The Universe Does Not Count: Promoting a Humanistic Ontology for Math

By Kenneth Butler
University of Dayton

This is an autobiographical narrative discussing mathematical ontology. I focus on how myths about the nature of math are related to oppressive pedagogy. Many in education see mathematics as a necessary progression of rules and procedures with these rules and procedures being universally true. This makes strict adherence to K-12 curricula mandatory, and it can be seen in the rigorous, very specific standards that are pervasive in education. These standards contain fixed formulas and concepts that must be covered, and this type of curriculum often leads educators to teach math as if it is also rigid and predetermined. This myth advances a narrow definition of math in support of a tiered social structure with people who know mathematics having more social capital than people who do not. In this paper, I discuss how the myth that mathematics exists beyond human knowledge and is discovered by gifted geniuses is related to fixed ontological mindsets about the nature of mathematics.

This misconception about the nature of mathematics can be summed up with a question I am often asked by students, "Is math invented or discovered?" I have been on both sides of this fence, but critical analysis has allowed me to reconcile my own contradictions.

Review

According to Voskoglou (2018), the idea that mathematics exists independently from human knowledge appears at least as early as the writings of Plato and the Pythagorean concept of universal mathematical forms. For Plato, geometric forms are perfections of reality and exist on a higher plane than ordinary perception. This type of mathematical realism is still common in many philosophical circles. Wigner's (1960) observation that math is unreasonably effective in the physical sciences is an appeal to mathematical realism. Taking this a step farther, Tegmark (2014) states that the universe is not just describable by mathematics, but it is mathematics. In opposition Livio (2009) notes that this argument is circular, as it begins with an assumption that mathematics is not a human invention.

The one concept that has the most legs when discussing the existence of mathematics is the natural numbers (Atiyah, 1995; Shapiro, 2000). Leopold Kronecker is known to have said, "God made the natural numbers, man made everything else." Voskoglou (2018) takes exception to this, as do I. Voskoglou discusses highly intelligent jellyfish in a pure continuum. As they don't experience themselves distinct from their surroundings, they may never experience the discreteness necessary to invent natural numbers. I too have thought that our reliance on counting at the early stages of mathematics may be a result of our subjective cultural experience as being distinct from others. Self-awareness may lead to isolation and, therefore, discreteness.

Kasner and Newman (1989) provide an argument against mathematical realism with an appeal to non-Euclidean geometries. Here, Riemann's invention and success with elliptic geometry reveals that the universe does not follow the geometric perfections within Euclidean geometry. This demotion of Euclidean geometry may provide evidence against mathematical realism.

Butler, K. (2024). The universe does not count: Promoting a humanistic ontology for math. *Currere Exchange Journal*, *8*(1), 24–31.

Voskoglou (2018) concludes that, although the discovered or invented argument is not settled, Livio's (2009) statement that mathematics is a part of human culture is certain. Voskoglou also conjectures that the way we conceptualize mathematics may have important implications for math education. This is my concern here.

Does the way we conceptualize mathematics affect how we teach and learn mathematics?

Conceptual Frameworks

This work is rooted in the extreme subjectivism of Freirean (1968/1996) critical theory. I begin with his concept that all knowledge is human knowledge and use this simple truth to speak to the positivist contradiction. I understand that we can make discoveries about our universe, and we can base these discoveries in data. We can also assign truth value within a given framework. However, we choose the questions to ask, and we interpret data based on previous knowledge. We invent the frameworks we use to define truth, and in agreement with Freire, we learn by reconciling the contradictions between new experiences and previous knowledge. Within a Freirean framework, all knowledge is human knowledge, and thus, a humanistic approach to epistemology is vital.

My discussion of a humanistic ontology for math begins with Skovsmose (1994). The mathematics that we observe from others is a particular type of formalization of language and behavior. However, I expand on this to explore math as a formalization of cognition and rely on Popper's (1972) three worlds framework for discussing a humanistic ontology for math. Popper's first world consists of all things in the universe. His second world is unique to each individual and consists of individual cognition. His third world consists of the products of human cognition. The principal outcome of this paper is that math cannot exist in Popper's first world.

