MIDDLE SCHOOL STUDENTS' TYPES OF MATHEMATICAL PERSONIFICATIONS

Nicole M. Wessman-Enzinger
George Fox University
nenzinger@georgefox.edu

Clara Stilwell
George Fox University
cstilwell18@georgefox.edu

Unpacking middle school students' mathematical relationships is important as a step towards improving mathematical relationships. In this study, 500 middle school students drew personifications of mathematics. We examined these personifications of mathematics for insight into their relationships with mathematics. Using constant comparative methods, we present various ways the middle school students personified mathematics. Negative relationships were personified with terrible beasts, abusers, authoritarians, and pests/nuisances. Positive relationships were personified with best friends and nature. Some personifications supported both positive and negative relationships or were neutral relationships. Reflecting on these personifications point to components of positive relationships with mathematics that we should support and confronts ways we may be perpetuating negative relationships with mathematics.

Keywords: Affect, Emotion, Beliefs, and Attitudes; Middle School Education

All mathematical learners deserve the opportunity to see themselves as "good at math" (Ruef et al., 2020; Wickstrom & Gregson, 2017). Having a positive relationship with mathematics is a component of developing a positive mathematical identity. Students have both relationships *with* and *in* mathematics (Hunter & Anthony, 2011); these relationships influence identities (Black et al., 2009). Relationships *with mathematics* impact equity, access, and empowerment (Smith et al., 2017) in thinking and learning. Students enjoy mathematics more (Parks, 2020) and engage in the deep work of mathematics (Smith et al., 2017) if they have positive relationships with mathematics. Exploring what the elements of positive relationships with mathematics entail will provide insight into how to support students in healthy mathematical relationships.

Students enter middle schools where math is "tracked," which can have negative impacts on their identities (National Council of Teachers of Mathematics, 2018). Mathematics has the potential to be a challenging adventure that opens doors to their future (Stinson, 2004). But, students may not see themselves as mathematicians (Wickstrom & Gregson, 2017) and that impacts their mathematical relationships and identities. Although we suspect that some middle school students have negative relationships with mathematics, we need to understand the challenges in students' mathematical relationships in order to meet students where they are at. Insight into the challenges of mathematical relationships, can provide perspective into how we may transform negative mathematical relationships.

Purpose

Although teachers and researchers might inherently understand that middle schoolers have negative relationships with math, we do not fully understand the complexities that are included within those mathematical relationships with middle school students. We sought to understand middle school students' relationships with mathematics. The research question that guided our work is:

What types of mathematical personifications did our middle schoolers create?

Describing the nuances of the different types of personifications will provide insight into the mathematical relationships and experiences we need to change, enhance, or continue supporting.

Theoretical Perspective: Narrative Theory

Relationships, in general, are complex, and even positive relationships have a slew of emotions that come with that relationship. Having a positive relationship with mathematics does not mean that there will not be elements of frustration or struggle. In fact, we know that productive struggle is a critical attribute of doing mathematics deeply (Baker et al., 2020; National Council of Teachers of Mathematics, 2014). But, the relationship we hope students have with mathematics is not toxic or abusive. Yet, prior studies that have used personification tasks have revealed that university students describe their relationships with mathematics as toxic or abusive (Ruef, 2020; Zazkis 2015). Prior studies have also shown that personification tasks are better than "draw a mathematician" tasks alone (Picker & Berry, 2000; Zazkis, 2015). We extend this prior research further by examining the ways that middle school students personify mathematics. Through personifications, we have some insight into the narrative of their experiences (Langer-Osuna & Esmonde, 2017). Indeed, it is human nature to personify things. Three personifications present in the literature, created by preservice teachers, are: terrible beast, (former) best friend, and lover (Zazkis, 2015; Zazkis & Mamolo, 2016). The terrible beast relationship is equated to fear and repulsion. While the best friend, or even former friendship, or lover are relationships that can be translated to a level of comfortability and enjoyment, even if former, of mathematics. These types of personifications can provide insight into mathematical relationships and we entered our study expecting to see these personifications from middle schoolers as well.

Qualitative Methods

Participants and Data Collection

During Spring 2019, 505 middle schoolers (grades 6–8) volunteered to participate in the study and completed a personification of math task. At the time of data collection, the participants attended a middle school with students that scored in the 37th percentile in the state for mathematics.

