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Education Notes bring mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, issues, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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One of the greatest and controllable influences on math success is math anxiety – a field of study which surfaced over 50 years ago when researchers identified individuals who were "emotionally disturbed in the presence of mathematics" (Dreger & Aiken, 1967, p. 344). Researchers in the field, primarily with psychology or education backgrounds determined that:

1. Math anxiety affects math performance: the greater the anxiety, the lower the score in the math-related course, leading to greater math anxiety and then an even lower score (Hembree, 1990; Ma, 1999; Namkung et al., 2019, Sonnert et al., 2020). Phew! I feel dizzy.
2. Math anxiety leads to math avoidance: students with math anxiety deny themselves a future in math-related fields, such as science, technology, engineering, and mathematics (STEM, Ashcraft, 2002; Hembree, 1990; Mighton, 2020; Namkung et al., 2019; Perry, 2004; Tobias, 1993). Perhaps, more importantly, these students shun mathematics in everyday life, limiting themselves, since math IS everywhere.

Math anxiety has no prejudice – it affects students of all social classes, ethnicities, races, sexes, and genders. There are many causes of math anxiety – from stressful timed tests, to instructor behaviours, to the attitudes of parents/teachers/family/community members, to previous poor math performance, to low competency levels, to socio-economic status. However, today, dear CMS *Education Notes* reader, let us focus on positives and appreciate things that might help.

I posited in my Master's thesis (Shayer, 2020) that math anxiety can be decreased for all students via the incorporation of contemplative practices while taking math courses. Contemplative practices include exercises based on reflection or introspection, which offer a variety of techniques, such as breath awareness, meditation, and visualization.

Now before getting into greater details, let us just begin by taking a deep breath. *In… Out…* You feel better already, right? In fact, Brunyé et al. (2013) determined that focused breathing minimized math anxiety, but did not totally undo its effects when test writing. Truth be told, they only investigated one exercise of focused breathing and suggested further work, over a longer period of time. Perhaps then, greater and sustained effects may emerge (as demonstrated with stress and anxiety in learning by Shapiro et al., 2011).

According to Bellinger et al. (2015), who examined the relationship between math anxiety and mindfulness levels, the more mindful the individual, the less math anxious they were in high stakes testing environments – timed tests, final exams, or any evaluation worth a lot of marks or could decide entrance to careers. Furthermore, Ashcraft and Kirk (2001) considered the drop in working memory – the memory which is used to break problems down into steps or to remember studied procedures – that math-anxious students suffer when test writing, depleting valuable resources to recall methods or to process steps toward a solution. Bellinger et al. (2015) shared that "individuals who received mindfulness training, and extensively practiced, did not show this drop in working memory" (p. 124), leading to their higher performance. Notice the expression "extensively practiced". Evidence demonstrates that regular practice is important for continued benefits (Hyland, 2016; Shapiro et al., 2011).

To support students taking mandatory first-year, university transfer math courses, I devised a program (further detailed in Shayer, 2020), entitled *Mindful Math*, which incorporated evidence-based practices emanating from Mindfulness-Based Stress Reduction (MBSR, a program created by Kabat-Zinn, 1994, the father of the secular mindfulness movement) and smartEducation (an MBSR-style program for pre-service and in-service teachers) curricula. This out-of-class support did not offer tutoring. Instead, the six 45-minute length sessions featured various contemplative practices. The Mindful Math sessions offered a means to observe the impact of contemplative practices on the perceived anxiety of students enrolled in these first-year mandatory math courses. The first three sessions occurred on a weekly basis, whereas the last three were offered biweekly to allow participants time to develop their own practice.

The three most popular (and helpful according to the participants) were:

1. The Pause Practice (involving focused breathing)
2. The 5-4-3-2-1 Practice
3. The Math Class Visualization

The first practice, the Pause Practice, involved taking three intentional deep breaths, focusing on the inhale and the exhale of each (see Figure 1).

Then, participants were invited to ponder their thoughts, sensations, and feelings. The practice ended with three more deep breaths.

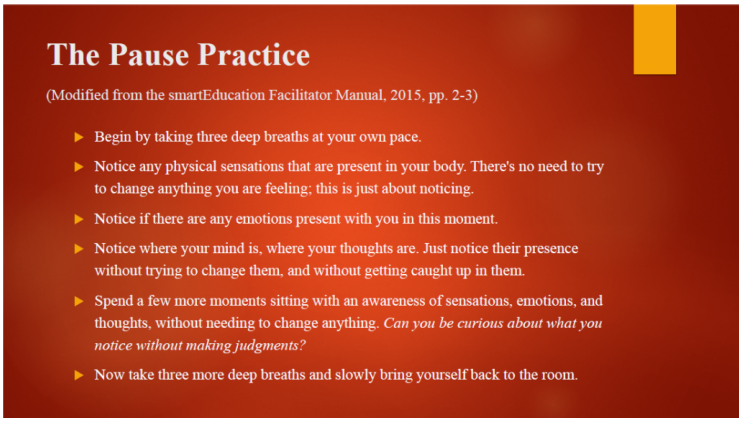

Figure 1. The Pause Practice

Side Note: See the excerpt from the field notes from Session 1 (Figure 2), when the Pause Practice involving focused breathing was first introduced. This description in the excerpt was the first presentation of Number-Induced Math Anxiety, when mere numbers make people feel anxious or react physiologically, as predicted by Namkung et al. (2019). Other such episodes occurred during that first session. In consequence, I steered cleared of counting and of saying "one", "two". Instead, "in" and "out" were used.

