

## SOCIAL NORMS CONDUCTIVE TO WOMEN'S LEARNING IN INQUIRY-ORIENTED ABSTRACT ALGEBRA

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*Gender-based inequities can arise within inquiry-oriented (IO) classes, affecting women's participation and achievement. Given that social norms can enable/constrain students' participation, it is pertinent for researchers to study social norms that are conducive to women's learning and how they can be fostered. In this paper, we explore social norms present in two IO abstract algebra classes with positive learning outcomes for women students. We found social norms related to working on tasks, giving contributions, and responding to others' contributions. We provide examples of these normative behaviors, discuss the instructors' roles in fostering these norms, and examine how these norms could promote gender-based equity in IO instruction.*

**Keywords:** Gender, Inclusive Education, Classroom Discourse, Post-Secondary Education

Prior research has shown that active learning approaches to instruction lead to improved student achievement (e.g., Freeman et al., 2014). However, Eddy and Hogan (2014) argued that any instructional intervention will affect different student groups in varying ways. Johnson et al. (in press) found men and women had differential learning outcomes in an inquiry-oriented (IO) setting; men experienced greater achievement gains than women in IO abstract algebra classes. This gap was not present in the non-IO classes that served as the comparison group for Johnson et al.'s study. In this study, we selected two divergent cases from the Johnson et al. data base. In these two classes, women students had positive learning outcomes. We analyzed the social norms in each class, identified the instructors' roles in fostering these norms, and hypothesized ways in which these social norms may be conducive to women's learning.

### Background

Given the interactive nature of Inquiry-Oriented Instruction (IOI), it is pertinent to consider how IOI settings align with aspects of equity. Gutiérrez (2002) outlined four dimensions of equity as access, achievement, identity, and power. These dimensions align with Cook et al.'s (2016) characteristics of inquiry-based classes, for access is given to students through inquiry pedagogies that encourage participation and peer involvement (Tang et al., 2017). Participation gives the opportunity to build knowledge, which can foster achievement and confidence in mathematics. Peer involvement may lead to a shift in a student's mathematical identity (Boaler & Greeno, 2000; Hassi & Laursen, 2015). There is also a shift of power from teachers to students in inquiry pedagogies. However, inequities may emerge with peer involvement. Group work may support privileged groups over marginalized groups by placing value on input given by students who are more likely to participate (Esmonde et al., 2009; Esmonde & Langer-Osuna, 2013). Smith et al. (2019) found evidence of instructors' gender bias, with men disproportionately contributing to class discussions and women disproportionately being asked to contribute in less sophisticated ways. Since women have been

marginalized in mathematics classes, we investigate the social norms present in mathematics classes that may be conducive to women's learning.

*Social norms* describe the general rules and expectations for the teacher and students' roles within any classroom. They "characterize regularities in communal or collective classroom activity and are considered to be jointly established by the teacher and student as members of the classroom community" (Cobb & Yackel, 1996, p. 178). Norms are a person's "beliefs about [his/her] own role, others' roles, and the general nature" of classroom activity (Cobb & Yackel, 1996, p. 177). Social norms within a classroom can support or constrain students' participation, which can potentially impact equity in students' participation and achievement. We posit that certain social norms may provide students with access and opportunities for mathematical identity development. We believe this warrants research on the social norms present in IOI classes and the role of instructors in fostering these norms. We address the following questions: What social norms were present in two IO abstract algebra classes that had positive achievement outcomes for women students? What is the instructor's role in fostering these social norms?

### Methods

We analyzed social norms present in two IO abstract algebra classes, taught by Dr. Carter and Dr. Ryan. Dr. Carter is a White man who taught at a large doctoral-granting institution in the Midwest US. Dr. Ryan is a White man who taught at a midsize masters-granting institution in the Northern US. Both instructors participated in a semester-long professional development focused on implementing IOI. Their women students had positive learning outcomes; their average scores on the Group Theory Content Assessment (Melhuish, 2015) were higher than the comparison sample of women. The same instructional unit involving the reinvention of definitions of isomorphism from the Inquiry Oriented Abstract Algebra curriculum (Larsen et al., 2016) was recorded for both instructors during weeks 4–6 in a 15-week semester.

