

# The Mathematics Enthusiast

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## Today's mathematics student: Take two

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**Abstract:** Current mathematics students are members of Generation Z, a generation proving to be quite different than previous ones. Generation Z has never known a time without Google, nor a time of safety. Generation Z has a declining tendency to even attend college. If they do attend college, their expectations need to be met to keep them engaged in mathematics. Professors will need to adjust pedagogy.

**Key words:** Generation Z, wellbeing, mental health, blended classroom.

### 1 Introduction

Generational research examines characteristics in common among a cohort of people of the same age. See Table 1 for the generations going back to 1946.<sup>2</sup>

Table 1. The Generations

Name	Birth Year	Age in 2023
Boomers	1946-64	59-77
Generation X	1965-80	43-58
Millennials	1981-1994	29-42
Generation Z	1995-2012	11-28

In 2007, I wrote an article entitled *Today's Mathematics Students*.<sup>3</sup> I am a member of Generation X, and at that time, I was teaching Millennials. Millennials wanted to be in college, even though students and professors differed in their outlook and background. To better align pedagogy, college professors needed to adjust their lecture format to involve students in their lectures. Perhaps at the time, it seemed like a radical change.

Sixteen years down the road, I am teaching members of Generation Z. Most members of Generation Z are children of Generation X and most current college professors are from Generation

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<sup>2</sup> Hart, 2018.

<sup>3</sup> Latterell, 2007.

X. The later members of Generation Z had both high school and college disrupted by a global pandemic.<sup>4</sup> Due to social unrest, the pandemic, and college expenses, the undergraduate college enrollment declined by 8% between Fall 2019 and Fall 2022.<sup>5</sup> Understanding generational differences is now of critical importance. Surely college students behave as individuals, but generations do share common characteristics, and understanding these characteristics can improve college mathematics teaching and learning.

## 2 The Generation Z

Members of Generation Z (born 1995-2012) are the true digital natives. Generation Z has seen social unrest and a global pandemic. They were born after 9/11 and have never known a “safe” time. Generation Z is known to be more private, more diverse, and more accepting of differences than previous generations. Generation Z tends to be loyal, full of passion, hardworking, and open minded. Generation Z is the first generation to constantly have a cell phone and to see an explosion of online education (due to the pandemic). They have a worldwide social network. Generation Z wants to make a difference in other people’s lives. More members of Generation Z were homeschooled than any previous generation, even pre-pandemic. Generation Z never knew a time before Google, which has proven to be a major college game changer, in terms of what they are willing to learn.<sup>6</sup>

Generation Z is often referred to as the “app generation,” the “iGen,” and the “phigital” generation. *Phigital* references the physical and digital together without drawing a distinction between them. Generation Z has extensive mobile media use. They are also multi-taskers and have a short attention span.<sup>7</sup>

The pandemic and the murder of George Floyd highly influenced Generation Z. They are the first generation to have less than half of their population report that they have good or very good mental health. Generation Z worries about their health, well-being, and safety. They have lower self-

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<sup>4</sup> Krislow, 2022.

<sup>5</sup> Selingo, 2021; Welding, 2023.

<sup>6</sup> Hart, 2018; Marin & White, 2023; Oxford Royale, 2021; McCrary, 2022; Prete, 2022; Seemiller, et al., 2019.

<sup>7</sup> Hart, 2018; Marin & White, 2023; McCrary, 2022; Prete, 2022; Seemiller, et al., 2019.

confidence than other generations and high levels of worry, anxiety, and depression. They have lower social skills than other generations. Mobile media use may lead to addictive behaviors. With the previous issues and the expense of college, it is not nearly as appealing to those in Generation Z to even attend college.<sup>8</sup>

In comparison to other generations, Generation Z has the least positive life outlook, the most emotional distress, and they “were also two to three times more likely than other generations to report thinking about, planning, or attempting suicide in the 12-month period spanning late 2019 to late 2020.”<sup>9</sup>

### **3 Their Mathematics Background**

Generation Z is struggling mathematically. The online high school mathematics courses they took during the pandemic were not of the quality of in-person classes. Teachers were not prepared to teach online and students were not prepared to learn online. In the latest National Assessment of Educational Progress, only 26% of eighth graders are proficient in math.<sup>10</sup> Although eighth graders are not in college, it is a troubling statistic. The DFW rates are higher in college mathematics courses than they have ever been, due to both under-preparedness and mental health issues.<sup>11</sup>

