

**LEARNING TO
ANTICIPATE IN AN
ONLINE CLASS:
PERSPECTIVES OF AN
INSTRUCTOR AND A
MATHEMATICS
SPECIALIST CANDIDATE**

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ABSTRACT

This paper will highlight two perspectives, a course instructor and a mathematics specialist candidate working together in an online course, on the practice of anticipating how a learner will approach a task or assignment. The candidate shares her experiences in developing an understanding of what it means to anticipate student responses and implement mathematical practice in the classroom. She also shares how learning to anticipate has impacted her teaching. The instructor reflects on her experiences (or lack thereof) in anticipating how students would engage in the online environment. From the instructor and the candidate perspectives, learning to anticipate helped to develop a rich community of learners that allowed everyone to grow through their interactions and reflections on course content.

KEYWORDS

online learning, mathematics education, mathematics specialist, teacher education

A mathematics specialist candidate was considering asking her middle school students to utilize mathematical symbols and order of operations to derive the numbers 1–20 using only four 4s. Anticipating student responses prior to the activity, the candidate wrote, “I perceive students will have difficulty with solving an expression for 13, 17, 18, and 19.” The instructor responded, “Why? Can you give me a reason?” This simple interaction between an instructor and a mathematics specialist candidate in an online course sparked a relationship that would have a lasting impact on both of them. The candidate recognized the importance of anticipating student mathematical answers. The practice of anticipation provided the candidate with a means to integrate the content knowledge from her online mathematics courses with the pedagogical content knowledge in her mathematics leadership course. Learning to anticipate not only had an impact on the teaching practices of the candidate but also on the practices and perceptions of the instructor. For both individuals, the importance of learning to anticipate student responses in an online graduate course and a face-to-face middle school class supported the instructor and candidate in revising their pedagogical beliefs.

Literature Review

Smith and Stein (2011) provide five practices for supporting teachers in leading more purposeful mathematical discussions. In the first step, anticipation, the teacher solves the problem and reflects on possible student strategies and misconceptions. Monitoring, the second step, requires the teacher to observe student thinking. In the third step, selecting, the teacher must purposefully identify student solutions to highlight in the whole group discussion. Sequencing, the fourth step, asks the teacher to make “purposeful choices about the order in which students' work is shared, [so] teachers can maximize the chances that their mathematical goals for the discussion are achieved” (Stein et al., 2008, p. 329). In the last step, connecting, teachers must pose questions that support students in finding connections between the different student strategies to develop the key mathematical ideas for students.

Embedding the practices into a class can change the way a teacher develops their mathematical understandings to support the learning of their students and improves their ability to lead productive discussions (Stein et al., 2008). Implementing the step of anticipation into the lesson planning process provides teachers a means to recognize different concepts, procedures, and practices that students can use to solve a mathematical task. Before a lesson, reflection on student responses supports a teacher in being prepared to address student misconceptions and solutions (Schoenfield, 1998). Anticipating allows the teacher to develop questions to assess and advance students' thinking. The process of anticipation not only promotes student-centered mathematical discussions that move beyond “show and tell discussions” (Stein et al., 2008, p. 316), but it also provides a chance for teachers to reflect on mathematical content and pedagogical strategies needed for high-quality mathematics instruction.

In any classroom, understanding effective teaching practices is imperative for student success. Research on online learning has focused on the importance of building a sense of community that includes and supports learners as they interact with the content (Barry, 2019; Swan, 2003). The instructor has to be visible and engaged in the online learning community. The benefit of the teacher and the student interactions can have a positive impact on student learning (Serdyukov & Sisteck-Chandler, 2015). Similar to interactions in a face-to-face classroom, in an online class “the quantity and quality of teacher interaction with students are linked to student learning” (Swan, 2003, p.25). Online teachers must be present in the online learning

environment, but the question is how does an instructor anticipate the level of engagement and the types of questions that will arise during the online interaction?

