PROFESSIONAL AND SOCIOMATHEMATICAL NORMS EXHIBITED BY PROSPECTIVE AND BEGINNING TEACHERS

Laura R. Van Zoest  Shari L. Stockero  Cynthia E. Taylor
Western Michigan Univ. Michigan Technological Univ. Univ. of Missouri

This study investigated the extent to which three sociomathematical and four professional norms intentionally fostered in an early mathematics methods course through the use of a video case curriculum re-emerged in a similar context later in the teacher education program and with program graduates. Comparisons of the behaviors exhibited by these two groups revealed that five of the norms were consistently durable over time with both groups, while the others were more variable. Details of this variation and ways in which all seven norms appeared to support continued teacher learning are examined.

Since the identification of sociomathematical norms as critical contributors to school mathematics learning (Yackel & Cobb, 1996), a growing body of research has investigated the subtle power of these norms to support the development of mathematical learners (e.g., Kazemi & Stipek, 2001). More recently, researchers have investigated the role of such norms in supporting teachers’ learning during professional development (e.g., Elliott et al., 2009; Grant, Lo, & Flowers, 2007).

Recognizing the potential that sociomathematical norms have for supporting teachers’ learning, Seago, Mumme, and Branca (2004) incorporated the development of such norms into the Learning and Teaching Linear Functions (LTLF) video case professional development curriculum. They also identified and included a set of professional norms that they felt would support teachers in learning from practice, and lead to what Franke, Carpenter, Fennema, Ansell, and Behrend (1998) called self-sustaining generative change—“changing in ways that provide a basis for continued growth and problem solving” (p. 67). The current study investigates the extent to which sociomathematical and professional norms intentionally fostered in an early mathematics methods course through the use of the LTLF materials re-emerge in a similar context, but with a different cohort: (1) at the end of the university teacher preparation program, and (2) during a professional development session for teachers who graduated from the program. Here we focus specifically on analyzing differences among the norms exhibited by participants at these two points in the teacher-learning trajectory—as prospective teachers and as beginning teachers.

THEORETICAL FRAMEWORK

We follow Yackel and Cobb (1996) by using sociomathematical norms to indicate standard patterns of behavior that are specific to mathematical activity, and Seago et al. (2004) by using the term professional norms to indicate standard patterns of behavior related to learning about teaching. Specifically, we focus on the professional

and sociomathematical norms embedded in the LTLF curriculum (Table 1). We see these norms as supporting teachers to: (1) improve their own mathematical understanding, (2) learn to view and analyze classroom practice in productive ways, (3) think about developing norms in mathematics classrooms with students, and (4) develop professional dispositions that support continued learning from practice.

Although the majority of work with sociomathematical norms has been in the context of learning what would be considered common content knowledge in Ball, Thames, and Phelps’ (2008) Domains of Mathematical Knowledge for Teaching, the methods course in which we do our work focuses on the development of specialized content knowledge. Even though the level of the activity is different, we have found that the sociomathematical norms themselves are similar. For example, both teacher- and student-learners could exhibit the sociomathematical norm of mathematical argumentation, but while the students’ focus would be on providing a mathematical argument for their solution, the teachers’ focus might also include determining whether a student’s justification is sufficient and mathematically adequate.

<table>
<thead>
<tr>
<th>Professional Norms</th>
<th>Sociomathematical Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Listening to and making sense of or building on others’ ideas ([listening])</td>
<td>• Naming, labeling, distinguishing, and comparing mathematical ideas ([naming and comparing])</td>
</tr>
<tr>
<td>• Adopting a tentative stance toward practice—wondering versus certainty ([tentative stance])</td>
<td>• Using mathematical explanations that consist of a mathematical argument, not simply a procedural description or summary ([mathematical argument])</td>
</tr>
<tr>
<td>• Backing up claims with evidence and providing reasoning ([evidence])</td>
<td>• Raising questions that are related to the mathematics and push on understanding of one another’s mathematical reasoning ([pushing understanding])</td>
</tr>
<tr>
<td>• Talking with respect yet engaging in critical analysis of teachers and students portrayed on the video ([critical yet respectful])</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Professional and sociomathematical norms in the LTLF curriculum.

Likewise, professional norms in the context of learning to teach mathematics are analogous to social norms in the context of learning mathematics. For example, the social norm of providing reasons for one’s mathematical statements is similar to the professional norm of backing up claims about teaching and learning with evidence from classroom artifacts.