Math anxiety is a term that goes back to the Boomers. Through the years, research has shown a connection between lower math achievement and higher math anxiety. “A substantial number of children and adults have mathematics anxiety, which may severely disrupt their mathematical learning and performance, both by causing avoidance of mathematical activities and by overloading and disrupting working memory during mathematical tasks.”<sup>12</sup> However, in the past, this math anxiety was more likely to sit within a student who had overall positive wellbeing. This is not the case, any longer.

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<sup>8</sup> Annie E. Cassey Foundation, 2023; Causey, et al., 2023; Hart, 2018; Oxford Royale, 2021; McCrary, 2022; Prete, 2022; Seemiller, et al., 2019; Selingo, 2021.

<sup>9</sup> *Addressing the Unprecedented Behavioral-health Challenges Facing Generation Z*, 2022.

<sup>10</sup> NAEP, 2022.

<sup>11</sup> Sanchez, 2022; Sapp, 2022; Selingo, 2021.

<sup>12</sup> Dowker, Sarkar, & Looi, 2016.

Some researchers are examining a broader term than math anxiety by examining mathematics wellbeing and, although this research is relatively new, “the following cannot be understated: student wellbeing in mathematics courses is consequential.”<sup>13</sup> Changes in the mathematics classroom need to be made to increase student sense of wellbeing, both for increased mathematics achievement and as a humanitarian endeavor. Students are seeing higher than ever levels of anxiety and disengagement from mathematics classes. Some of this is due to a disconnect between their values, including what they want to see in a math class, and what they actually experience. For example, Generation Z students value having a relationship with the professor. If this relationship is absent, they feel disengaged with the subject. We offer implications later to address how this disconnect might be bridged.<sup>14</sup>

The bottom line is Generation Z is both at greater risk of being under-prepared for college mathematics, and at greater risk of being unwilling to spend much time trying to learn material. They want it to come quickly. However, they do want to learn. If they can be engaged, they will work hard.<sup>15</sup>

#### **4 The College and Parental Experience**

It is more difficult to get Generation Z students in the college door. There are obvious reasons, such as the cost of college and the pandemic, but there are also generational reasons. Most Generation Z’s parents and professors are from Generation X. Although Generation Z resembles Generation X in many ways, there are fundamental differences. For example, Generation X loved to learn and didn’t care so much if it led to a career or a higher paying job. This is very different from the Generation Z viewpoint; “They mainly go to college for one thing: a job.”<sup>16</sup> Generation X respected hierarchy and this is not so true with Generation Z. Generation Z does not respond well to email, and that is a preferred method for Generation X.

Millennials had helicopter parents, required numerous adjustments in college, and didn’t really care if college took a long time. Generation Z doesn’t want to be in college a long time. Generation

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<sup>13</sup> Almora Rios, 2023, p. 3.

<sup>14</sup> Almora Rios, 2023; Hill et al., 2021.

<sup>15</sup> Sapp, 2022.

<sup>16</sup> [Selingo](#), 2021, p. 18.

Z has “lawnmower” or “snowblower” parents who wish to remove obstacles out of their children’s way. Generation X was referred to as the “latch key” generation, as they were left alone while both parents worked. Generation X wants their children to have a different experience. In a recent study sponsored by the Bill & Melinda Gates Foundation, parents rated mathematics as the most important course, but also as the one most in need of updating. They agree with Generation Z that mathematics should have real-life applications.<sup>17</sup>

Once they are in college, more Generation Z students drop out than ever before. For those that attend and stay in college, they want more supports than ever before. They are interested in majors that lead directly to employment (which is another reason that the number of math majors is down, as they do not see it as leading directly to employment). They like hands-on learning, self-directed learning, and high-tech learning. They dislike group work. They like relationships, they like having control over their learning, and they demand fast feedback.<sup>18</sup>

## **5 Implications**

It is not suggested that math professors change the math content in their courses or lower their standards. However, there are ways to appeal to Generation Z.