Gutierrez et al. (2023) discuss harmful narratives that reinforce inequity in mathematics education and how to turn these harmful narratives in a more positive direction. In their analysis, they use the term mathematics in the plural because there are many types of mathematics. I acknowledge this and use the term similarly. They also use the term mathematics *conocimiento* as the informal thought processes associated with pattern, relation, and structure that all beings use to make sense of experience. Although in the current political climate of education we may need to label this type of cognition as something different than the mathematics that is taught in school, I prefer a more revolutionary approach. Here, when I refer to math in the singular informal sense, I am referring to this type of cognitive abstraction that is common to all humans. By labeling this type of cognition as math, I am suggesting this is where math education should focus. I also suggest that, when referring to different types of mathematics, people are generally referring to the different types of mathematical artifacts that humans produce and not the math they used to produce these artifacts.

Methodology

This is a qualitative autobiographic study aligning with the *currere* methodology developed by Pinar (1994). I use a temporal approach to an autobiographic narrative. I begin with a regressive exploration of past experiences. This is meant to be a freeform reflection. This is not a step-by-step historically accurate rendition. I begin this regressive exploration with the experiences that are, as the saying goes, at the top of my mind. I then proceed to other relevant experiences. Like all memory, these experiences do not have a linear progression. After exploring relevant memories, I discuss present—on topic—understandings. Next, I move to a progressive exploration of my vision for the future. Finally, I analyze how the past and the future influence my present and then synthesize a framework to support a humanistic ontology for mathematics.

Regressive

I remember working on my master's in mathematics and being asked to prove some new property in my first analysis course. I spent much of my time thinking about this proof. Looking at other similar proofs from class. I walked and thought. Then, something happened. I had an epiphany, I wrote it down, and I took it to my professor. He looked at it, turned to a bookcase, found a book, spent some time, and finally found the relevant page. The proof in this dusty tomb was almost identical to the one I had just discovered.

As an undergraduate in Philosophy, thinking about the nature of math was not new to me. I liked the idea that there is more to existence than physical experience. I saw math as getting us closer to Kant's *noumena*. If math existed and we discover it, then math was like reading tea leaves. Math was giving us a portal to something otherwise unknown.

In my undergraduate math courses, I began to realize that math was at its heart deductive. Mathematical statements were true because they had to be. We begin with undefined terms, define axioms, and then we see how a structure built from these elements behaves. I began to think of math as a science that does not depend on the world. Instead, I began to see it as a creative human endeavor.

This contradicted many of my mentors. Several were devout with a combination of Christian, Islamic, and Hindu beliefs. These professors saw math as a way to better understand God. They were never explicit in this, but I could see the desire to portray math as supernatural. For one professor, who we affectionately called the preacher, the motivation for teaching seemed to be to instill in us an appreciation of the beauty and spiritual discovery that he found in math.

This dichotomy between discovery and invention began much earlier. In elementary school, I was taught that an apple fell on Newton's head and he discovered gravity. At the time, this was not questioned, and it helped me remember Newton's name. Much later I learned more about Newton's life and his devotion to math and alchemy. Unfortunately, the seed was sown. That image of the apple persists. The people who discover these things are lucky geniuses who just happen to be in the right place at the right time.

In my K-12 experience, no one ever told me where the math came from. I just thought math was math. It was written in stone. Two plus two is four. The ideas seemed forever existent. When taught how to solve a problem, we did not question the strategy. Algebra was about following rules, and these rules did not change. It was not until my junior year in college that anyone talked about the history of math or the people who created it.

As a math graduate assistant, I taught a methods class to future elementary teachers. The professor I was working under had me teach the Mayan base twenty system. It was only then that I began to realize math could look different to different cultures. However, the contradiction still persisted. The more I looked at the history of math, the more I realized that seemingly isolated cultures came up with the same mathematical constructs. Zero appeared independently in Mesopotamia and in Central America. If math did not have independent existence, how could isolated people invent the same constructs independently. Math still seemed to be magical.

