Support Patterns in Classrooms Implementing a Computer Science and Physical Computing Curriculum

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ABSTRACT

Teacher support is pivotal for promoting collaborative learning. Students often face challenges in self-regulating their learning within small group settings, especially when presented with open-ended learning opportunities. Analyzing 542 moments of support in small group work with the MOSAIC protocol during a unit on physical computing suggests a relationship between support type and activity design. Students showed more initiative in seeking support in more complex tasks. Teacher support focused on small groups rather than the entire class during complex or open-ended activities. Support focus on the direction of the task is the most common type across all activities. Support for collaboration was most frequent in the activity requiring students to coordinate knowledge developed individually. This analysis provides insights into potential areas for enhancing student support in a computer science classroom, particularly for collaboration.

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INTRODUCTION AND BACKGROUND

Promoting classroom collaboration offers significant benefits, including improved learning outcomes [1], fostering inclusivity and equity in the classroom, with a particular benefit to female students [2], and the development of employer-valued skills [3]. However, students often encounter challenges controlling their learning during small group work [4]. Simply grouping students does not automatically result in productive collaboration [5]. "Smart" groups – where the expertise to solve problems is present, can often fail [6].

Before introducing strategies to enhance collaboration in classrooms, understanding existing dynamics is crucial. Our study examines classrooms implementing the Sensor Immersion (SI) unit, a curriculum designed to enhance collaboration, to answer three key questions: (1) Who initiates support, teachers or students, in various classroom activities? (2) Who are the recipients, the entire class, specific groups, or individual students, in various classroom activities? (3) How do support patterns, focusing on task completion and collaboration, vary across different types of activities?

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METHOD

This study was conducted within a research-practice partnership between the Institute for Student and AI Teaming and two rural and suburban districts in the Western United States. The instructional context is the SI unit, a CS curriculum that focuses on teaching students to program, wire, and use sensors and significantly emphasizes developing their collaborative skills through diverse small-group activities:

1. *Program and Wiring Activity*: Students work with physical sensor systems, including environmental, sound, and soil sensors.
2. *Card-Sort Activity*: Students discuss to identify effective explanatory science models and their characteristics.
3. *Classroom Norms Discussion*: Students participate in a meta-collaborative activity to brainstorm community agreements to enhance their collaboration.
4. *Jigsaw Activity*: Individual students gain expertise in one of three sensors. They then work in groups to share their sensor knowledge with others, promoting positive interdependence.

Students worked in small groups of 2-4, asking for and receiving support from the teacher as needed. Videos of these interactions were captured using iPads and Yeti microphones. 205 videos, approximately 21 hours of small group work, were collected from four classrooms.

In the videos, we identified *support moments* as instances where individuals outside the recorded group provided guidance or instructions to group members. We then applied the Moment of Support Analysis in Classrooms (MOSAIC) coding protocol to analyze these support moments, including identifying initiators, recipients and categorizing the support into twelve specific categories [7]. There were 542 moments analyzed. We used Krippendorff's Alpha to assess coding reliability [8]. The result for the final coding was an acceptable 0.69.

FINDINGS

Among 542 identified moments, 65 support moments were associated with the card sort activity, 30 with classroom norms discussions, 356 with programming and wiring, and 91 with the jigsaw activity.

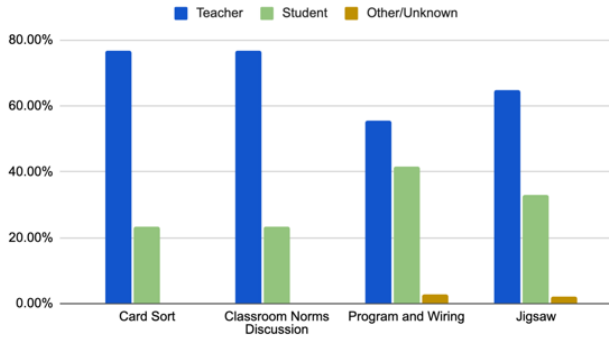

Figure 1. Initiators of support across all activities

Though the teacher most frequently initiated support across all activities, students more proactively initiated support in the program and wiring activity, the most complex of the tasks. This accounted for 41.5% in program and wiring compared to 23%-33% in the other activities (Figure 1).

There were variations in whom the teacher provided support depending on the activity (Figure 2). In the card sort and jigsaw activities, the teacher typically addressed the entire class (52% and 46%, respectively), while in classroom norms discussions and programming and wiring activities, the teacher primarily engaged with specific groups (57% and 48%, respectively). The task design, which is open-ended in classroom norm discussions and a complex task with context-based problems in programming and wiring activities, might contribute to this result.

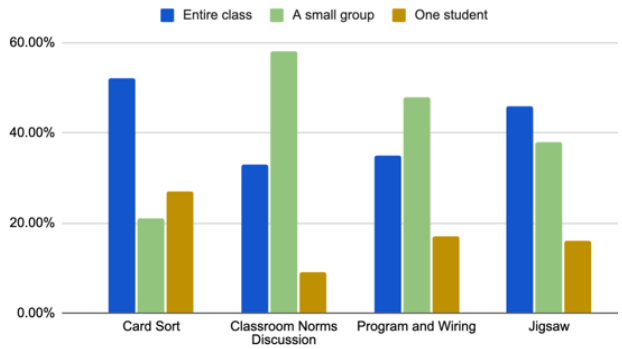

Figure 2. Support recipients across all activities

Support across activities focused on providing directions about assignments was high for all activities, ranging from 58% in model card sorting to 73% in programming and wiring. Collaboration-focused support was rare across all activities, with a notable variation. It was highest at 18% in the jigsaw activity but was six times less, at 3%, in discussions of classroom norms (Figure 3). The jigsaw activity required students to share knowledge developed individually with peers to complete a task where they had to apply that knowledge.

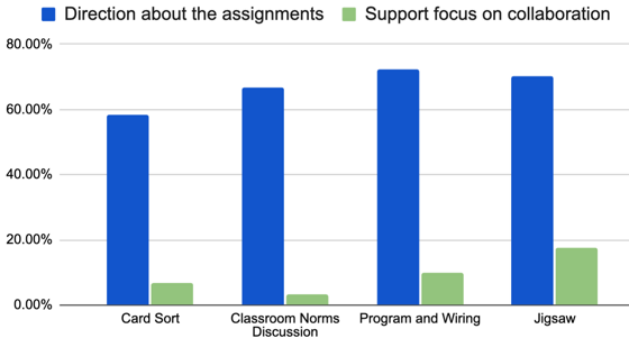

Figure 3. Type of support across all activities

DISCUSSION

There appears to be a link between activity design and the requested or provided support type. Teachers often initiated support, but students sought help more actively during more complex tasks. Collaboration support was most evident in tasks that made high demands on students' collaboration skills; that is, in the jigsaw activity. However, support for collaboration was less common than task-focused support in all activities.

Future research will explore the effects of teacher- or student-initiated support and to whom this support is provided. We also aim to understand why support for collaboration is limited, examining whether activity designs adequately promote teamwork or if teachers and students underestimate the need for such support.

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