Setting the Stage

The Class

Mathematics Education Leadership I is a course designed to develop effective school-based mathematics teachers and leaders. Course readings, discussions, and assignments support the development of mathematical content knowledge and mathematical content pedagogical knowledge. Course objectives mirror the effective teaching practices and guiding principles presented in *Principles to Actions: Ensuring Mathematical Success for All* (National Council of Teachers of Mathematics [NCTM], 2014). Careful attention is given to the designing, teaching, and evaluating lessons and assignments that supported inquiry-based learning in the classroom.

The Candidate

I (Melody) had been a fifth-grade teacher for thirteen years and a middle school mathematics teacher for four years. I considered myself to be a successful, knowledgeable teacher when I enrolled in an online professional development program. I had completed one mathematics course in the program and, from that experience, knew that my interactions with the Leadership I course instructors would take place through email, phone calls, and online course meetings. During each course session, I was busy taking notes and digesting the new information that I learned through our class discussions. Initially, I was afraid to ask questions in the online class out of my fear of not having the skill set to be successful in this program. If the class met face-to-face, I would ask the instructor, Kristina, any questions or request clarification at the end of a class meeting. At times, I felt isolated in the class due to the geographical distance between program participants and the online nature of the program.

The Instructor

I (Kristina) had been a K–8 mathematics teacher and university instructor for over twenty years before teaching Leadership I. I thought of myself as a knowledgeable instructor, but I had concerns about teaching an online class on pedagogy when most of my prior work as an instructor had focused on mathematical content knowledge in a face-to-face setting. I had completed variations of the Leadership I course assignments when I completed a similar professional development program a few years ago. Through the process of anticipating the questions and misconceptions that could arise for candidates, I reflected on my own prior face-to-face experiences.

The Assignments

The Task-Based Assignment

One task-based assignment in the course began with each candidate selecting a cognitively demanding task to implement in a K–8 classroom. The purpose of the assignment was to help candidates in their development of listening, observing, and questioning skills. The

assignment consisted of two components. In the first component, candidates addressed the goals for the task, the purpose of the task, and the implementation of Smith and Stein's (2011) five practices for orchestrating a productive mathematical discussion. Implementing the five practices in the development stage enabled the candidates to make meaningful connections between their mathematical knowledge and pedagogical knowledge to reflect on anticipated student mathematical ideas. The second component of the assignment was for candidates to write an analysis of the implementation of the task including providing a description of the mathematical thinking of several students as they worked through the task, the future instructional needs of the class, and a personal reflection on the entire process. Candidates received feedback on the first component before completing the second component of the assignment. This assignment afforded candidates the opportunity to reflect on their students' mathematical thought process before, during, and after the task.

The Candidate

I had questions before the assignment even began. This was my first time doing an assignment like this, and I needed support. I reached out to other students, but they were not always able to help me. After feedback from other students and a conversation with Kristina, I chose the task "The Four 4s" (see youcubed.org). The task required my students to utilize mathematical symbols and order of operations to derive the numbers 1–20 using only four 4s. As part of the assignment, I anticipated student solutions. This was the first time I had chosen such an open-ended task to implement in my classroom, and I struggled to think like a middle school student. I had a (one) method for using fours to come up with each of the numbers 1–20 but had difficulty thinking of others.

For the first component of the assignment, I stated that certain solutions would be a challenge for students because they were challenging for me. In her feedback to me, Kristina asked me why I thought the students might struggle with these solutions. I had to admit that the task was hard for me. When I implemented the lesson in my classroom, my students did not have difficulty with the same numbers that I did. This experience helped me to reflect on how I could anticipate student solutions and the approaches my students would utilize to complete the task. I had gone through the process of anticipating as part of the assignment, but I had not anticipated as thoroughly as I should have. For example, I had not thought through the possible misconceptions about the order of operations or misuse of grouping symbols. Connecting the learning experiences in the mathematics content course with what I was learning in the leadership course was important if I was to become a mathematics specialist. I needed to think about how there was more than one way to solve a problem. I had to challenge myself before I could challenge my students.

