

**A Review of the Literature on  
Trauma, Learning, and Mathematics**

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EDUC 632: Research in Education

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2 November 2021

### **Abstract**

This paper explores the prevalence of trauma in the US and reviews literature on the cognitive impacts of trauma, especially as they relate to school and learning. It also examines the phenomenon of math anxiety and considers the possible interplay between the cognitive effects of trauma and math anxiety. Finally, it puts forth some possible strategies to enhance learning for students with trauma and/or math anxiety.

*Keywords:* trauma, PTSD, cognition, learning, mathematics

## **A Review of the Literature on Trauma, Learning, and Mathematics**

Trauma is a disturbingly common experience with complex and far-reaching impacts on the lives of those it touches. Research suggests that over 60% of US adults had at least one adverse childhood experience (ACE) (Merrick et al., 2018), and neurocognition studies show that trauma and PTSD have far-reaching effects on students' ability to learn, including impairments in concentration, self-regulation, language learning, and memory (Perkins & Graham-Bermann, 2012). These learning difficulties may lead students to doubt their intelligence or to dislike or fear learning (Perry, 2006). Mathematics, as a widely disliked and feared subject, is an especially sensitive area of learning, for those with or without trauma histories; traditional math education fosters math anxiety in the majority of students (Luttenberger et al., 2018). Given the confluence of these factors, it is salient to consider how teaching and supplemental math instruction (tutoring, remedial lessons, etc.) can help students with trauma histories overcome challenges in learning math. Strategies for teaching traumatized students range from the environmental, to the interpersonal, to the pedagogical. This literature review synthesizes research about trauma, learning, and math education in particular to consider how math instructors might help meet these students' needs.

### **Prevalence of Trauma**

Childhood trauma is widespread. The 2011-2014 Behavioral Risk Factor Surveillance System (BRFSS) collected data about adverse childhood experiences (ACEs) from a sample of nearly a quarter of a million US adults, the largest and most diverse sample to date. Over 60% of respondents reported at least one ACE; nearly 16% reported four or more (Merrick et al., 2018). This represents over half of the population that may be suffering from the impacts of trauma, and a sizeable minority of people who have been repeatedly traumatized. Nor do traumatic experiences

cease to happen in adulthood: “as many as 50 percent of college students are exposed to a PTE [potentially traumatizing event] in the first year of college” (Galatzer-Levy et al., 2012, as cited in Davidson, 2017, p. 5).

And it seems like the prevalence of traumatic experiences is only increasing. The BRFSS mean ACE scores have a statistically significant ( $r^2=0.8564$ ) negative correlation with age<sup>1</sup>; that is, younger adults seem to have had more childhood trauma than older adults (Merrick et al., 2018). In addition, it’s likely that trauma prevalence will increase as climate change induces extreme weather, droughts, fire, and famine. Survivors of the 2018 Camp Fire—“the deadliest and most destructive wildfire in California’s history” (Stanley, 2021)—show significantly higher rates of PTSD, anxiety, and depression than the general population (Silveira et al., 2021). And “rates of serious mental illness doubled” among those exposed to Hurricane Katrina in 2005; over a decade later, one-sixth of the population were still experiencing PTSD (Stanley, 2021).

It’s important to note demographic differences in ACE prevalence, too. As a general rule, those who are marginalized have experienced more trauma: people of color have higher ACE scores than white people, queer people have higher ACE scores than straight people, women have higher ACE scores than men, poor people have higher ACE scores than wealthier people, and under-educated people have higher ACE scores than highly-educated people (Merrick et al., 2018). The intersectional impacts of marginalized identities were not explored by Merrick et al., but it is likely that multiply-marginalized people have even higher ACE scores.

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<sup>1</sup> Calculated using Desmos, by comparing the midpoints of six age groups to the mean ACE scores for each group.

It's clear, then, that students with trauma histories are present in every classroom and in every academic support program. In fact, students with trauma histories are disproportionately likely to need academic supports.

### **Effects of Trauma on Cognition and Learning**

The impacts of trauma on the brain are well studied. Perkins and Graham-Bermann (2012) summarize research about relationships between violence exposure and neurocognitive processes, brain development, learning disorders, language development, sensory processing, mental health, and social skills—all factors in thinking, learning, and academic success. There is clear evidence that violence exposure correlates strongly with impairments in all of these categories. Perry (2006) points out that many students have shame and anxiety from past negative experiences in the classroom creating “cumulative educational trauma leading to fear conditioning” (p. 21). Perry explains how activation of the sympathetic nervous system impairs students’ ability to store and retrieve information, because stress-response processes lead to hypervigilance and reactivity while inhibiting attention to non-threat-related information. Many traumatized students are, quite literally, too scared to learn.

Trauma’s effects can also indirectly impact learning success. Bessel Van der Kolk’s (2015) book *The Body Keeps the Score* explores the ways trauma permanently changes the brain, and the far-reaching impacts those neurological changes have on people’s lives. Van der Kolk proposes “developmental trauma disorder” to reflect the fact that trauma during critical periods of brain development can result in lingering abnormalities. Even students who do not exhibit PTSD may experience lingering effects of past trauma. The ACE Study (Felitti et al., 1998) found that childhood trauma is correlated with higher rates of smoking, alcoholism, and drug abuse;

depression and suicidality; and overall health and fitness. Poor mental and physical health, in turn, sap students' energy, focus, motivation, curiosity, and self-efficacy.