We approach both the development of the program and our research from a situated perspective (e.g., Borko et al., 2000). That is, we generate learning situations that are similar to those in which we intend the learning to be used, and we study the way in which participants interact in these situations. We also follow Cobb, Stephan, McClain, and Gravemeijer (2001) in our interest in coordinating the social and psychological perspectives. For this study, this means that we focus on both individuals’ behaviors and statements relative to a norm in their written work and interview responses (psychological perspective), as well as the ways in which they interact within the group (social perspective), in order to determine whether a behavior is normative among the members of the group.
CONTEXT

The participants were 11 prospective mathematics teachers (PTs) enrolled in their final mathematics methods course at a U.S. university and 16 self-selected beginning mathematics teachers (BTs) who were graduates of the university with fewer than 4 years of teaching experience. Participants had all engaged in sustained reflection on teaching practice using the LTLF curriculum in their first mathematics methods course, from one semester to five years earlier.

In the first methods course, each LTLF video module began with the participants solving a mathematics problem on their own, after which they shared and discussed their solution strategies with the group. They then viewed video clips of school students sharing their thinking about the same tasks, and analyzed and discussed the student thinking and teacher actions seen in the video. Throughout this work, the instructors intentionally fostered the professional and sociomathematical norms embedded in the LTLF curriculum, without explicitly discussing them as norms. When participants shared their mathematical thinking, for example, they were pushed to provide a mathematical justification, rather than just report the procedure they had used. When analyzing the student thinking and teaching in the videos, participants were prompted to provide specific evidence for their analyses, which they usually did by citing line numbers from the video transcripts. Instructor observations and results of our earlier work indicate that these behaviors did, in fact, become normative.

As part of the study, the PTs and the BTs engaged in parallel activities that were similar to those they had participated in during the first methods course—the PTs during one 80-minute class session during their final mathematics methods course and the BTs during a one-day professional development meeting that was held at the university. Both groups used the same mathematical task, analyzed the same video, and completed the same written work; the only difference was that the PTs solved the mathematics problem as homework prior to the session, while the BTs completed all activities, including the mathematics, during the professional development session.

The first two authors facilitated both sessions. Both had taught the first methods course, but approximately half of each participant group had taken it from other instructors. The facilitators made a point of not introducing professional or sociomathematical norms during the sessions in order to see whether any of the norms established in the first methods course would spontaneously re-emerge when groups of PTs and BTs analyzed video cases of teaching with others who had the same methods course experience, but not necessarily with one another.

DATA COLLECTION AND ANALYSIS

The data for the study included participants’ written work and recordings of the group discussions. The written work included individual work on the mathematical task, predictions about how students might complete the task, and reflections on the video cases and on the session overall. This work was collected at the conclusion of each session. Both sessions were recorded using audio and video to document the
discussion around the participants’ mathematical thinking and the teaching and learning in the video case of practice. The recordings were transcribed for analysis.

In order to analyze the data for evidence of the seven professional and sociomathematical norms, transcripts of the mathematics and video discussions and all written work were coded independently by at least two researchers for examples and counterexamples of each norm, using qualitative data analysis software. The research group met throughout the coding process to verify that the coding was consistent and to resolve any differences first through refining the code definitions and then through discussions of the coding among the research group members.

One challenge of investigating norms is determining normative behavior from a snapshot of practice. For example, each participant may not have an opportunity to present a solution to a mathematical task, but if most who do include a mathematical argument, a reasonable inference is that this is a norm for the group. On the other hand, if few include a mathematical argument, it is safe to conclude that it is not a norm. To say that a behavior is a group norm does not mean that everyone engages in it all the time, but rather that it is the standard pattern of behavior to which the group aspires. Thus, another way to infer the presence of a norm is when a counter behavior is recognized and addressed by other group members. Instances that were coded as examples of the norms included those in which participants engaged in one of the target behaviors themselves, corrected others who did not exhibit the behavior, or indicated that the norm was important in their analyses of the videos.

After the coding was complete, the analysis involved developing multiple charts for each participant group that cross-referenced examples and counterexamples of each norm by participant and data source. These charts were used to determine the number of participants who engaged in each target behavior and the number of behaviors in which each participant engaged. This allowed the researchers to draw conclusions about whether each behavior was, in fact, normative for the group.

RESULTS AND DISCUSSION

Three of the 11 PTs exhibited all seven norms in the discussion and/or their written work with no counterexamples. One additional PT also exhibited all seven norms, but had two counterexamples. Four PTs exhibited six norms overall—two with no counterexamples and two with one counterexample—and 1 exhibited five norms. In sum, 9 of the 11 PTs (82%) exhibited five or more of the norms during their session.

