How Can Children Learn Math Better?

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Math is an essential part of children's schooling, from preschool all the way to the end of high school. Early math learning (grades 3 to 5) centers around identifying/building/describing numerical and geometrical patterns, and looking for/applying relationships between varying quantities to make predictions (Kieran, 2004). A perfectly reasonable conclusion to reach is that the more exposure children get to such ideas by way of practice problems, the better children will be in math. While this may be true to some extent, solely practicing extra math problems will not necessarily make someone good at math. In fact, we all know the relatable feeling of being stuck in a math concept and, since attempting to solve more of something we find hard is frustrating, this may lead us to start to dislike math. From this we see that one's attitudes towards math are important to remain engaged and develop the necessary skills mathematical reasoning provides. One specific emotion towards math that past research has found to be telling of future math achievement is math anxiety, as its presence has been shown to decrease children's interest in the subject (Pantoja et al., 2020; Uscianowski et al., 2018).

Math anxiety is the stress and helplessness a person may feel when doing math. Pantoja et al. (2020) ran a longitudinal study, with children in first grade, where they measured two things throughout a two-year span: (1) children's number line estimation skills (e.g., if there is a 0-100 line, children would be asked to place a number n on the line, where $0 < n < 100$), and (2) math anxiety using a Child Math Anxiety Questionnaire from Ramirez et al. (2016). They found that first graders' math anxiety was related to their math achievement in first grade through third grade, controlling for baseline knowledge (i.e., line estimation test). This finding suggests two things: (1) that math anxiety in children contributes to future math learning over and above an important foundational math skill such as line estimation, and (2) that this trend starts to develop as early as first grade. In this, Pantoja et al. (2020) showed that regardless of whether math anxiety stems from poor math skills, math anxiety leads to low math skills. With these results we can reach a supported conclusion that educators must look past the physical act of doing math and also pay attention to children's attitudes towards math. A possible plan of action is to develop new curricula, starting in first grade classrooms, such that math appears to be fun and approachable rather than hard and intimidating. A possible way to do this is to encourage schools to allow some math-related play time instead of just handing kids worksheets (Seol et al., 2017). There are games out there, made specifically for educational purposes and not, that incorporate math skills and allow a friendly ease into math. Teachers can use such games that students may already be familiar with to explain concepts in class.

Nevertheless, teachers and other educators are not the only ones that have an effect on children's math anxiety. Outside of the classroom, parental attitudes towards math have been shown to influence children's own attitudes (Hildebrand et al., 2022). For example, parents' math anxiety at the beginning of the school year was highly correlated with their child's math anxiety at the end of the school year, but only if the parent frequently helped their child with their math homework (Maloney et al., 2015, as cited in Hildebrand et al., 2022). Thus, math anxiety is transmittable by socialization. This should come to no surprise because if the person that is supposed to help appears to be dreading the task, then they are more likely to get stressed out more easily and be less productive. In turn, a child does not want to aggravate their parent or even put themselves in such an uncomfortable situation. At this point, the child can just try to do their math homework alone and be better off. But what if the child also cannot do the math homework? Now, they do not have any help—which may lead to frustration itself—and so they have no choice but to go back to their parent and continue an anxiety-filled cycle.

We know kids are raised in a house ran by parents and learn about society as a whole through their parents. Therefore, parents holding harmful stereotypes can be detrimental to their children's academic self-efficacy. Related to math self-efficacy, data from implicit

association tasks reveal that both parents and their children have implicit associations between math and difficulty, but only parents significantly associated math with masculinity (Hildebrand et al., 2022). This data show that, on average, parents tend to have a gender-based stereotype about who is more suitable to pursue math. This is disappointing as parents may implicitly be discouraging their daughters from math and other math-related fields.

Hildebrand et al. (2022) discussed that parents who hold stronger explicit and implicit gender stereotypes (e.g., math is for men, literature is for women) are more likely to (1) explicitly endorse math as being more important for their sons, and (2) to think their sons have higher math aptitude than their daughters. This means that such parents are much more likely to believe their son is more capable of understanding a certain math concept than their daughter of comparable age and education. Clearly, this will lead to different treatment and even to increased math anxiety levels in their daughters. This only reinforces the stereotype cycle because these girls are likely to grow up to be women with higher math anxiety and lower confidence in their math abilities, and thus, hold stronger traditional explicit math-gender stereotypes. Simpkins et al., (2006) found that such negative attitudes towards math contribute to women discontinuing the pursuit of advanced math courses and activities as early as middle school, despite their math abilities being strong.

Furthermore, male-dominated fields are more likely to be considered fields in which success hinges upon "brilliance" (Bian et al., 2018), and evidence suggests that members of STEM fields believe that raw, innate talent is necessary for success in STEM (Leslie et al., 2015, as cited by Hildebrand et al., 2022). Analogous thinking is found among children as well. Bian et al. (2017) found that boys are more likely to select a task that requires them to be "smart," while girls prefer tasks that require them to "work hard" (Hildebrand et al., 2022). This suggests that boys are more likely to prefer tasks that require an intellectual challenge because they believe they can innately do it, while girls tend to believe that they do not necessarily know how to do it but can work for such an achievement (though of course this is more work and a greater chance of quitting). Perhaps this reasoning stays with children throughout development and is the reason why STEM fields like math have such a big gender imbalance.

Taking it all together, to succeed in math, children need encouragement and non-anxious adults guiding them through the learning process. Parents should also become aware of the biases they hold, as such beliefs may hurt their daughters. Of course, no parent that believes that their son has better mathematical aptitude is maliciously doing so to hurt their daughter. Regardless of the intentions, though, data show that such sexist and micro-aggressive comments and attitudes negatively affect girls' confidence and performance in math-related activities. We can comfortably make a conjecture that if a teacher were to hold such attitudes as well, we would see a similar negative impact on female students (See Riegle-Crumb & Humphries, 2012). This is because, like parents, teachers act as students' role models, and it is therefore likely that a comparable pattern would arise. Therefore, studies show that children can become more fluent in math when their adults provide them with a comfortable, inviting, unbiased learning environment.

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