We analyzed two 50-minute subsequent class periods for each instructor. We identified episodes of behavior that conveyed students' roles during class. We focused on how participants reacted to those behaviors. We wrote descriptions of these episodes, as well as memos (Maxwell, 2013) reflecting on how the behaviors in each episode seemed normative. We inferred a certain behavior was normative if it was common, classroom participants did not challenge one enacting that behavior, and/or class participants challenged a class participant when they did not comply with that behavior. These criteria were based on Clark et al.'s (2008) conditions for documenting the development of norms. We open coded these episodes (Miles et al., 2013), naming the norms present in these episodes. We also analyzed how the instructors fostered these class social norms.

### Results

#### Norms for Students Working on Tasks

**Working on new tasks individually.** Dr. Carter explicitly stated his expectation for students to work on tasks individually, saying phrases such as, "I want you to do this on your own" and "Paper. Pencil. Human. Solo." Students behaved this way for the rest of the class. Each time they started a new task later in the class period, they worked on it individually before they talked to other members of their groups, without being prompted to do so. The commonality of this behavior was evidence of this being a social norm in Dr. Carter's class. He fostered this social norm by setting expectations for students' behavior.

**Discussing tasks with group members.** After students in both classes worked on tasks individually for a few minutes, the students commonly started discussing the tasks with other group members, often without prompting. After some students began discussing the task, Dr. Ryan reinforced this behavior by telling the class to "convene in our groups and discuss what you've done so far and any

progress you've made." The entire class began to discuss their ideas within their groups. This behavior seemed normative, for once students had ideas from their work, they began talking. Dr. Ryan fostered this social norm by reinforcing his expectations for students' behavior, particularly when students did not yet comply with the expected behavior.

### **Norms for Students Providing Contributions**

**Sharing contributions.** Dr. Carter and Dr. Ryan fostered this norm of students sharing contributions by explicitly leveraging students' contributions to inform the lesson. For instance, Dr. Carter's student, Jessica, shared a conjecture regarding necessary conditions for the correspondence between the elements in  $D_6$  and elements in the group represented by the mystery Cayley table. Dr. Carter assigned a follow-up task to Jessica's conjecture, asking why a specific correspondence, which met the conditions Jessica specified, would not work for showing the mystery group was  $D_6$ . Dr. Carter said, "So Jessica, I am challenging your conjecture. I'm gonna put it up here [on the board] as well. It has merits! It has good merit." Dr. Carter reinforced his expectation that students should share their conjectures by giving the opportunity to share contributions, writing Jessica's conjecture on the board, assigning a follow-up task that leveraged her conjecture, and saying that her conjecture had "good merits."

**Explaining their reasoning.** Another social norm present in these classes involved students explaining their reasoning. Dr. Ryan demonstrated his expectation for this behavior by calling on a student, Matt, and telling him to "explain your reasoning, tell us about the mappings you found, how you found them." The instructor reinforced the social norm of explaining reasoning by stating his expectations for the student's response. Matt then complied with this social norm and was not challenged because he did not violate the norm. If students violated this social norm by giving contributions without explaining their reasoning, the instructors challenged them for doing so by asking questions. For instance, as Dr. Carter's class discussed a student's definition of isomorphic groups, which said " $a, b \in G. c, d \in H. a \cdot b = c * d$ ," Becky claimed, "I'm a smidge bothered by the equal sign...so I think that we need to define some kind of function that maps one to the other." Dr. Carter responded, "Wait, hold on, why are you a smidge bothered? I don't understand. What's wrong with the equal sign?" Dr. Carter fostered this norm of explaining reasoning by challenging students when they did not comply with it.

