SPIN-UPS: HOW TEACHERS SCAFFOLD GROUPWORK WITH WHOLE CLASS PROMPTS AND THE MESSAGES THEY CONTAIN

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Teachers often employ groupwork to actively engage students in mathematical activity. While groups work, teachers may support groups in a number of ways. We extend the metaphor of a "launch" to define a "spin-up" as an instance in which teachers scaffold groupwork with whole class prompting. We examined an AP Calculus AB classroom in which the teacher often used spin-ups for a variety of purposes to support groupwork. We describe our findings from analyzing the occurrence of each spin-up during the lesson, the content of each spin-up instance, and the messaging around each spin-up. These findings help highlight the complex decision-making involved in supporting students' more autonomous work in the classroom.

Keywords: Classroom Discourse, High School Education, Instructional Activities and Practices

As educators seek to involve students in mathematical activity, groupwork has become increasingly important for both researchers and educators (Cohen & Lotan, 2014; Dunleavy, 2015; NCTM, 2018). The groupwork format shifts the responsibility of problem-solving and confirming solutions from the teacher to students. Using groupwork in the classroom creates opportunities for the unpredictable, often requiring teachers to improvise how they build on students' thinking or give feedback to groups. To begin to account for the pedagogical judgments that teachers use and their impacts, researchers have documented the ways in which teachers monitor and decide to intervene in individual groups (Ehrenfeld & Horn, 2020) as well as students' uptake of such scaffolds (van de Pol et al., 2019). Yet, teachers may also choose to provide scaffolds to the entire class, rather than an individual group, during groupwork time.

We refer to such scaffolding as a *spin-up.* We build on the metaphor of a rocket *launch* (Jackson et al., 2012) to describe teachers' work to initiate an activity, and extend this notion to a *spin-up* which stabilizes rockets while in flight to describe teachers' support to stabilize groupwork. This notion of a *spin-up* builds on the practice of monitoring (Stein et al., 2008). Rather than monitor for students' ideas to build on in a discussion to follow groupwork, *spin-ups* are used to support and sustain the continued activity of groups. A spin-up may not only consist of additional content information, it may also convey messages to students about how knowledge is built and their role in that process.

In this brief research report, we describe the preliminary findings from our investigation of one teacher's use of spin-ups and its impact on her class, by answering the following questions: (1) When do spin-ups occur in class during groupwork? (2) What is the content and purpose of each spin-up offered? (3) What messages are conveyed via the teacher's framing of the spin-up?

Theoretical Framing

We consider classroom learning to be a *situated interactional activity* among students and teachers and the content. Effective teaching that centers students is highly improvisational, context-dependent, and responsive to activities that happen within the classroom (Robertson et al., 2017). Especially in the enactment of groupwork, in which students take on a central role,

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outcomes may be unpredictable. Yet, patterns still exist in these interactions that emerge as routines, which we can characterize and investigate (Horn & Little, 2010).

Within this framing of classroom interaction, we adopt a lens of framing and messaging (Scherr & Hammer, 2009; Russ, 2018) to characterize teachers' use of spin-ups as whole-class scaffolds to support groupwork. Framing and messaging are one dimension of teachers' behavior that impacts student-teacher interaction by communicating to students their roles in the learning process and notions about the content itself. This communication is not direct, but embedded in the routine moves of the teacher and interactional routines the students and teacher negotiate together (Kelly, 2020). Literature on framing and messaging does not attempt to make inferences about teachers' judgements or purposes for enacting instructional moves. Instead, the theoretical lens of framing and messaging recognizes the ways that meaning about "what is happening here?" are socially constructed within classroom interactions among the teacher and students.

