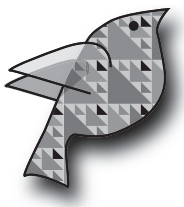

CHAPTER 1

All Students Are Motivated: Why It Matters to Understand the Reasons Students Do What They Do

This chapter begins with a story about a middle school student named Grace. Her story illustrates that students are neither motivated nor unmotivated; they are both. Under certain conditions, a student may behave one way, but she may behave differently in another situation. A student's engagement can be seen to be a function of the classroom organization and social setting as much as her own beliefs about her abilities and about mathematics.

After Grace's story, we will discuss the purposes and goals of this book. We begin each chapter in this book similarly to this chapter – with a story that illustrates either one of six principles of students' motivation or one of five research-based categories of teaching practices that can motivate students. Through Grace's story, we explore facets of three of the six principles of students' motivation: ***Motivation is adaptive***, ***motivation is social, and success matters***. *We examine Grace's story through these principles to illustrate how the principles can be used as lenses to think about students' motivation, and we entertain instructional dilemmas present in Grace's story to think about implications for teaching practice.*

A Typical Day in Grace's Mathematics Class

(Adapted from the Master's Thesis of Kateryna Ellis)

Today in third-period prealgebra, Grace wasn't really anxious, but she wasn't excited to be there, either. If you talked to her and asked her to describe herself as a mathematics learner, she would say that she was fourteen years old, outgoing, willing to try hard or challenging math problems, and liked to explain her answers. Grace also would say that she liked to work with numbers and liked to learn more about math. When she was most open and honest, she would tell you that solving a

difficult math problem not only helped her learn, but it helped her show other people that she was smart, which mattered to her. She would share that she would always try every problem on her math homework and would offer to participate during discussions in math class. However, she also would acknowledge that she would get in a rush sometimes. She was sometimes inattentive when reading problems, and sometimes this carelessness led her to solve problems incorrectly. Mr. Lawson, her mathematics teacher, never admonished her for being incorrect, but sometimes she was embarrassed when she was asked to explain her reasoning when she was wrong.

Mr. Lawson thought that Grace was quite smart. She frequently showed sophisticated methods when solving problems. She talked about how she planned to go to college, and these future goals seemed to motivate her to try to be successful in mathematics class. Grace's motivation showed especially when the material was of great interest to her or when she was learning something she felt strongly about, like the environment. Mr. Lawson noted that if he could get Grace curious about something, she would put out effort and work hard to learn.

Grace's eighth-grade prealgebra class consisted of students in an accelerated track, fairly evenly divided between boys and girls. Earlier in the year, Mr. Lawson had established clear norms for participation; students appeared to understand that anyone could be called on to justify any answer at any time during the period. Mr. Lawson did not give students a lot of time to work in their small groups, and he encouraged class members to help one another. There was no penalty for not understanding—if you could not get a handle on the problem, the teacher would stop by and give you some assistance. The students could be seen gazing around the room, writing, or looking at the book in front of them. Some students talked to one another, some called out to the teacher, and some sat silently at their tables waiting for someone to give them the answer.

Although the atmosphere within tables was of cooperation, the feeling among tables was definitely of competition. Students would rush to be the first to solve any given problem and loudly proclaim to be "the smartest kids in the class!" This need for social recognition was a hallmark of this high-ability class. Students believed that being in an accelerated class separated them from the other students in the school, and they tried to find ways to win recognition both from their teacher and their peers.

Grace usually sat at a table with Nacho, Adam, and Janey. On this particular afternoon, Grace came into class as she usually did, talking with Nadia and Jenn. She split from her two friends to join Nacho and Adam at their table. Janey arrived just before the bell rang, puffing because she had to run all the way across campus from the gym.

"Jeez, Janey, you are sweating like a pig!" Adam commented.

"Oh you love it!" said Janey, putting Adam in a sweaty headlock. "Weee! Weee!"

"Ahem," coughed Mr. Lawson. "I have heard that pigs are quite intelligent. It doesn't seem as if you are of that family, given that you are on the verge of detention."

The group eyed each other, laughing, but calmed down and tried to pay attention. Mr. Lawson continued, "I think I am going to have to split you up. Janey and Grace, come over here and sit with Monica and Marisol. Adam, you and Nacho sit with Carlos and Terrell. Okay? Here we go." He proceeded to hand out a worksheet with the following problem.

> A group of students want to share a cake shaped like a cube. (This is a mathematical cake: It is frosted on all six sides). They want to cut it into portions of 1-unit cubes. Each student receives one small portion. Being smart students, they notice rather quickly that the number of people who have no sides frosted is *exactly* 8 times the number of people who have pieces with three sides frosted. How many students got a piece of cake?