The personification task included three different parts modified from (Ruef, 2020; Zazkis, 2015; Zazkis & Mamolo, 2016): (1) a picture of how they personify math and describe it; (2) a paragraph about who math is to them; and (3) a conversation with math. Of the 505 middle school participants, some of the responses were blank or illegible, leaving exactly 500 of the responses for analysis.

Data Analysis

The unit of analysis included the collective responses to the personification task—the drawing, description of drawing, and a written conversation with math. Sometimes students only had a drawing or a drawing and description, but no conversation with math. We used whatever they provided as the unit of analysis to help understand the personification.

The first pass of the data analysis entailed: (a) taking notes about each drawing and (b) coding the relationship with the Zazkis and Mamolo framework (2016): terrible beast, lover, (former) best friend. Using constant comparative methods (Merrriam, 1998), we went through each piece of data and negotiated what relationship was personified. We did about two passes of the data. First, we began with examining between 20-50 pieces of data at a time, iteratively meeting and comparing, and discussing if these themes aligned with our data. Second, we adjusted the themes—modififying the descriptions from Zazkis and Mamolo (2016) and adding categogies as needed. Third, we went through our data again with our new framework. This was a lengthy iterative process with the 500 pieces of data, but it spurred conversations about the themes and development of descriptions of our drawings.

In this research report, we present our modifications the Zazkis and Mamolo framework that fit the data for middle schoolers. For example, none of our participants personified their mathematical relationship with lovers as Zazkis and Mamolo described. Perhaps this is due to the age of our participants or their mathematical experiences. On the other hand, our participants emphasized authoritarians (e.g., drawings of mean teachers), pests, and nature which are were not highlighted in prior work. Therefore, for the results section of this research report, we describe the different personifications and how they relate to students' mathematical relationships.

Different Types of Mathematical Relationships

Negative Relationships

The middle schoolers personified negative relationships in mathematics with terrible beasts, authoritarians, abusers, and pest/nuisances.

The terrible beast. The terrible beast personifications included monsters, devils, or other terrifying animals (see Figure 1). Consistent with the Zazkis and Mamolo (2016) framework, the beast relationship showed fear or repulsion. When including beasts, students shared two dichotomous perspectives. One perspective with the beast included elements of consistent failure and defeat. The other perspective included elements of conquering math or beating "the beast." Figure 1 on the left shows a monster leaning over a student calling her stupid, dumb, and wrong. There is a sense of defeat in the student's face. However, in the second example in the middle of Figure 1, the student is trying to have some power and ability to fight back. The figure on the right, is a fetus that has a snake-like tongue, red eyes, and two sets of sharp teeth.

Figure 1: Terrible Beast Personifications

The authoritarian. The authoritarian personifications showed someone or something exerting power and control. This authority figure seems related to a beast relationship; but the authoritarian relationship differed from the terrible beast because the focus is on power and control and may not be a beast. Some drawings, for example, included stern or angry teachers. This is a theme that we added to the Zazkis and Mamolo (2016) framework. In Figure 2 math is illustrated as authoritarian that has all the control by putting the student in prison (math class). Freedom is outside of math class. In this example, the student wrote about how they desire to have more freedom within math class. In Figure 2 there is a student slumped and labeled with a depression; another student seems to be looking out of math class to freedom. The middle schooler wrote, "It's like a slap in the face every day. Math puts me in prison only [letting] me look at freedom."

