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Introduction: Teaching in the Face of Disengagement

Our methods for teaching K-12 mathematics have changed considerably over the last hundred years, and yet, in some ways, the experience of studying mathematics has not changed much at all. Ideally, every learner would come to class excited about mathematics, ready to dive into rich and fulfilling concepts, but the reality is that some children are disengaged with mathematics and with school in general.

Some of this comes from a child's home experiences, where they may have heard a parent say, "I'm not a math person." A child may not understand why mathematics is important to their future and may not have learned to see the beauty in geometric patterns and algebraic relationships.

There is no single panacea. Disengagement cannot be eliminated through a single brilliant lecture. Educational games, while sometimes more engaging than traditional approaches, walk a fine line between engaging students and appearing to be a form of "chocolate-covered broccoli"—an unappealing but "good for you" lesson wrapped in something fun to cover up the taste. When done poorly, such an approach can actually encourage the idea that mathematics is unimportant and unappealing.

Teaching in the face of disengagement is hard. Fortunately, learning scientists and education researchers have discovered quite a bit about engagement and disengagement, particularly in recent years.

One important lesson is that not all disengagement is created equal. Different forms of disengagement may stem from the same root causes (although even that is not entirely clear!), but there is increasing evidence that the emotions students experience and the disengaged behaviors they display are associated with very different outcomes.

The Causes (and Benefits) of Off-Task Behavior

Off-task behavior is a form of disengagement, but it is not necessarily always bad. It is common for a student to stop working on mathematics and turn to his or her neighbor to discuss some subject of mutual interest (for my 8 year old daughter, that topic would be dinosaurs. Your students may differ). Teachers put a lot of energy into stopping off-task behavior. What's surprising, though, is that off-task behavior doesn't matter as much as many people think. Clearly, it's not good to spend an entire class period off-task, but students also occasionally need short breaks.

There have been hundreds of studies on off-task behavior and learning, and a clear consensus is emerging: In traditional classrooms, where students work alone, off-task behavior is associated with mildly poorer learning outcomes. In classrooms where students work collaboratively, there appears to be no relationship between off-task behavior and learning. The same pattern (no relationship between off-task behavior and learning) is seen in students using computer software to learn in class.

Perhaps even more importantly, personalized learning systems change classroom culture. As first noted in Janet Schofield's work (but repeatedly replicated over the years, including by my research group), teachers using learning software must switch from lecturing to working one-on-one with students. This is more engaging to students, and it's better for their learning, too.

Even better results can be obtained when students use learning software that explicitly considers and empowers the teacher. When teachers get analytics reports on student performance and success, they can use this information in what Neal Miller and his colleagues term proactive remediation. In other words, when a teacher determines that a student is struggling, he or she can intervene before the student gives up and becomes bored.

Teachers can also support students who are becoming bored and disengaged in other fashions. The evidence that boredom may be disrupted by off-task behavior presents an opportunity that educators can leverage. While it may not be feasible or even desirable to encourage students to go off-task, it may be possible to re-direct students to other learning activities in order to re-engage them. If many members of a class are becoming bored, a new class activity can be chosen. If only a small number of students are becoming bored, they can be redirected to different activities. This is particularly easy to achieve in classes using personalized learning software, where the remainder of the class can continue to make progress within the software.

Redirection as an intervention not only addresses boredom, it is directly linked to improved learning. Shimin Kai and Mia Almeda researched the differences between middle school students who persist productively in learning mathematics versus students who persist but do not learn successfully. They found that one of the biggest factors separating these two groups of students was whether their teacher assigned them to work on multiple topics or on a single topic until they mastered it. Switching between topics made it much more likely that the student's persistence would lead to success.

Addressing students who are gaming the system can be done in many ways. Perhaps the best approach was conceived by Ivon Arroyo and her colleagues who found that explaining to students why gaming the system leads to poorer learning outcomes reduces how often they game the system and improves their learning. Another approach, which I'm embarrassed to say that I studied as a graduate student a dozen years ago, is to give students more mathematics problems to complete if they gamed. You would then explain that they would have to keep completing problems until they stopped gaming. This reduced gaming and improved learning… but students hated it. In general, solutions that substitute one form of negative emotion for another type of negative emotion are probably not desirable. Hopefully, I have learned a few things since then.

Addressing carelessness has been less thoroughly studied in itself. However, as mentioned earlier, carelessness is associated with the broader concepts of conscientiousness and self-discipline. Although conscientiousness has often been treated as a stable, long-term personality trait, other work argues that people (including young children) can learn self-discipline and how to behave in a more conscientious fashion.

Adele Diamond and her colleagues find evidence that curricula that teach students self-disciplined behaviors can lead to better outcomes for students, even as early as in preschool. (Diamond et al. 2007). Darshanand Ramdass and Barry Zimmerman find that teachers can help students learn self-discipline in the context of homework activities by having students log their homework activities and then reviewing students' homework habits with them. (Ramdass, D., & Zimmerman, B. J. 2011).

A fuller review of some of the approaches for teaching self-discipline and self-control strategies to children can be found in Angela Duckworth and Stephanie Carlson's article "*Self-regulation and School Success.*" (Duckworth, A. L., & Carlson, S. M. 2013). One common finding across this research is that relatively simple interventions, such as telling students to check their work, are less effective than more comprehensive approaches where the student is guided by the teacher through more complex practices of understanding and learning to regulate their behaviors.

Summary

In this article, I have reviewed some of the recent scientific findings on engagement and learning in the classroom. I discuss how both emotional engagement and behavioral engagement are associated with diminished learning and poorer student outcomes. However, not all disengagement is equal in its impact. Gaming the system, carelessness, and boredom have substantially stronger relationships with student outcomes than off-task behavior, for example. Fortunately, disengagement can be addressed. Although considerable research is still needed on how to best support all students in surpassing disengagement in mathematics, several approaches have been successful at re-engaging students and helping them learn the self-discipline necessary to avoid disengagement and succeed at learning.

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