importantly, teaching in collaborative classrooms can feel riskier than teaching in more traditional methods. Teachers must navigate the uncertainties of what students will learn as students share their budding understandings and misconceptions with each other (Cohen, 2011). Even more, students who are accustomed to the discourse found in traditional classrooms may resist a transition to a collaborative classroom if the new expectations for participation cause a contradiction within the student about what it means to learn and succeed in mathematics (Calleja & Buhagiar, 2022; Lampert, 1990).

CPM infers from this research that…

Teaching for Collaborative Learning can require significant learning for teachers, especially because most teachers were not taught through collaborative learning techniques. Teaching for Collaborative Learning also increases the complexity of fostering student learning as teachers have to attend not only to the ideas students develop from listening to the teacher but also from interacting with their peers. The remainder of this document outlines why teaching for collaborative learning is worth the investment in navigating the added instructional complexity.

Who is Collaborative Learning good for?

Attending to ability and status is essential for equity in collaborative settings as ability grouping has implications for both *access* and *achievement* and status issues that can manifest in teamwork have implications for both *identity* and *power* (i.e., Gutiérrez's [2011] four dimensions of equity).

Ability grouping

Research on the effects of ability grouping on low-achieving, high-achieving, and average-achieving students is contested, with some finding that homogeneous ability grouping (e.g., grouping students with similar achievement levels) benefits all students (Steenbergen-Hu et al., 2016) and others finding that heterogeneous grouping (e.g., grouping students with various achievement levels) benefits all students (Burris, 2006). Shah and Lewis (2019) found that equity within group interactions was amplified and attenuated by the ways teachers shared their rationale for collaboration with students, with the authors arguing that sharing the purpose of collaboration with students allows them to better invest in their own and their group members' learning.

CPM infers from this research that…

Collaborative Learning supports all students' access to meaningful engagement in high cognitive demand tasks, which then also supports student achievement. It is less productive to label and sort students as high- and low-achieving than it is to allow students to work with many of their peers by re-grouping on a regular basis.

Status issues

While smartness tends to be socially conferred upon students as a trait they either possess or do not, as does being a "hard worker" or having a "growth mindset," labeling an individual as smart and hardworking (and others as not) is dangerous from an equity perspective because it can serve to perpetuate problematic cultural stereotypes, also called cultural narratives or storylines. Instead of being enduring individual traits, these traits vary depending on what each task requires, who students are working with, and students' current interactional experiences within the group (Engle, Langer-Osuna, & McKinney de Royston, 2014; Langer-Osuna, 2011; Sengupta-Irving & Agarwal, 2017, p. 118–119).

CPM infers from this research that…

Collaborative Learning creates opportunities for more learners to experience mathematical competence. Equitable facilitation of Collaborative Learning requires attending to both what is

positioned as mathematical activity and the ways students are positioned as mathematical contributors, both by students and the teacher. When all students are given opportunities to meaningfully participate and publicly be labeled as providing valuable mathematical contributions to their teams and the class, differences in status are mitigated and more students' learning is supported.

What does it look like for students to engage in Collaborative Learning?

In the mathematics classroom, teachers can attempt to support student learning by using an "authoritative discourse" (Bahktin, 1981; Cazden, 2001) in which students are expected not to challenge the knowledge being presented, or, by cultivating students' "internally persuasive discourse" (Bahktin, 1981; Cazden, 2001) in which students consider alternative perspectives and explanations. Staples (2007) identified several collaborative mathematical practices that illustrate opportunities to cultivate students' internally persuasive discourse, including juxtaposing or comparing strategies, approaches, and ways of understanding and understanding and evaluating another's argument (for a full list, see the full report).