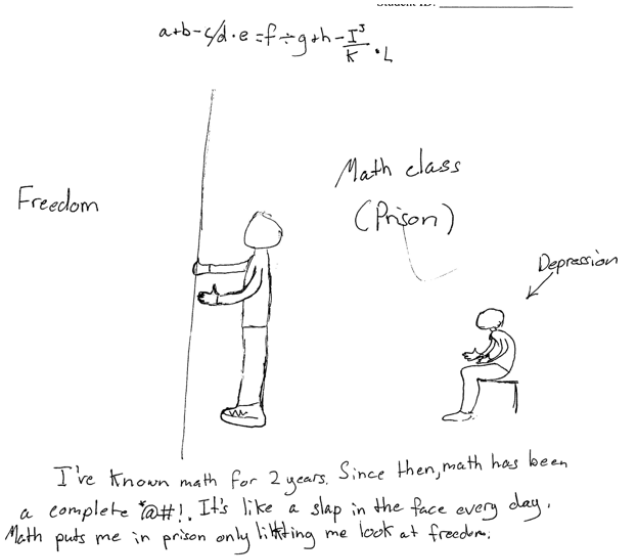

Figure 2: Authoritarian Personification

The abuser. With the abuser personification, the personifications included evidence of emotional or physical trauma. This is similar to the authoritarian relationship in that there is no power and control; however, the abuser relationship is an extreme version of an authoritarian with extreme emotions and/or trauma involved in this relationship. Although trauma and abuse in math is evidenced in the literature (e.g., Ruef et al., 2020), we made it a distinct category based on the amount of clear abuse that differed from a fantastical beast drawing (e.g., drawings of torture chambers). Within the abuser personifications, there are themes of hopelessness and cycles of abuse. Most of the abuser personifications in our study were incredibly graphic in ways that made us uncomfortable and reluctant to place in a proceeding. We selected Figure as a personification of abuser that "hit(s) kids with a ruler" as our example. Most of the personifications were more intense than this.

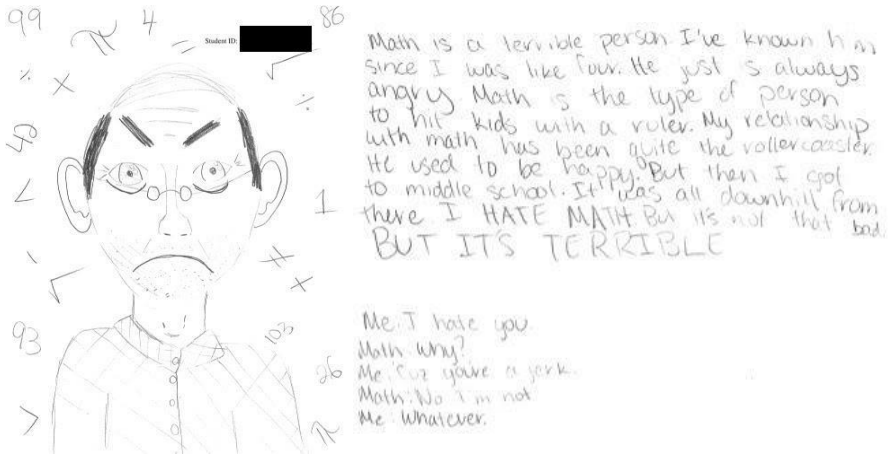

Figure 3: Abuser Personification

The pest/nuisance. Students that drew math as a pest often describe math as something that is intentionally annoying highlighted a pest/nuisance personification of mathematics. A pest is

typically irritating or an inconvenience. These inconveniences can look like losing your keys or a skunk making you smell. It can also look like either doing math or smelling something gross. Figure 4 highlights a pesky macaw stealing keys form a student.