The Instructor

In the first component of assignment, candidates addressed three questions about the learning goals, the task description, and anticipated student strategies for the task they had chosen. The candidates uploaded their chosen task and question responses to a discussion thread that was used for providing feedback to each other. Melody initially picked a task on integer operations. Her classmates suggested reflecting on the open-ended nature of the task or developing context for the problems she had chosen. I agreed with the suggestions but also

noticed that in her response to the question about anticipated student strategies she had provided some general misconceptions instead of possible solutions.

Melody and I communicated several times about her concerns and questions about the initial task assignment. In our discussions, Melody shared that the task "Four 4s" was more open-ended and provided multiple entry points for her students. As I graded her assignment, I read her statement about several of the numbers in the 1–20 range being hard for her represent with only 4s and her conclusion that they would be hard for her students. I asked Melody about this. My question led to a conversation about what it meant to anticipate in a mathematics lesson. For me, I had not thought that anticipation would be an issue within the assignment; I assumed that her prior work in her previous mathematics content course had given her a foundation for exploring strategies and misconceptions to support her in learning to anticipate. Reflecting, I believe my prior experience in teaching mathematics and my lack of experience teaching a mathematics pedagogy course led to my inability to anticipate these types of issues.

The Lesson Planning Project

The Lesson Planning Project in Leadership I required candidates to revise and refine a lesson plan for their K–8 class. Candidates used their prior knowledge from course discussions and the task-based assignment to plan, teach, and analyze a student-centered mathematics lesson. Similar to the task assignment, this project was broken into two components. First, a current lesson plan or school division lesson plan had to be revised using backward design and the Smith and Stein (2011) five practices. After the lesson was completed, the second component of the assignment was for candidates to analyze student work and develop an instructional plan to meet student needs.

The Candidate

This project stood out to me because of its use of backward design. I had written many types of lesson plans, but I struggled to anticipate what the instructors wanted for this specific type of lesson plan. Connecting the mathematics content standards to students' prior knowledge and to their post-lesson knowledge to rewrite a lesson plan was a new experience for me. My lessons tended to focus on the mathematics content my students needed to understand, with little consideration about what they needed to know after they left my classroom. This was a new form of anticipation that I needed to incorporate in my teaching practice. I had to anticipate where my students had been, where they needed to be, and how to help them bridge any gaps to aid their mathematical understanding. I was just beginning to learn to anticipate my students' responses, but this added a new twist.

I choose to do a lesson on order of operations and mathematical properties. I remember the lesson plan template said, "Let go!" But I was not ready to let go. I was working on handing over more responsibility to my students, learning to anticipate their strategies, and then I needed to let go so they could think about mathematics. This was all new for me. I knew I needed to anticipate strategies and misconceptions, but I would never have all the possible solutions. I knew I needed to anticipate their strategies to guide their thinking. I knew I could do this, but I needed support.

I contacted Kristina. I asked her: What does "understand" mean in backward design? In the assignment, it said "understand," but are these the "big ideas?" We would communicate

when I needed support. I think Kristina was learning to know when I needed clarity or just a probing question to help me reflect on what I was thinking. Sometimes it would just take a simple question of “what would you do if this happened?” or “how would you do this?” Through our communication, I realized that I could do the assignment. In my reflection on the lesson plan project, I shared how I had been narrowly focused on the skills at hand and had never thought about how my students would solve a problem. In our communication, I realized that I did know where my students would make mistakes from my prior experiences with them and with other students and I could be prepared to address them. As a teacher, when I can anticipate a student's mistakes, I can have strategies prepared to address my student's needs.

The Instructor

In anticipation of the lesson plan project, the candidates worked in small groups on the steps of backward design planning. The instructors moved among the groups (in online breakout rooms) and supported the candidates as they worked. Again, I felt that the students were prepared for the assignment. I believed the assignment was written clearly and prior activities in the course had prepared the candidates to successfully complete the assignment. It was not long before I heard from Melody about her struggles in thinking about the “big ideas” and the meaning of “understand” in backwards design (Wiggins, 2005). As I talked with Melody, it appeared that the problem was not with the assignment itself but was related to her ability to communicate her thinking. Our conversations centered on what a concept meant for her and how it could be transferred to her classroom.