Heteroglossia, multi-vocal discourse, & translanguaging

Creating opportunities for internally persuasive discourse requires welcoming students' everyday language as they make sense of mathematics with their peers. Heteroglossic discourse (e.g., bringing students' everyday ideas into conversation with their mathematical ideas; Bhaktin, 1981) and multi-vocal discourse (i.e., talk in which students cite one another when developing explanations; Lampert & Cobb, 2003) require teachers to recognize, value, and expand upon what each student knows even if mathematical thinking is expressed without the incorporation of the mathematical registrar. Over time, students develop a mathematical vocabulary to reference mathematical ideas; however, this can happen in non-linear ways as students move back and forth between the origins of ideas in the classroom and their meaning in the broader mathematical community. In linguistically diverse classrooms, there are additional considerations that teachers must take into account as they foster heteroglossic, multi-vocal discourse. The notion of *translanguaging* — a theory of language that tells us that students' home languages and English are not inherently separated but are *interrelated* in communicative practices — supports new ways of conceptualizing students' mathematics learning (The Translanguaging Study Group, 2020; Cenoz, 2017). Translanguaging includes the many ways people communicate and is not limited to spoken (e.g., sign language, body language, gestures) or named languages (e.g., dialects of named languages).

CPM infers from this research that…

In Collaborative Learning classrooms, it benefits students' participation and thus their learning when teachers welcome their out-of-school/everyday experiences and languages, including informal language and home languages. This supports students' sense of belongingness and provides them with appropriate resources for mathematical sensemaking.

Accountable argumentation

Mathematical disagreements will happen in collaborative mathematics classrooms, and these disagreements should be intellectually productive and minimize social discomfort. In "accountable

argumentation" (Horn, 2008), specific practices, expectations, language, and roles mediate the tensions usually associated with disagreement (in White culture in the United States) by framing disagreement as collective rather than as personal. According to Horn, team roles can structure valid ways of participating in teamwork. Though roles can be beneficial for increasing students' access to mathematical participation, they can also end up reinscribing problematic social patterns (Sengupta-Irving & Vossoughi, 2019).

CPM infers from this research that…

Collaborative Learning requires students to build on or critique each other's *reasoning* without critiquing each other. Evidence of collaborative learning includes students asking each other questions that press for learning, such as clarification or further explanation not only of how a strategy works but also why it works. In collaborative learning classrooms, precise mathematical vocabulary is used only after it emerges as necessary for the class and references the ideas of particular students. Students see mathematical vocabulary as a needed resource for their communication rather than as a learning objective itself.

Collective productive struggle and perseverance

One of the biggest cultural shifts in collaborative classrooms is how teachers and students conceptualize productive struggle, moving from viewing it as an individual endeavor to a collective endeavor. In 2021, a study identified five types of productive struggle specific to collaborative classrooms: (1) Clarification of task expectations or features, (2) Conflict in declared solution or strategy, (3) Declaration of uncertainty about solution or strategy, (4) Declaration of inelegant or inefficient strategy, (5) Seeking teacher support (Sengupta-Irving & Agarwal, 2017). In all of the identified types of productive struggle, teams were classified as persevering if they collectively modified their thinking as they exchanged ideas.

CPM infers from this research that…

In Collaborative Learning classrooms, students look to each other in moments of mathematical uncertainty or conflict. Productive struggle is not an individual accomplishment.

Off-task talk

Off-task talk can be beneficial for learning. In an analysis of 13 classroom videos of students working on collaborative problem-solving tasks, researchers found that 59% of off-task talk actually supported students' collaborative process by helping students "warm up" to collaboration, garnering peers' attention in order to move the conversational floor towards mathematics, resisting one or few students taking over the mathematics of the group, or extending the mathematics task. Even more, another 20% of off-task interactions functioned to bring more students into the collaboration. Descriptive studies of students' off-task talk have observed off-task talk to alleviate status issues by making students' identities outside of their academic status relevant (Langer-Osuna et al., 2021).

When social and academic discourse are positioned as mutually exclusive, then students and teachers can co-develop an oppositional classroom culture that can continue to devolve since restricting students' discourse also restricts their opportunities for mathematical meaning-making (Hand, 2010).

CPM infers from this research that…

Collaborative Learning is an educational right for students. While CPM does not suggest teachers allow off-task activity to persist without teacher intervention in all cases, collaborative learning should be continued even when off-task talk emerges. When teachers sense that a student group is off-task, teachers can pause for a moment and then decide whether to intervene or step back and permit the off-task talk to occur in rhythm with on-task mathematics activity. Off-task talk is an important characteristic of inclusive, student-centered, collaborative classrooms. Opposition within classrooms can be decreased if the range of valued student practices and discourses is extended to include competencies that students bring from non-academic parts of their lives as a foundation for building mathematical practices and discourse (blurring the lines between everyday activity and mathematical activity).