Methods

Using a grounded approach (Corbin & Strauss, 2014), we analyzed video and audio recordings of one lesson from an AP Calculus AB teacher, Barbara, from the 2014-2015 academic year. Barbara taught in a racially diverse, high-performing, suburban school. In this school, teachers were beginning to consider access and representation of students who had historically not taken advanced mathematics classes, which Barbara discussed in reference to her AB Calculus students. These data come from a larger study (Dyer, 2016), which investigated 10 high school mathematics teachers aiming to become more attentive and responsive to student thinking in their teaching. The lesson video was captured with several cameras placed around the classroom, and audio recorders placed at the center of desks that were grouped together in the room, and included all five groups of students in the classroom. The content of the lesson was the use of integration to calculate volumes of solids of revolution. Specifically, the students were given a warm-up task, which they worked for the first 15 minutes of the lesson. Then, the students worked on a related task, which was given as "team practice," described in Table 1.

Table 1: Groupwork Tasks Used in Lesson

	Class Time	Task
Warm-up Task	~00:30-15:00	1. Make a sketch of the region bounded by $y=2x+4$, $y=4$, and $x=5$. 2. Rotate this region around the line, $y=4$. What shape have you formed? What is the formula you learned in Geometry to find its volume? 3. Use the formula from #2 to calculate the volume of this solid. 4. Use calculus to find this same volume.
Team Practice	~16:00-42:00	Find the volume for each solid of revolution described below: 1. Region created by y-axis, x-axis, $y=\sin(x)+1$ and $x=3\text{pi}/2$, revolved around x-axis (three more solids of revolution are given)

We first used *Datavyu* software to code the activity formats used in the lesson according to the codes: launch, content discussion, groupwork, and other for unstructured time. Portions of the lesson were coded as content discussion when the teacher addressed the class as a whole regarding content, for a duration longer than twenty seconds. From our analysis, a notion of spin-up emerged as we attempted to classify the teacher's interaction with the class as students worked in groups. We classified an instance of teacher intervention as a spin-up when she offered a supporting statement, question, or direction to the class as a whole, meant to sustain the

activity of students in groups. We then coded instances of spin-ups by marking the beginning of the spin-up. Through a process of open and axial coding (Corbin & Strauss, 2014) to analyze the content of the spin-ups, we developed definitions of six types of spin-ups. Finally, we began a preliminary analysis of messages embedded in the framing of each spin-up according to three dimensions: epistemic, social, and disciplinary framing. Throughout this process, we listened to the audio recordings of each group the teacher interacted with before and after each spin-up to better contextualize the spin-up, alongside the videos.

Results

We identified 12 instances of spin-ups in the calculus lesson that we analyzed. The time series in Figure 1 shows the occurrence of each spin-up as a blue asterisk overlayed on the varied types of activity formats used in the lesson. The official lesson ran for approximately 42 minutes of the video recording, and three different activity formats were used in the lesson: launches (l), content discussions (cd), and groupwork (g). Unstructured time at the end of the lesson was coded as other (o). The density and spacing of the spin-ups in the lesson provide more insight into how the teacher made use of them. Nine of the twelve spin-ups occurred in the first fifteen minutes of the lesson, when students worked on the warm-up task and were given in closer proximity the earlier in the lesson they occurred. Furthermore, the first six spin-ups occurred in very close proximity to each other, within a four-minute window, shown in portion of the time series magnified in Figure 1. Only three of the spin-ups were given in the portion of the lesson when students worked the team practice tasks. Additionally, four of the spin-ups led to content discussions, shown in green on the time series, which also became increasingly spread apart as the lesson progressed.