More recently this question came up in my math methods course for future high school teachers. One of my best students asked me if I thought math was discovered or invented. Of course, as a teacher my answer was, “What do you think?” He was on the discovery side of the argument, and he stated many of the ideas I have already discussed. The same math concepts spring up in isolation, and he had had a similar experience as me. He had worked on abstract math and come up with proofs in isolation only to discover that his proof was the same as one created hundreds of years ago. I told him of my experiences and then asked, “Would math exist if there were no people?”

I have also recently discussed this with both of my sons. One is an engineering undergraduate student and is much better at differential equations and applied calculus than I ever was. Although he is open to both sides of the argument, I believe he is currently in awe of discovery. He is seeing firsthand how the mathematical models are used to explain, predict, and modify experience. We both agree that the world seems to be well-ordered. We might even say the world is necessarily well-ordered, and math is humanity’s attempt to explain this order. However, it is the belief that experience follows a mathematical model that is the source of my contradiction.

My other son received his BA in history and is an aspiring film student. He recalls his first math class as an International Baccalaureate-tracked middle school student. His teacher told the students that they were special and different than the other students in high school. Because they were smart and would be taking IB math, they would be learning mathematics that most people were not taught. My son said that even at this early age he realized how “messed up” this was. To me, this revealed how a cultural myth about mathematical truth supports a hegemonic social structure. I realized that the purpose of this cultural myth is to promote inequity in mathematics education in support of white supremacy.

Present

Today, I am caught up in critical theory. I have opened my eyes to how our ontological mindset concerning the nature of mathematics can produce oppressive or emancipatory outcomes. When we proclaim math exists outside of human knowledge and humans discover it, we limit our creativity, since anything other than the objectively perfect math must be a mistake. We relinquish our power. Math no longer comes from hard work, and we begin to see it as static and unchanging. We also begin to see the people who discovered math as having some supernatural ability that is not available to the common person. These discoverers are no longer humans. We have replaced God and Scripture with math and science, and the saints we worship are named Newton and Einstein.

The myth of the apple hitting Newton in the head portrays him as getting lucky. The truth could not be more different. Newton spent his life dedicated to mathematics and other scholarly pursuits. He accomplished so much because he worked so hard. Notice there are also myths that Einstein was a bad student, and he flunked math. Although there is no truth to these myths, they serve to dehumanize. Similar to Newton, Einstein was somehow special and gifted.

My question now becomes, why do we need to dehumanize mathematicians? The answer may be obvious. Teaching math in K-12 may not be about empowering students to create math. Perhaps, it is about indoctrinating students into a hegemonic social structure that requires them to accept math and science as producing objective truth and to accept that people who do math and science are special and deserve to be treated as such. Notice this keeps students from questioning the inequities in our educational system and in society. People who are good at math are special and, therefore, deserve more. This lets students off the hook. They can rationalize that they are not one of those mathematicians. They are not interested in how their cell phone works. They just know it works. They are OK with letting someone else control the technological aspect of their lives, because the people who do mathematics are weird and dissimilar to them. Unfortunately, this mindset promotes inequity by creating a division between people who do math and people who don't.

The idea that all knowledge is human knowledge is fundamental to any critical pedagogy. Students must see themselves not only as doers of math, but they must see themselves as similar to the people who invented the math they are doing. All students do math every day, and it is only through the humanization of the ontology of math that we will be able to promote it as something that is intimately human.

Progressive

I imagine a future with math education based in a humanistic ontology. Math is presented in historic context with human perseverance at the heart of the discussion. Newton did not discover gravity after getting hit in the head with an apple. Instead, Newton spent his entire life studying math and alchemy. His advances in calculus and physics were a result of perseverance and hard work. With this mindset, formulas and rules are not static truths to be forced on students. Instead, students are allowed to invent math and see where their structure leads. In this way, students begin to understand that different assumptions lead to different conclusions, and that certain assumptions will always lead to the same conclusions.

By presenting math as a human endeavor in which all people engage, we can begin the transformation of math education to an equitable space. Math would no longer be about rigor and discipline; instead, math would be about creativity and hard work. Once students and teachers realize that all people do math and that math was invented by people similar to them, they will have the critical consciousness necessary to liberate math education from the shackles of mindless procedure. Math would no longer be about following the rules and language of the dominant culture. Instead, math would be the most creative class in K-12 education. Creative exploration of structure would be the norm, with students formalizing their own thoughts, and exploring the thoughts of previous generations. Instead of the current situation with much of math education being about memorizing formulas and following rules in order to perform well on standardized tests, learning math would be about removing the contradictions between current understandings and new information.