Each of the girls in her group, including Grace, first tried to solve the problem separately. They knew that their teacher expected them to try the problem on their own before discussing the problem with their peers. Individually, the girls took notes and wrote down their thoughts. After they each made some progress on the problem, Grace and her new tablemates shared their ideas with each other in quiet conversations.

"I drew a picture of the cube. I saw that the 8 corners had 3 sides frosted, so the total number of unfrosted pieces is 8 times 8 equals 64. From my picture, the middle cube has to have 64 little pieces, so I thought what times itself 3 times is 64?" Marisol offered. "So that has to be 4 times 4 times 4. So I drew in 4 by 4 in my picture. Then I saw it had to be two more on each side so the whole cube had to be 6 by 6 by 6 equals 216 cubes."

Grace said that she did a similar drawing (see fig. 1.1) but then said, "I saw the 4 by 4 by 4, but then I saw two sides which were 6 by 6, and another two sides that were 6 by 4. So 4 times 4 times 4 equals 64, plus 2 times 36 equals 72, plus four 24s equals 96. 64 plus 72 plus 96 equals 216."

"No it doesn't! That equals 232."

"You can't both be right if your answers are different," broke in Mr. Lawson. "Can you prove your answer?"

Argument ensued, with Grace defending her point and Marisol countering. Eventually they discovered a small mistake in Grace's counting. The surface of the cube had to have 2 sides of 6 by 6, 2 sides of 6 by 4, and 2 sides of 4 by 4; otherwise some of the cubes were double-counted.

All three girls participated in solving the problem and had been involved in active teamwork discussions. When they worked on these problems, the girls first used their own individual strategies and solutions to find the answer. Only then did the group look over the proposed strategies and choose the correct answer. This practice encouraged the girls to discuss the answers that they had found and the methods by which they generated them. These conversations and discussions

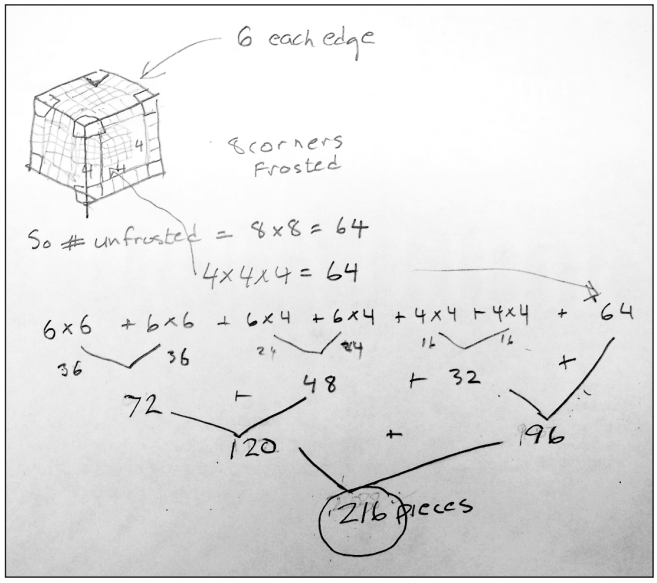

Fig. 1.1. Grace's drawing

were expected to increase the likelihood that girls would detect and correct one another's errors. Once errors were detected, students made attempts to remediate those errors for themselves, with a *little* prodding by the teacher. This group of girls showed a strong, positive dynamic among themselves in cooperative learning and understanding mathematics.

During the whole-class discussion after group work, Mr. Lawson asked Grace to explain her reasoning. She gave her answer and explained the steps she used to solve it. She spoke in a clear voice that expressed confidence in her reasoning. Grace's choice of strategy and her solution were logical, building on her understanding of volume and surface area.

Following this portion of the lesson, Mr. Lawson moved Grace from the homogeneous group of girls to a newly formed, heterogeneous group, because he hoped that Grace's enthusiasm would catch on with the members of her new group to involve themselves and discuss their thinking with one another more thoroughly. This class, like many middle and high school classes, had a variety of behavior issues related to personality clashes, friendship groups, and random mood swings among its members. Mr. Lawson often switched membership in groups, attempting to obtain better overall classroom behavior. But Mr. Lawson did not share that rationale with Grace. She was the only girl in her new group, mixed with three boys. Grace was not excited about the change in the seating arrangement. She walked slowly from her desk to the new group and made a couple of comments to her earlier group of girls and the teacher that she would prefer to stay at her desk. Once new mathematics tasks were presented to the class, Grace's behavior changed dramatically, as if she perceived the move as a punishment. Grace seemed to lose her interest in the