How can I facilitate equitable Collaborative Learning?

In collaborative classrooms, teachers work to establish and monitor a common ground, support students in making contributions, and facilitate engaging in mathematics (Staples, 2007). Common ground is the mathematical ideas and practices, generated by students, that are assumed to be shared in a classroom (Clark, 1996; Staples, 2007). Facilitating mathematics in a collaborative classroom involves asking *high-press* questions (Kazemi & Stipek, 2001) — questions that support students to not only share their explanations but to also evaluate each other's explanations. In order to establish common ground and facilitate mathematics, it is critical to begin with eliciting student ideas in a way that makes their ideas available to each other by asking students follow-up questions such as (a) why they chose a particular approach or method and (b) to make a record of their process (in addition to explaining their ideas). Beyond eliciting student ideas, teachers can create a collaborative classroom environment by revoicing (O'Connor & Michaels, 1993) student contributions (e.g., verbally reformulating a student's explanation in order to clarify ideas, introducing new terms for familiar ideas, etc.).

CPM infers from this research that…

In Collaborative Learning classrooms, students create a common ground — shared understandings of mathematical ideas — as they refer to each other's ideas by name and thereby elevate their peers' academic status. Teachers support students to find common ground by creating opportunities for students to make their ideas available to one another, such as by modeling high-press questions and making records of student thinking that are visible to the entire class. High-press questions go beyond asking how to ask why, as the former facilitates procedural descriptions or summaries and the latter facilitates students to form mathematical arguments. When teachers re-state students' ideas, they can assign students competence and mitigate some of the social risks for students as they make their ideas available for critique by their peers.

Teacher positionality and the relational work of teaching

The relational work of teaching is complex: teachers need to know their students as individuals while also having awareness of broader storylines that need to be disrupted and social inequities that they must take care not to reproduce or perpetuate (Ball & Cohen, 1999). The outcome of not examining power and privilege is harmful: teachers who teach in low-income schools serving predominantly students of color often perceive stereotypes to be reinforced, feeling confident about themselves as teachers but characterizing their students or their families increasingly negatively and pessimistically (particularly for White teachers; Sleeter, 2001). However, when teachers participate in learning about their power and

privilege that come with it, these outcomes can shift dramatically. The pedagogical strategies that can make teaching mathematics easier — which stem from theories of equity as equal treatment — are exactly the kind of instructional practices that reproduce negative conceptions of students and low achievement (Ladson-Billings, 2011). The goal of understanding students and having positive relationships with them is not to leverage that relationship to spur motivation, it is to design instruction that draws students into learning in meaningful ways, by building on what they know.

CPM infers from this research that…

In Collaborative Learning classrooms, it is essential for equity that teachers critically analyze their own experiences and social positioning. Equity means that students experience mathematics class in ways that are (a) affirming to their full selves, including their individual personality, their intersectional identity (race, class, gender, sexuality, ability, etc.), and culture/s; and that (b) have equal outcomes that cannot be predicted by social markers like race, class, gender, sexuality, etc. Currently in the United States, too many students experience mathematics class as a place where they have to leave most of who they are at the door to the classroom, and achievement outcomes can be predicted based on social markers. Teachers can work against these pernicious trends by taking a humble approach to their teaching and reflecting on the ways their ideas about both mathematics learning and their students are shaped by their own identities, experiences, and assumptions about what is "normal." Whether acknowledged or not, everyone's views of the world are influenced by experiences of privilege and oppression. When teachers become more conscious of the ways privilege and oppression shape their teaching, they are better able to relate to their students as individuals who may experience privilege and oppression differently than they do. Questions to consider include:

- How have your experiences been shaped by privilege and oppression?
- How do your experiences differ from and align with your students' experiences?
- How does your understanding of the social histories of groups that your students are members of impact your ability to teach mathematics in ways that are meaningful to them?
- How does knowing your students as individuals allow you to better meet their learning needs?