In the BT group, 5 of the 16 exhibited all seven norms with no counterexamples. Another 5 BTs exhibited six norms, one with one counterexample, and 2 exhibited five norms; each of these also had a counterexample. Overall, 12 of the 16 BTs (75%) exhibited at least five of the seven norms during the meeting.

Comparing Normative Behavior

Table 2 gives the total number of participants—in each group and in the two groups combined—who showed evidence of participating in each norm, along with the
number who exhibited behavior counter to the norm. One can see that four of the behaviors of interest—listening, critical yet respectful, mathematical argument, and pushing understanding—were exhibited comparably by the two subgroups. The fact that they were exhibited by 70% or more of all participants and of each subgroup provides strong evidence that they were uniformly normative within both participant groups. The other three behaviors—tentative stance, evidence, and naming and comparing—differed between the subgroups and are discussed in more detail below.

Table 2: Total participants exhibiting each norm.

<table>
<thead>
<tr>
<th>Norm</th>
<th>PTs Exhibiting Norm</th>
<th>BTs Exhibiting Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Both T &amp; W</td>
</tr>
<tr>
<td>Listening</td>
<td>10 (91%)</td>
<td>7</td>
</tr>
<tr>
<td>Tentative stance</td>
<td>5 (45%)</td>
<td>0</td>
</tr>
<tr>
<td>Evidence</td>
<td>9 (82%)</td>
<td>4</td>
</tr>
<tr>
<td>Critical yet respectful</td>
<td>8/2C (73%)</td>
<td>3</td>
</tr>
<tr>
<td>Naming and comparing</td>
<td>11 (100%)</td>
<td>7</td>
</tr>
<tr>
<td>Mathematical argument</td>
<td>11/2C (100%)</td>
<td>9</td>
</tr>
<tr>
<td>Pushing understanding</td>
<td>9 (82%)</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: T refers to transcript; W refers to written work; #C refers to number of counterexamples

Tentative Stance

The percentage of participants (45% PTs, 69% BTs) who exhibited the professional norm of adopting a tentative stance towards practice-wondering versus certainty was substantially higher for the BTs, who were further removed from the methods course in which the norm was intentionally developed. Further data analysis suggests that the difference between the groups’ tentativeness may be due to the BTs’ classroom experience, particularly their experience working with students. Only 3 PTs (27%), as compared to 10 BTs (63%), were tentative about student-centered topics—all in the context of making sense of student thinking during the whole-group discussion. In contrast, BTs focused on making sense of student thinking in both their individual reflections and the whole-group discussion. The BTs also questioned whether there was evidence that all students in the class understood the mathematical task being discussed and engaged in wondering about issues related to student participation.

To illustrate the difference in tentative and non-tentative reflections of student thinking, consider the following responses to a written prompt that asked what participants noticed about two students’ thinking in the video. All of the PTs responded to this prompt with some degree of certainty. For example, PT6 wrote, “They had the slope figured out by their reasoning of the picture and found the intercept by fitting the line into their data. They didn’t have a conceptual reasoning based on the picture why you should subtract 4.” In contrast, the BTs tended to reflect more tentatively. For example, BT6 responded, “I think the girl’s confusion about the arm length of the first building is what prompted them to find another logical solution…I’m not sure they understood their final equation, only that it worked for each building.” We conjecture that this difference may be due to the BTs’
more extensive work with students—work in which they may have come to realize that making sense of students’ responses is not always a simple task.

The BTs’ focus on student participation also contributed to the differences in the tentative stance percentages. In the discussion, many BTs focused on issues such as the confidence students in the video displayed as they discussed and justified their different solutions, and on the number of student groups who participated. The BTs conjectured about factors that might lead to this type of participation, such as the role the teacher assumed in the classroom, classroom norms and expectations, and the way in which the teacher sequenced the student presentations and prompted students to compare their solutions. It appears that this focus was a direct result of the contrast between the type of student interactions they saw in the video and those that were typical of their own classrooms. We conjecture that, while both groups had learned about theories and ideas related to effective mathematics instruction, the PTs’ lack of experience in trying to put these ideas into practice made the events in the video seem unproblematic to them, so they did not become the focus of discussion. The BTs’ classroom experience, however, allowed them to notice the ways the interactions in the video had the potential to support student learning, and thus motivated them to consider what the teacher was doing to facilitate such interactions.