**Blend the Classroom:** Generation Z doesn’t like group work, although that may not have been a large part of math courses, anyway. They also don’t want to do something in person that they could as easily do online. They prefer short projects to long. They prefer the digital. They have no patience for a lecture.

Combining all of that with Generation Z’s desire for a relationship with their professor, perhaps the best way to teach math is to “blend” the course. It is like flipping the course, but this flipping is different than in the past. Generation Z wants to see the same content in person as they do online, without it being an exact repeat. The professor could provide digital material for students to go

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<sup>17</sup> Hart, 2018; Seemiller, et al., 2019; [Selingo](#), 2021.

<sup>18</sup> Blad, 2023; Hart, 2018; Marin & White, 2023; McCrary, 2022; Prete, 2022; Seemiller, et al., 2019.

through on their own and then also meet with the class in-person and go through the same material in short bursts, using online resources.

For example, the professor could provide PowerPoints or videos for students to go through online. Then, in class, provide a whole-class hands-on, preferably real-world, interactive learning process, with the professor working alongside the students, using the same material. If professors can learn student names, that is all the better. The in-class portion of the class needs to feel like a real relationship with the professor.

Load the in-class portion with technology, using backchanneling. Backchanneling provides feedback and engages students in live-time. There are many free online resources that professors can use. Here is a non-exhaustive list:<sup>19</sup>

- Padlet, see <https://www.educatorstechnology.com/2023/01/what-is-padlet-teachers-step-by-step.html>
- Google Slides for Q &A, see <youtu.be/afdlqhED8Xg>
- Google Jamboard, see <https://www.educatorstechnology.com/2022/11/what-is-jamboard-and-how-to-use-it-in.html>)
- Socrative, cloud-based student response system, see [youtu.be/1wkDwbWM\\_YQ](youtu.be/1wkDwbWM_YQ)
- Plickers, <https://youtu.be/bejiz2HzUz8>
- Poll Everywhere, <https://www.polleverywhere.com>

Using these methods, students could present something small themselves, such as the way they are viewing content, and/or present the solution to a problem. These can be gathered quickly in class and the professor can respond quickly. The main idea is to have resources online (the flipped part) and then use technology to go through content together in class. These methods will also be effective for putting in (just-in-time) needed remedial skills. Even things done together can be done digitally and in small chunks. The “flipped” part of the class should not be a large project that takes all class period.

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<sup>19</sup> Kharbach, 2023; Marin & White, 2023; May 2017.

**Lots of Points and Quick Feedback:** Generation Z also wants “credit” for their efforts, so professors should provide points for the various things that students do. Generation Z wants nearly constant feedback. One method that would appeal is to break up assignments into smaller chunks and give feedback along the way. This last method is also known to help with mental health. It is important that the points are awarded very quickly. If it is possible to write the assessments so they are given online and students take them on their own, with at least some automated feedback, that would work well for Generation Z.

**Flexibility and Empathy:** The professor of Generation Z needs to be flexible. If it is possible to be lenient on due dates, that is ideal. If it is possible to have a variety of ways to earn points, that will introduce flexibility. Professors need to treat Generation Z students with understanding and empathy. The statement “kindness costs nothing” should be a motto of the class.

**Webpages:** It is important to Generation Z students that faculty have a digital presence. Faculty should have up-to-date webpages, where the students can (and will) go to read about the professor.

**Real-life, Career Bend:** Examples and topics should be as real-life as possible and/or things that they might do in their career. Generation Z has no patience for “math for math’s sake”. Let it apply to something. Also, assignments should be crafted so that Generation Z does not perceive them as “busy” work. Generation Z students are quick to say, “I don’t have time for that.” Assignments that are obviously useful for their life and earn points are ones that will most interest Generation Z.

**Think Technology:** Whatever can be done online, should be. This is not a suggestion that the course itself is online. Rather provide some online office hours, online assessments (as much as possible), and other online opportunities. Have an online communication/announcement system. The professor can still pull this up during class and emphasize points, while having it online works well for students.

## **6 Closing Statement**



Perhaps the two most sobering points about Generation Z is the high rate of mental health issues and their declining interest in college. To engage them in mathematics, Generation Z needs digital learning, a close relationship with an empathetic and flexible professor, and nearly constant feedback.

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