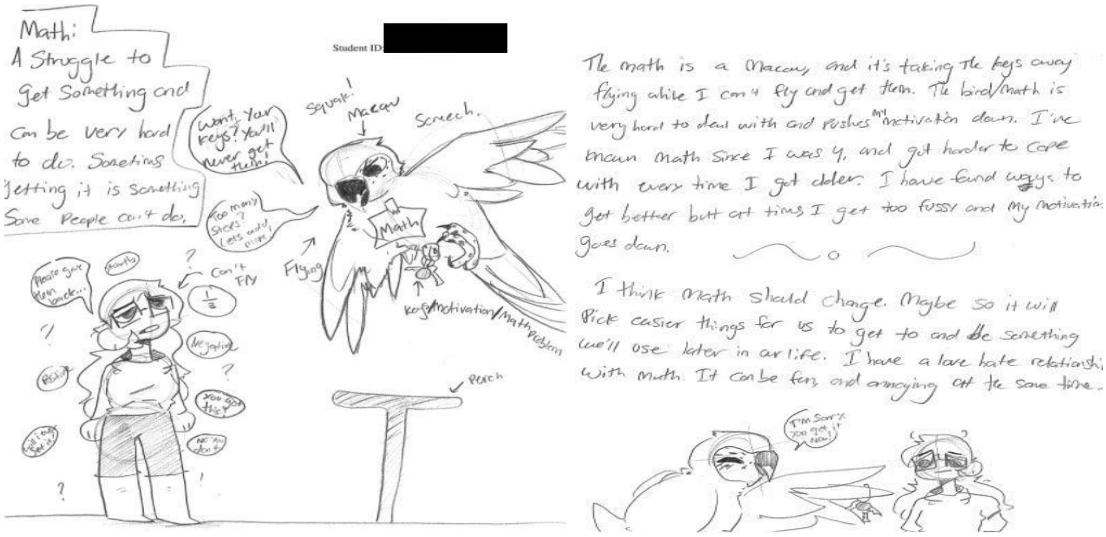

Figure 4: Pest/Nuisance Personification

This is a category that we added to the Zazkis and Mamolo (2016) framework of personifications.

Positive Relationships

The middle schoolers personified positive relationships in mathematics with best friends and nature.

The best friend. Students personified mathematics as a best friend. Zazkis and Mamolo (2016) described how math was personified as both a lover and also a (former) best friend. We did not see lovers as a theme; instead, there was an abundance of math personified as a best friend. The best friend personifications showed themes of comfortability and enjoyment of mathematics. The students described their friend as someone that you can do many things with, including but not limited to: playing games, going to the store with, and even being a helpful resource. This did not mean that the students did not think that mathematics had flaws. In Figure 5, the student described math as someone that is shy but kind. The student described her best friend as "She might be challenging to understand at first, you might have to tell her to slow down, and take a step back, but she will be with you through thick and thin." The student wants to be friends with math for as long as they can—It will be a useful asset all through life." This student highlighted that they are not a stranger to the challenges of mathematics, but it is worth the struggle.

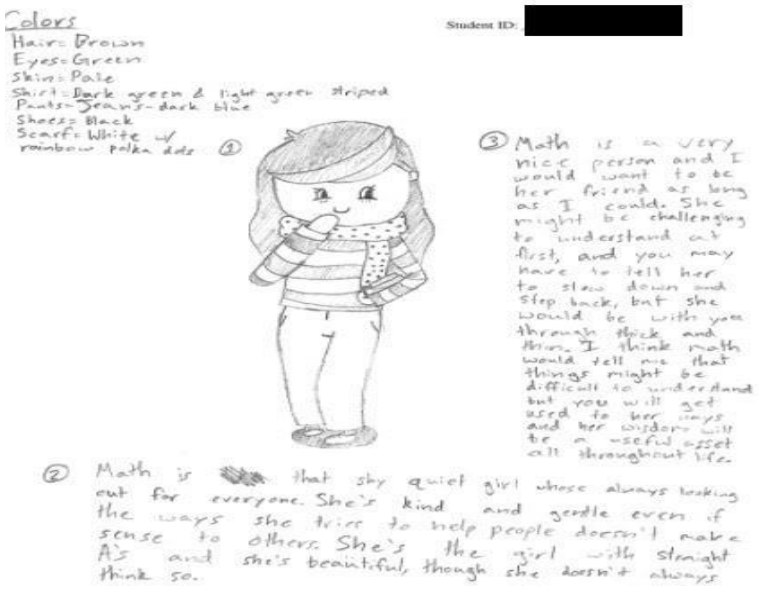

Figure 5: The Best Friend Personification

Nature. The students also personified mathematics with nature. These personifications described the push and pull of nature, how sometimes nature is beautiful and sometimes it is a challenge. Nature is beautiful and to be enjoyed, but also can be harmful and dangerous. We added this type of personification to the Zazkis and Mamolo (2016) framework. As the transcript below states, "math starts out looking like tangled videos with thorns like a rose bush, but after you get to know math and understand it, it can look like simple, harmless flowers."

Figure 6: Nature Personification

Both Positive/Negative Relationship or Neutral Relationships

The middle schoolers personified relationships in mathematics that could be considered both positive and negative or neutral with former friends and cartoons.