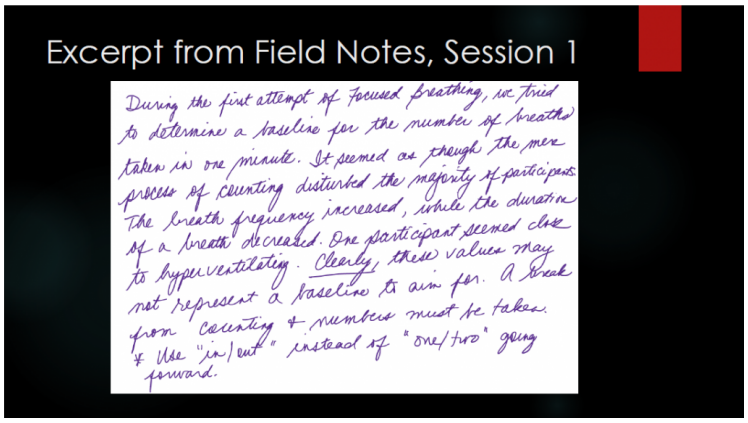

Figure 2. Excerpt from Field Notes, Mindful Math Session 1

I delayed the introduction of the 5-4-3-2-1 Practice due to the presence of numbers; however, by the fourth session, the participants' willingness to engage with it was noticeable. In the end, the 5-4-3-2-1 Practice is an excellent grounding exercise. It quickly became a participant favourite as it is easy to do anywhere and does not require a large time commitment (see Figure 3, 5-4-3-2-1 Practice). As always, you can start and finish with three deep breaths.

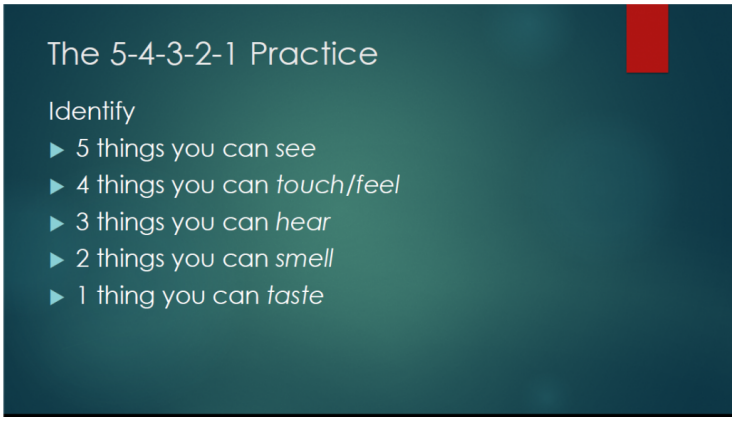

Figure 3. The 5-4-3-2-1 Practice

Finally, one participant felt more at ease in the class after practising visualizations. In consequence, they were more apt to ask questions when they did not understand or ask the instructor for help. The Math Class Visualization was a guided visualization beginning and ending with three deep breaths. It involved the description of a regular student classroom, along with its sights, smells, and sounds. At every instance where anxiety would start to increase (such as when the instructor entered, discussed a difficult topic, or mentioned an upcoming test, or when fellow students would discuss the ease or difficulty of the homework), I would remind the participants that they had done all that they could, that they had done all their homework and that they could manage. Extra deep breaths were had. Positive, yet realistic outcomes were visualized – passing a test, understanding a concept (eventually), problems becoming more manageable with practice, feeling more comfortable asking questions in class or during office hours. As it is a longer practice, please consult Shayer (2020) for the step-by-step visualization.

The case study results also demonstrated that with regular practice over the span of nine weeks, participants were able to manage their math anxiety, all while demonstrating better control of their emotional reactions to math.

I believe that math anxiety is a "chicken or the egg scenario". We can easily get hung up in discussions relating to how math anxiety starts or the best age to squash it. However, those discussions do not lead to solutions. It is never too late to affect change. No matter which grade you teach, whether you have children or adult learners, it is worth a try. Plus, math anxiety is interconnected with many things, from job opportunities, to self confidence, to happiness in life.

Hence, if contemplative practices CAN decrease self-perceived math anxiety, then many ripples can occur, including decreases in math avoidance and increases in math performance. As Tobias (1993) wrote, decreasing math anxiety increases math self-confidence and greater confidence in life in general. Why not give our students the ability to have greater confidence in their lives and in themselves?

Update: I am continuing to work with these ideas now in my Ph.D., incorporating the practices into the classroom itself. Interested readers are encouraged to contact me with questions or comments.

Leslie has been an educator all her life, whether it be as a piano teacher, gymnastics coach, or math instructor. She obtained her master's in applied math in 1998, which led her to the post-secondary classroom experiences. For over twenty years, she has seen students struggle with the very subject that she loves. Leslie returned to graduate school in 2018 to not only complete an M.A. in education, but is currently working on her Ph.D. at UBC Okanagan under the supervision of Dr. Karen Ragoonaden. Her research investigates how contemplative pedagogy may be used to improve the learning of mathematics by decreasing math anxiety.

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