I was not anticipating her questions, but what I was beginning to understand was that it was not about my helping Melody directly. Instead, she needed me to ask a probing question to support her in her understanding. Melody was learning to make sense of the pedagogical knowledge that she was gaining. Melody shared with me that she was allowing her students to take more chances in the classroom, and she was taking more chances as well. I was beginning to see a change in her, but at the same time, I was seeing a change in how I anticipated Melody's needs. My concerns about teaching an online class made me unsure about how to anticipate and address student needs. Melody's needs were no different than any other student learning to make sense of new material, and what she needed was a place to feel comfortable asking questions. I needed to pose questions that allowed her to reflect on her thinking.

Conclusion: Learning to Anticipate Together

We each used the idea of learning to anticipate in different ways to inform our practice in our respective classrooms. Our takeaways from this experience are presented below.

The Candidate

A big takeaway from the Leadership I course was that I can prepare for student answers. I will never have all the possible solutions, but that is alright. Mathematical learning is not about the correct answer but is instead about guiding student thinking. Schoenfield (1998) stated that “having a deeper understanding of teaching should have real payoffs in the long run” (p. 92). I have learned the importance of building strategies and filling my student's mathematical “tool-box.” I need to anticipate how students could solve a problem and what misconceptions they

might have as I guide their instruction. In my final written reflection during the course, I think I said it best:

Anticipating was new for me. I had never really thought about how students might solve a problem. I would work the problems and I knew what the answer was, but here was this new concept of analyzing what I thought they might do. I always chose a student with the right answer to go up to the board and share. I didn't look for different ways to solve the problem. If you didn't solve it the same way as me, then it wasn't correct. You had to do it the ONE and ONLY way. I sometimes wish I could go back and apologize to those early classes. (M. O'Quinn, personal communication)

Learning to anticipate allowed me to connect the ideas from my mathematical content classes with the pedagogical ideas in the leadership courses. I now share the idea of anticipating students' work with others in my school building to help them see the importance of this step before teaching.

The Instructor

Learning to anticipate in an online class helped me to recognize that teaching in an online setting does not mean I have to be a different teacher. Instead, the mode that I use to communicate with my students needed to change. Just like in a face-to-face class, I cannot always anticipate all of the misconceptions that may arise, but what I can do is ask questions that make the student reflect on what they know and where they want to go. This is also true in a mathematics course or a mathematics education (leadership) course. Prior learning experiences had an impact on how I anticipated what took place during the class. I needed to remember that my experiences in any classroom are not the same as others. I need to take time to reflect on how others may interpret assignments based on their own classroom experiences to improve my teaching (Ball & Bass, 2003). Focusing on the interaction between my prior experiences, beliefs, and knowledge when anticipating will support my learning and the learning of my students (Schoenfield, 1998). Recognizing that this does not change in an online learning environment is important.

Learning Together

Together, the instructor and student became learners in this online class. It was a new setting for both of us, but in learning to anticipate in our respective classrooms, we formed a community of inquiry. This community allowed both of us to reflect on our teaching practices and beliefs. Swan (2003) described the importance of engaging with the content and with each other in an online learning environment. Instructors cannot "give a sense of community to learners" (Conrad, 2003, p.17). Instead, the sense has to grow out of members being present and active in the community.

Through our interactions during the Leadership I course, we both learned the importance of anticipating student strategies and misconceptions. The true mathematical and pedagogical learning did not emerge from the correct answers but developed through being reflective as part of the learning experiences that took place. Our interactions in the online learning environment were high quality (Swan, 2003). These interactions supported both of us as we worked to develop deep connections between content and pedagogy (Ball & Bass, 2000).

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