The former friend. Consistent with Zazkis and Mamolo's (2016), the students personified mathematics as a former friend. Figure 7 highlights a variety of emotions and types of relationships, both an abusive relationship and a former friend are illustrated. This is a reminder that sometimes relationships can be more than one thing. Emotions and relationships are complex in general and that does not exclude mathematics. This means that these classifications can overlap. Figure 7 shows some fingers that have various faces (e.g., smiles, frowns), indicating evidence of both positive and negative relationships. For example, in the transcript the relationship is described as "love/hate." The student described math as "fun," but math says things like "you ruin my life."

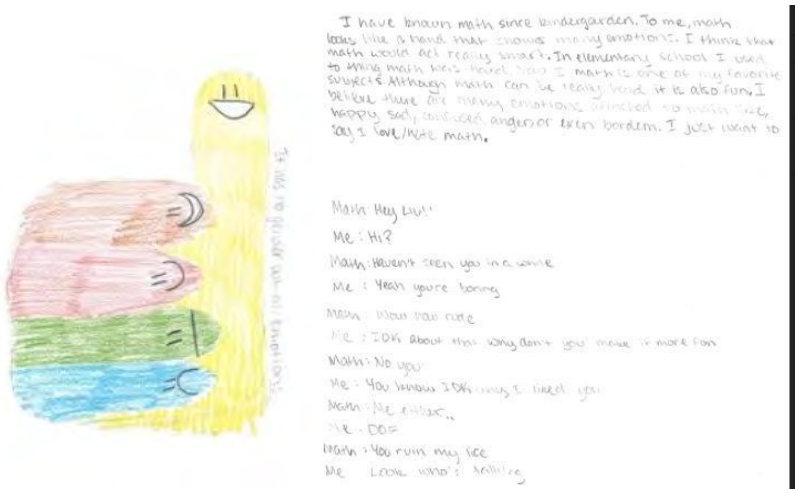

Figure 7: Former Friend Personification

The mathematical cartoons. We also added the mathematical cartoon personification to the Zazkis and Mamolo (2016) framework. Our students personified mathematics as cartoon mathematical symbols or objects, sometimes with no transcript or unemotional transcript. We struggled with determining what type of mathematical relationship was depicted. Although the drawing on the left in Figure 8 describes math as nice and funny, the cartoon depicted does not show much more emotion. The figure on the right says that "math likes to annoy kids," which is slightly negative, but the drawing itself is neutral. For the mathematical cartoon personifications, the drawings looked neutral, but if text was included, there was more insight the relationship with mathematics.

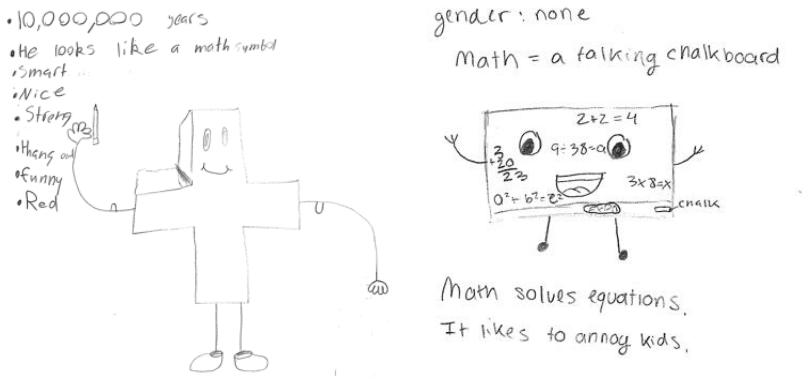

Figure 8: Cartoon/ Personification

Discussion

Unpacking middle schooler's personifications of mathematics is one aspect that makes this study significant. Prior studies on personifications of mathematics have been done with preservice teachers (Zazkis, 2015; Zazkis & Mamolo, 2016). This study extends this work to middle school students, which is important for understanding relationships with mathematics. Further, we describe additional personifications of mathematics (e.g., pests, nature).