**Explaining difficulties they experienced.** Students were expected to share the difficulties they experienced with mathematical tasks. For example, a student, Mallory, volunteered to share what Dr. Carter called a "productive failure." Mallory shared her initial failed attempts for a homework problem. She explained how she got stuck on the problem, took a break from it, and later tried a new strategy. Dr. Carter asked, "your productivity in the failure is?" Mallory replied, "Well I learned about that strategy...I feel a little bit more resilient now 'cause I just learned to like try stuff... not be afraid to try new different things." Mallory's experience in sharing her productive failure could have been an instance in which she developed her identity as a mathematician. This showed her confidence in her problem-solving ability, despite her previous failed attempts. By having Mallory present her productive failure, Dr. Carter reinforced the idea that it is okay to fail because something productive might come from it, which fostered the norm.

### **Norms for Students Responding to Others' Contributions**

We identified social norms of responding to other students' contributions, giving productive feedback, and being non-judgmental. Dr. Carter explicitly stated his expectation for this behavior at the beginning of class, saying "remember that we are in a non-judgmental phase in our lives right now, so keep your comments very productive." To demonstrate these social norms, consider the following episode of Dr. Carter's class where each small group presented their definition of isomorphic groups on whiteboards, displayed at the front of the class.

- Dr. Carter: “ $a, b \in G, \phi(a \cdot b) = \phi(a * b)$ .” What is going on here?  
Madison: We would have to split up the phi. (This means  $\phi(a \cdot b) = \phi(a) * \phi(b)$ )  
Dr. Carter: This is another operation, right? [pointing to \*]...so G is defined as G and dot, right?...But I think there is something going on here as well. Right? There's this phi. Not sure what it is yet, but there's this kind of correspondence as well.  
Dr. Carter then directed the students' attention to another definition on the whiteboard.  
Dr. Carter: What's going on over here? “G is isomorphic to H if and only if there exists a homomorphism.”  
John: I think that it is relevant to mention the homomorphisms. I think to add to that, you have to say that there exists a homomorphism G to H and there also exists a homomorphism H to G.

**Responding to other's contributions.** In this episode, both students, Madison and John, responded to other students' definitions of isomorphic groups. This behavior was common throughout the class discussions. Dr. Carter gave students an opportunity to respond to a group's contributed definition by asking “what's going on over here?” This reinforced the social norm.

**Providing productive feedback to contributions.** Both students then responded by giving productive feedback to make the contributed definitions more precise. Dr. Carter fostered this norm by providing productive feedback, thereby modeling the behavior in his own response.

**Being non-judgmental of contributions.** These students responded in a non-judgmental way, by not commenting on the imprecision or the incompleteness of the contributed definitions; rather, they validated and elaborated on the other students' contributions. Dr. Carter fostered this norm of being non-judgmental of contributions by modeling that behavior in his responses.

### Discussion

We explored the social norms present in two IOI classes that had positive learning outcomes for women. We hypothesize these norms may be conducive to women's learning and promote the equity dimensions of access and identity (Gutiérrez, 2002). Working on a task individually gives access to the opportunity of engaging in meaningful mathematics tasks. Discussing tasks with group members, sharing contributions, explaining reasoning, and responding to others' contributions gives women opportunities to develop their mathematical identity as they present and evaluate each other's ideas (Hassi & Laursen, 2015). Having students explain the difficulties they experienced and normalizing productive failure can promote women's confidence. Norms of being non-judgmental and giving productive feedback to peers' contributions can promote a positive learning environment where students can contribute without fear of judgment. Although researchers have documented deficiencies in women's mathematical confidence (e.g., Lubienski & Ganley, 2017), these social norms can foster women's confidence and give opportunities for access and identity development, which can lead to achievement and power (Gutiérrez, 2002).

We aimed to explicate the instructor's role in fostering positive social norms. Instructors in our study fostered social norms by establishing expectations for students' behavior, modeling the expected behavior, challenging students when they do not comply with those expectations, and reinforcing those behaviors by showing they are valued. Our study contributes to research on social norms by further explicating the instructor's role in fostering norms. Instructors can use these strategies to foster positive social norms in their own classes.

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