**Evidence**

The professional norm of backing up claims with evidence and providing reasoning occurred when participants referenced specific line numbers from the transcript or quoted the transcript verbatim (or nearly so) to support an argument they were forming. Sixty-three percent of the participants—82% of the PTs and 50% of the BTs—exhibited this norm. The difference of 32% made this norm the most variable between the two groups. A further breakdown of the results (Table 3) illuminates the differences. “General” represents instances where a participant made a general argument or claim and used evidence to back it up. For example, PT9 wrote that he noticed that “[the teacher] did not tell students, he asked students questions that focused them to specific aspects of the work (lines 32, 35, and 61)” [W]. He made a claim and cited specific line numbers as evidence to support a generalization about the teacher’s actions. “Specific” represents instances where a participant used evidence in a narrower way. For example, PT8 wrote, “I didn’t really like how he funneled the question on line 85. It was a yes or no question.” [W]. While grounded in the evidence, this statement focuses on commenting on a specific instance, rather than making a generalization and using the evidence to support the claim.

<table>
<thead>
<tr>
<th>Number of Instances</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
</tr>
<tr>
<td>PT</td>
<td>5 (24%)</td>
</tr>
<tr>
<td>BT</td>
<td>8 (42%)</td>
</tr>
</tbody>
</table>

Table 3: Participants exhibiting the use of evidence.

Looking at the total number of instances, the PTs were much more likely to invoke evidence in a narrow way (24% General; 76% Specific), while the BTs use was more...
balanced (42% General; 58% Specific). When general and specific uses of evidence are looked at by number of participants, this becomes even clearer. Where generalized claims were involved, roughly the same percentage of participants in each group used evidence (PT: 18% General, 18% Both; BT: 13%, 19%). The difference is in the participants who used evidence in specific ways or didn’t use it at all, with the percents being nearly reversed (PT: 45% Specific, 18% Neither; BT 19%, 50%). This suggests that the difference between the groups regarding the use of evidence may be due to a growing maturity on the part of the BTs and the PTs’ role as students, rather than a decay of the norm itself. That is, the PTs may have been more cognizant of providing evidence since they were still in a university setting and not as far removed from the context in which this more academically-oriented norm had been introduced, and thus did so more frequently in superficial ways. The fact that the BTs who provided evidence did so in more meaningful ways suggests that the more significant aspect of this sociomathematical norm endures over time.

**Naming and Comparing**

The sociomathematical norm of *naming, labeling, distinguishing, and comparing mathematical ideas* was exhibited by all 11 of the PTs (100%) and 13 out of 16 BTs (81%). The widespread participation in this behavior provided strong evidence that it was normative for both groups. To understand why the percentage of participants exhibiting the norm varied so widely between the groups, we looked at specific ways the behavior was exhibited. These included participants (1) comparing their own and other participants’ mathematical solutions, (2) comparing the solutions of students in the video, (3) comparing their own solution to that of a student, (4) noticing that students compared their solutions with one another, and (5) noticing ways that the teacher in the video pushed students to compare their solutions with one another.

An analysis of the number of participants who exhibited the norm in each of these ways revealed a pattern consistent with the overall participation pattern; the number of PTs was consistently greater than the number of BTs in each category, with a difference of no greater than two participants in any given case. For example, eight PTs and seven BTs compared the thinking of two students from the video, and seven PTs and five BTs noticed ways in which the teacher prompted students to compare their solutions. Thus, while normative in both groups, this seems to be a norm that was particularly strong within the context of the program.

**CONCLUSIONS**

The three sociomathematical norms that were introduced in the early methods course—*naming and comparing, mathematical argument, and pushing understanding*—seemed to be consistently durable across both the PTs and BTs. The four professional norms were exhibited to some extent by both groups, but with more variation. There was strong evidence for *listening* and moderate evidence for *critical yet respectful* being normative in both groups. The differences in the ways that participants exhibited the other two norms of *tentative stance* and *evidence*—ranging
from some evidence to strong evidence—suggest that the ways in which the BTs exhibited these norms supported them in learning from practice. The BTs’ tentative stance combined with their teaching experience to allow them to recognize the instance of practice in the video as a site for reflecting on ways in which they might improve their own practice. Their use of evidence to support generalizations about practice provides a means of connecting specific instances of practice with general theories about teaching and learning, and thus could support learning from practice.

This research supports the idea that intentionally developing sociomathematical and professional norms early in a teacher education program has the potential to contribute to self-sustaining generative change (Franke et al., 1998). This is particularly the case since the types of behaviors exhibited by the beginning teachers in this study do not automatically occur in teacher professional development. This research also suggests that establishing these norms in an early mathematics methods course may have long-term benefits, as it positions beginning teachers to make connections between their own teaching and what they learn in professional development focused on student thinking.

*This work was supported in part by U.S. National Science Foundation award ESI-0243558.*

**References**