Positive relationships in mathematics can lead to students pursuing careers in STEM. We want all students to have a positive relationship with mathematics and to see themselves as young mathematicians, especially those that have been traditionally underrepresented in STEM (Wickstrom & Gregson, 2017). Understanding and describing mathematical relationships helps researchers and educators support more positive relationships with mathematics. In this study, positive relationships were illustrated in personifications of mathematics as bests friends and in nature. The nature personification highlights the beauty and complexity of mathematics. The best friend personification illustrates someone that you spend extended, enjoyable time with. When we think about those personification, in what ways do we support our students in befriending mathematics or seeing the nature in mathematics?

Similarly, understanding the depth of negative relationships in the person is also important for supporting transformation in mathematical experiences of our students. If we understand what is negative about the relationship, then researchers and educators can work together towards specific changes. Negative relationships in this study were personified as mathematics as terrible beasts, authoritarians, abusers, and pest/nuisances. In what ways do we perpetuate these personifications in school mathematics?

Acknowledgments

We would like to thank the Paul K. Richter Memorial Fund and the Evalyn E.C. Richter Memorial Fund, distributed by the Bank of America, for funding this work.

References

Baker, K., Jessup, N. A., Jacobs, V. R., Empson, S. B., & Case, J. (2020). Productive struggle in action. *Mathematics Teacher: Learning & Teaching, PK–12*, 361–367.

Black, L., Mendick, H., & Solomon, Y. (2009). *Mathematical relationships in education: Identities and participation*. New York: Routledge.

Boaler, J. (2002). Paying the price for "sugar and spice": Shifting the analytical lens in equity research. *Mathematical Thinking and Learning, 4*(2–3), 127–144.

Braun, V., & Clarke, V. (2020). Thematic analysis. In H. Cooper (Ed.), *APA Handbook of Research Methods in Psychology* (Vol. 2., pp. 57–71). American Physiological Association.

Hunter, R., & Anthony, G. (2011). Forging mathematical relationships in inquiry-based classrooms with Pasifika students. *Journal of Urban Mathematics Education, 4*(1), 98–119.

Langer-Osuna, J. M., & Esmonde, I., (2017). Identify research in mathematics education. In J. Cai (Ed.), *Compendium for research in mathematics education* (pp. 637–648).

Martin, D. B. (2000). *Mathematics success and failure among African-American youth: The roles of sociohistorical context, community forces, school influence, and individual agency.* Mahwah, NJ: Lawrence Erlbaum.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2018). *Catalyzing change in high school mathematics.* Reston, VA: Author.

National Academies of Sciences, Engineering, and Medicine. (2016). *Barriers and opportunities for 2-Year and 4-Year STEM degrees: Systemic change to support diverse student pathways.* Committee on Barriers and Opportunities in Completing 2-Year and 4-Year STEM Degrees. Washington, DC: The National Academies Press. doi: 10.17226/21739.

Parks, A. N. (2020). Creating joy in PK-Grade 2 mathematics classrooms. Mathematics Teacher: Learning and Teaching PK-12, 113(1), 61–65.

Picker, S. H., & Berry, J. S. (2000). Investigating pupils' images of mathematicians. Educational Studies in Mathematics, 43(1), 65–94.

Ruef, J. (2020). Visions of possible: Using drawings to elicit and support visions of teaching mathematics. Mathematics Teacher Educator, 8(2), 59–80.

Smith, M. S., Huinker, D., Bill, V. (2017). Taking action: Implementing effective mathematics teaching practices (K–5).Reston, VA: National Council of Teachers of Mathematics.

Steele, C. (2011). Whistling Vivaldi: How stereotypes affect us and what we can do. W. W. Norton & Company.

Stinson, D. W. (2004). Mathematics as a "gatekeeper" (?): Three theoretical perspectives that aim toward empowering all children with a key to the gate. The Mathematics Educator, 14(1), 8–18.

Wickstrom, M. H., & Gregson, S. (2017). Responding to inequities in mathematics education: Opening spaces for dialogue. Journal of Urban Mathematics Education, 10(1), 16–31.

Zazkis, D. (2015). Monsters, lovers, and former friends: Exploring relationships with mathematics via personification. *For the Learning of Mathematics, 35*(1), 33–38.

Zazkis, D., & Mamolo, A. (2016). Personification as a lens into relationships with mathematics. *Proceedings of the Conference for Research in Undergraduate Mathematics Education*. Pittsburgh, PA.