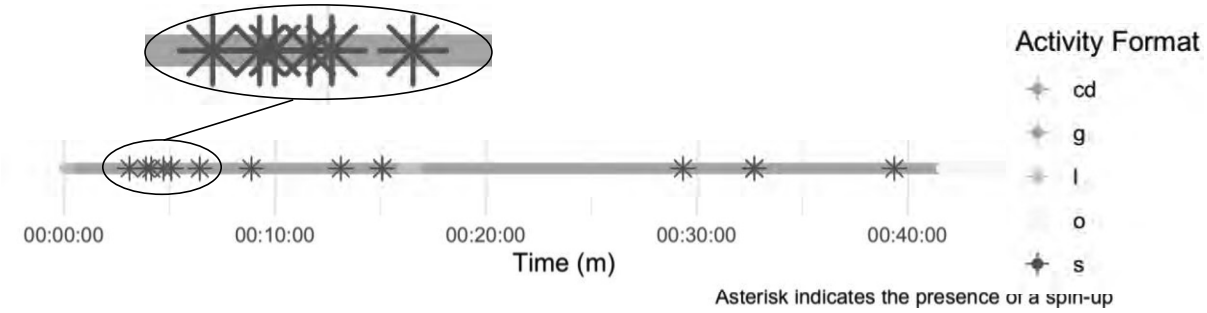

Figure 1: Time Series of Lesson's Activity Formats and Instances of Spin-ups

To better understand the messaging contained in the spin-ups, we first analyzed the content of each spin-up Barbara offered. We developed codes to classify the spin-ups according to their content and purpose and found six distinct purposes to the spin-ups, shown in Table 2. These purposes are: restating a question, referencing previous work, offering a method to check a solution, giving a directive, asking for a status check, and offering content information. We note that a single spin-up may be classified as multiple types, as it may contain multiple statements with distinct purposes given in the same talk turn of the teacher. The six distinct types of spin-ups center students, support students' group activity, and frame mathematics in strategic ways through the messages they contain. Analyzing the content and type of spin-up through a framing

lens revealed three categories of messages: (1) framing students as epistemic authorities, (2) framing learning as social, and (3) framing the discipline as coherent and cohesive.

Table 2: Six Types of Spin-Ups Identified in this Lesson

	Spin-Up Type	Definition	Example (Instance #)	Instances
1	Restate a Question	The teacher restates a question asked by a student	Restating a question that a student asked the teacher in his group: "I don't know, *is* the radius 2*x*+4?" (#1)	1, 2, 5
2	Reference Previous Work	The teacher references previous work as guidance	"Isn't that the one Megan asked us yesterday?" (#3)	3, 6
3	Offer Method to Check Solution	The teacher suggests a method for students to check their solution	"So [number] 4 is you get the integral…you should get an answer that matches the one you know from Geometry" (#7)	7, 8
4	Give Directive	The teacher directs students to do a specific step of the task	"Do me a favor, make a little 10-second sketch of the revolution…" (#4)	4, 7, 8, 12
5	Status Check	The teacher asks about or provides expectation of student progress through tasks	"What's the consensus on the radius?... So, make sure you have someone in your team can convince why the radius is 2*x*" (#6)	6, 9, 10
6	Offer Content Information	The teacher provides mathematical information	"What's 2x+4 measuring? The height to the axis, right? …The 2x+4 is this height" (#5)	5, 11

The messaging in spin-up types 1-4 frame students as owners of their mathematical activity, communicating to students that they are central to the knowledge-building process. Restating a question (type 1) to the whole class amplifies an individual student's thinking, and gives groups the chance to hear others' thoughts beyond those of their own group. Referencing previous work (type 2), offering a method to check a solution (type 3), and giving a directive (type 4) all serve to give students a path forward without directly giving content knowledge. Some spin-ups contained messages that framed learning as social. For instance, in Spin-up 6, Barbara asked students to make sure someone in their team could convince them why the radius was 2*x*. The message embedded in this spin-up is that students can and ought to rely on each other for knowledge building. Finally, some spin-ups framed the discipline of mathematics in a particular way. For instance, by referencing previous work, Barbara sent the message that the current content (volumes of solids) was directly related to other topics and tasks (area between curves), framing mathematics as cohesive and coherent.

Discussion

The findings of this study further characterize how teachers orchestrate group work and whole class activity. With the use of spin-ups, Barbara supported her class with various scaffolds to advance groups' activity while also signaling about students' roles in learning, supporting each other, and mathematics as a discipline to the class as a whole. Future work in this study will follow each groups' activity throughout the lesson, note instances in which a teacher scaffolds a group without using a spin-up (not speaking to whole class), the content and messaging of these scaffolds, and what precedes each intervention type for any discernable patterns. More broadly, future research into the messaging of spin-ups in mathematics classrooms may analyze connections between such messaging and larger discourses and ideologies, such as those researchers have identified in other settings (Louie, 2018; Louie et al., 2021; Philip et al., 2018).

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