Analysis

I have seen the wonder and beauty in mathematics. I understand how this can lead to a belief that it exists objectively beyond human understanding. This is an illusion. Any appeal to mathematical realism is ad hoc. The question becomes, what math is the real math? At one time people thought that Euclidean Geometry was a godlike perfection of reality. We then found it does not work on many larger scale problems. Instead of being a perfection of reality, I now see mathematics as art. Just as the artist captures beauty in landscapes, the mathematician expresses beauty in the order of experience. The artist's painting is not the landscape, just as the mathematical model is not the experience. One can insert a higher being to solve the contradictions in the question of whether math is invented or discovered, but this ad hoc solution only prolongs the issue.

On the other hand, the conceptualization of math as a human endeavor is strongly aligned with critical pedagogy. Mathematical artifacts have been created in all cultures throughout the world. When math is presented as a creative human construct, students realize they already do math. This is why a humanistic approach to the ontology of math is a foundation to equitable education. One of the main goals of a critical pedagogy is to empower students to believe they can be historical (Freire, 1968/1996). To promote positive mathematical identities, math educators must encourage students to believe they are inventors of new mathematics. In this way, our ontological conceptualization of math affects how we teach and learn mathematics.

Synthesis

Conceptualizing mathematics in alignment with critical theory, Skovsmose (1994) explained math as a formalization of language and behavior. He stops short of stating that math is abstract thought. Gutierrez et al. (2023) discuss mathematics *conocimiento* as a cognitive abstraction in which all humans engage. For them, everyone uses pattern, relation, and structure to make sense of experience, and critical inquiry reveals a need for mathematics *conocimiento* to be the foundation for learning more formal mathematics. By conceptualizing math as this cognitive abstraction in which we all engage, we acknowledge a shared humanity. We put an end to positivism. All mathematics is and was built by humans, and math becomes a type of cognitive abstraction where humans use quantitative and spatial reasoning to make sense of experience.

I find Popper's (1972) three worlds to be convenient structure for discussing a humanistic ontology for math. The first-world consists of all objects in the universe. This world is the focus of study for physical science. I submit that math does not exist here. The pulp and graphite utilized when doing mathematics with paper and pencil exist in the first-world, but the math itself does not. This first-world may necessarily be well-ordered, and math gives us a powerful tool for describing the order we experience, but this well-ordered universe is not obeying mathematics. Popper's second-world of cognition is math's home. This world is unique to each individual. This is where math is invented and practiced. Everyone cognitively performs math. This is similar to Gutierrez et al.'s (2023) mathematics *conocimiento*. Popper's third-world consists of human made products. This is where an individual's math is shared. The written mathematical expression exists in the third-world, but the math itself is performed in the individual's second-world. When we see someone else doing mathematics, when they explain their math to us, they use artifacts to demonstrate their understanding. The third-world is where Skovsmose's (1994) formalization of language and behavior lies. Without the use of Popper's third-world for communication, there would not be these formal constructions we label as mathematics.

Formal third-world mathematics are human expressions of our cognitive understandings of order. These representations may or may not be useful in modeling experiences of the first-world, however, even when a model is useful, it is a mistake to believe it is an objective truth. Physicists changed the theory of gravity from the Newtonian model to Einstein's relativity not because the universe changed, but because relativity is more encompassing. It explains previously misunderstood experience. Notice, Einstein died working on a unified field theory. He knew there were still contradictions in even the best models. The first-world does not follow our model. Instead, third-world models are explanations of our individual second-world experiences.