mathematics problem. In her new group, students did not interact with one another and did not participate in an open discussion. Nevertheless, each of them did write some examples in their notebooks. When some of the students in the group did not understand a given question, they did not try to ask their teammates for help. They did not share their thinking; they simply tried to match their answers to the correct ones. During the rest of the class period, Grace sat quietly behind her desk and withdrew herself from participation. Rather than positively influencing the quality of participation in her new group, she adopted their approach of keeping to themselves. Grace twice tried to interact with her earlier group of girls instead, but the distance between tables made it impossible for her to do so effectively. As soon as the bell chimed to signal the end of the class period, Grace jumped and rushed toward her original group, where the girls were discussing the whole "relocation" deal.

Principles of Students' Motivation in Mathematics Classrooms

Teaching mathematics is a wonderful job, but it is a tough job. Children come to us with a variety of abilities and interests, reflecting a myriad of cultures and values. These individual characteristics are so varied that no two children are exactly alike, so much so that the strategies we devise to support one student often fail when applied to another.

From your time as a student, perhaps you can remember a day like the one Grace experienced, one where you have conflicting emotions, conflicting goals, definite opinions about the role of mathematics in your life, and definite opinions about your role in the mathematics class. Sometimes life seemed to conspire to make you grumpy, even in a class where you had friends, where the teacher assigned challenging problems and was careful to listen and support your learning.

Of course the goals, abilities, and opinions of teachers and students need to work together somehow for a productive learning environment to exist. This book addresses this issue. We are intent on helping teachers reflect on the goals they have for instruction, matching them with the knowledge, beliefs, aspirations, and emotional needs students bring to the classroom. We then make instructional decisions that increase the probability that the student will buy into the argument that engaging in mathematics is *important*, *useful*, *interesting*, *safe*, and *socially productive* in a personal sense. In other words, we believe that teachers can begin to change their practice so that it builds students' mathematical interest, self-interest, and self-confidence as an integral part of building their mathematical knowledge and skills.

Throughout this book, you will meet mathematics teachers and mathematics learners like Grace with her conflicting motivations, in stories. We believe that stories are an important tool for professional learning in that they present realistic people, in all their complexity, trying to do what is best, what is expedient, or what will help

them just get through a situation with their self-confidence intact. Stories show how a person's behavior reflects both their internal beliefs and the environment within which they must negotiate life's presses. Time plays a special role, helping us think strategically about how to affect students' motivation, because events that appear earlier in a story relate causally to events that appear later. Mr. Lawson's actions, along with those of Janey, Marisol, and the other classmates, together affected the decisions Grace made to engage in a rather substantial mathematical task on the one hand, and to disengage on the other. Grace's decisions, therefore, can be seen as much a function of the classroom organization and social setting as of her own beliefs about her abilities and the role of mathematics. Through these stories, we can illustrate pivotal principles that reflect the best research on motivation as they play out in real classrooms with real teachers and real students.

Each chapter in this book will begin with such a story. After each story, we will discuss the salient features of motivation to learn mathematics through six essential principles. These six principles are general, drawn from the wide range of research on students' motivation, self-regulation, social behavior, and learning, and we can thus adapt them to a wide range of academic subject matter. But research also shows that mathematics is a special case. The social benefits and stigma of being "good" or "poor" in mathematics, the role of success and failure, and the impact of societal attitudes and personal beliefs about the subject's importance are more pronounced for mathematics. The resulting impact on future engagement in mathematics courses and mathematics-related occupations is therefore more dire than that of other subjects. These principles, then, make up what we know affects students' feelings, engagement patterns, and long-term valuation of mathematics with reasonable certainty.

Briefly, the five principles of motivation to learn mathematics, and the chapters in this book to which they relate, are the following:

1. **Motivation is learned (chapter 2)**. No inherent reason exists for mathematics to be considered any more difficult, confusing, or okay to perform poorly in than any other school subject. The fact that mathematics in general is viewed this way is a function of the learning environment where students grow up—the classroom, school, and home environments and the larger culture within which these institutions exist.
2. **Motivation is adaptive (chapter 3)**. If, at its most basic level, we can define motivation as the reasons people have for behaving a certain way in a certain situation, then we can see that children are always trying to adapt meaningfully to the features of the environment in which they find themselves. Even maladaptive behaviors—such as not doing homework—can be useful to help us design productive learning environments, if we ask *why* the student chose to engage in the maladaptive behavior and to what personal goals this behavior appealed.