### **Mathematics Anxiety**

Most people are afraid of math. Mathematics causes an estimated 93% of the US some anxiety, and an estimated 17% experience high levels of math anxiety (Luttenberger et al., 2018). The phenomenon of math anxiety has been extensively studied, and researchers know that it involves both emotional and physiological responses (Suárez-Pellicioni et al., 2016). There's a feedback loop here, with math anxiety leading to math avoidance leading to lower math competence leading to further math anxiety. Suárez-Pellicioni et al. (2016) conducted a review of the literature on the neurocognitive effects of math anxiety, and found that it has enormous impacts on performance on everything from tests to computing sales prices. Math anxiety has been shown to have negative correlations with reaction time, accuracy, working memory, and attention. In the long term, math anxiety can have negative or limiting effects on class and job selection; motivation, interest, and positivity about math; and learning behaviors like procrastination (Luttenberger et al., 2018).

Math anxiety is highly correlated with, but separate from, general anxiety—those who are generally anxiety-prone are more likely to experience math anxiety (Luttenberger et al., 2018). But math anxiety seems to be influenced by environmental factors as well: parent and teacher attitudes, stereotypes, academic pressure, and prior knowledge. Working to combat stereotypes and myths about math ability, using positive messages about math, encouraging questions and mistakes, eliminating time constraints for performance, emphasizing that math skills require hard work, and giving students time for reappraisal prior to tests are all strategies that can reduce math anxiety and its impact on math performance (Luttenberger et al., 2018; Suárez-Pellicioni et al., 2016).

## **Strategies for Reaching Traumatized Learners**

Paramount to helping traumatized students learn is fostering a sense of safety. According to Wilson (2020), “[L]earning will not take place when the learner is in a state of mental distress” (p. 10). Enabling students to process, learn, and remember information requires getting them out of fight/flight/freeze mode, soothing the fear and pain centers that are often hyperactivated by trauma (Perkins & Graham-Bermann, 2012; Perry, 2006; Wilson, 2020). Consistency and predictability in schedules, rules, and surroundings—and prior notice of changes or transitions—may allow students to relax their hypervigilance of their surroundings enough to focus on lessons (Davidson, 2017; Perry, 2006; Wilson, 2020). Allowing and even encouraging students to ask questions and make mistakes can also contribute to a sense of safety (Wilson, 2020).

Many students with trauma histories have been robbed of a sense of confidence and agency. Developing self-efficacy and promoting a growth mindset can empower them to work on not only academic skills but also interpersonal and life skills (Davidson, 2017). Furthermore, treating each student as a capable learner can help students to believe they are capable (Davidson, 2017).

Because students of color are more likely to experience trauma than white students, it’s important to practice pedagogies that actively seek to engage and support students of color. Culturally responsive pedagogy (CRP) is an organic and flexible strategy for teaching students of color. Gay (2002) describes CRP as a process of teacher education, diversifying curriculum, community building, thoughtful communication, and responding to students’ changing identities and needs. In effect, Gay argues that teaching these students should be a matter of learning about their cultural backgrounds and endeavoring to meet them where they’re at, rather than forcing them to conform to Western educational norms.

The principles behind CRP can be extended to include not only racially marginalized students but also students who are marginalized in other ways—disability, sexuality, gender identity, religion, and trauma history. Wilson (2020) suggests that treating students with respect, drawing them in through cooperative activities, and acknowledging their cultural identities can help them feel a sense of belonging and security. All of these strategies are standard practice in CRP.

### **Directions for Future Research**

While we have a fairly good understanding of the impacts of trauma on learning, and many hypothesized strategies to support learners with trauma histories, there is little research examining the actual efficacy of various trauma-informed teaching strategies. Experimental and observational research to ascertain the impact of certain teaching methods on traumatized students might offer validation of these hypotheses and/or suggest alternative trauma-informed teaching methods not yet recognized.

### **Conclusion**

Helping students with trauma histories feel safe and supporting them in their learning may require new strategies and approaches. However, given how common trauma is, it's important to ensure that traumatized students are given the best possible opportunity to learn.



## **Appendix: Instructional Strategies for Trauma-Informed Math Teaching**

Below is a (non-exhaustive) summary of instructional strategies drawn from Cole et al. (2005), Davidson (2017), Gay (2002), Perkins and Graham-Bermann (2012), Perry (2006), and Wilson (2020).

- Combat stereotypes and myths about math ability, and use positive messaging about math
- Encourage questions and mistakes
- Avoid imposing time constraints for performance; reduce pressure of getting “the” right answer
- Foster a growth mindset; emphasize that math skills require hard work
- Give students time for reappraisal before or reflection after a test
- Maximize transparency
- Maintain routine, consistency, and predictability; give students notice prior to major transitions or changes in routine
- Assume each student is a capable learner and treat them as such
- Provide positive and constructive feedback; identify students’ strengths and successes to foster self-efficacy
- Meet students where they’re at; use culturally responsive pedagogy
- Build a cooperative community atmosphere
- Provide clear information and instructions; lay out explicit goals, expectations, rules, and boundaries
- Give students choice where possible, and inform them about their options
- Ask for student input, engage in dialogue, and give students leadership opportunities
- Help students build self-regulatory, social, communication, and other skills

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