The myth that mathematics are objectively true, appears partially because formal school-based mathematics are almost always deductively true. Students are taught mathematical proofs are true because they must be. This can lead one to believe that proofs exist before they are invented. This is an illusion. Formal mathematics begin with counting numbers and undefined terms such as point and space. These are as close as mathematics get to Popper's first-world. There are no points outside of human knowledge. A point can't be drawn without adding thickness, but people can agree on the concept of a point. People can formalize the idea of a point in their second world and use third world language to explain their concept to others. We can then invent axioms based on these undefined concepts and use the rules of logic to build formal mathematical structures. Some of these structures such as Euclidean geometry are extremely useful for modeling experience, but structures exist that are applicable when Euclidean geometry is not. Every mathematical model fails in certain situations.

As a mathematics educator aligned with critical theory, I believe that all students have the capacity to learn nonroutine mathematics. This begins by promoting positive math narratives. I want my students to believe that they are capable of inventing math. They are historical. This radical empowerment is best achieved through a critical pedagogy where the teacher-student contradiction is erased. Both student and teacher must believe that all people do math. To support equity, we must deconstruct the meritocracy that is supported by this cultural positivist myth that mathematics is this ultimate truth that exists beyond human imagination.

I see no benefit to framing math as somehow existing outside of human knowledge. However, the philosophers and mathematicians who have historically posited mathematical realism do have something to gain. If mathematical realism is true, then mathematicians are in contact with a higher realm. This places an enormous amount of cultural capital in the hands of the mathematician. The argument is that they alone are able to converse with this higher power. This myth places mathematicians as the epistemological Shaman of society and puts truth in the hands of the mathematically educated elite. I grew up in a cultural tradition that posits some knowledge as authored by God. I think this is the root of mathematical realism. For many in my culture, there is a belief that mathematics somehow exist outside of human knowledge and are divinely posited onto unusually gifted people. To ensure math is accessible to all people, this oppressive ontology must be replaced by a humanistic approach. One truth seems to be unquestionable. All knowledge is human knowledge.

This result may not be satisfying to the most ardent philosophers, as I do not rely on a philosophical argument. People define mathematics. In the end, I suggest this framework because it becomes necessary. Throughout the shared history, highly educated humans in oppressive societies have argued that they alone are discovering real objective knowledge. Scholars use the tools of philosophy and math to prove that they alone possess truth. By critically looking into these elitist biases that are housed in circular arguments, I now understand how these arguments support their authors by giving them divine insight. These arguments have worked to support a hegemonic class system, with scholars justifying their existence while their sustenance is maintained by an historically underpaid and often unpaid working class. When this is understood, you can begin to think critically about why these arguments persist. As for me, I have reconciled my own contradictions, and the answer is clear. Math is not magic. The universe does not count.

References

Atiyah, M. F. (1995, September 29). Book review [of *Conversations on mind, matter and mathematics*, by J. -P. Changeux & A. Connes]. *Times Higher Education Supplement.*

Freire, P. (1996). *Pedagogy of the oppressed* (Revised ed.). *Continuum*. (Original work published 1968)

Gutiérrez, R., Myers, M., & Kokka, K. (2023). The stories we tell: Why unpacking narratives of mathematics is important for teacher conocimiento. *The Journal of Mathematical Behavior*, *70*, Article 101025. https://doi.org/10.1016/j.jmathb.2022.101025

Kasner, E., & Newman, J. R. (1989), *Mathematics and the imagination*. Tempus Books.

Livio, M. (2009), *Is God a mathematician?* Simon & Schuster.

Pinar, W. F. (1994). *Autobiography, politics and sexuality: Essays in curriculum theory 1972-1992*. Peter Lang.

Popper, K. (1972). *Objective knowledge: An Evolutionary Approach.* Clarendon Press.

Shapiro, S. (2000). *Thinking about mathematics.* Oxford University Press.

Skovsmose, O. (1994). *Towards a philosophy of critical mathematics education.* Kluwer Academic.

Tegmark, M. (2014). *Our mathematical universe: My quest to the ultimate reality*. A. Knopf.

Voskoglou, M. G. (2018). Is mathematics invented or discovered by humans? *Philosophy of Mathematics Education Journal*, *33*, 1–12.

Wigner, E. P. (1960). The unreasonable effectiveness of mathematics in the natural sciences. *Communications on pure and applied mathematics*, *13*(1), 1–14. https://doi.org/10.1002/cpa.3160130102