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Mathematizing Perceptions: Preservice Teachers' Use of Mathematics to Investigate their Relationship with the Community

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Mathematizing Perceptions: Preservice Teachers' Use of Mathematics to Investigate their Relationship with the Community

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Abstract

Preservice teachers often hold deficit views about the students they will teach and their communities. These limiting beliefs can result in lower expectations of and poor outcomes for the students, and need to be addressed in all areas of teacher education, including mathematics courses. The assignment described in this manuscript provides an example of the work that can take place in mathematics content courses for preservice K-8 teachers. As part of the assignment, preservice teachers used mathematics to investigate negative perceptions that their campus community has of the surrounding neighborhood. Through working on the assignment many preservice teachers began to question their stereotypes about the community. Because of the preservice teacher interest in the topic, and because some problematic beliefs were displayed in the reflections, there is a need for similar assignments in this and other courses, in order to help preservice teachers see the strengths of diverse communities, instead of just their shortcomings.

Keywords: PSTs, K-8 education, social justice, deficit beliefs

Matematizando Percepciones: Uso de las Matemáticas para Investigar la Relación con la Comunidad de los/as Futuros/as Maestros/as

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Resumen

Los/as futuros/as maestros/as a menudo tienen concepciones del déficit sobre sus estudiantes y sus comunidades. Estas creencias limitadas pueden dar lugar a bajas expectativas y a pobres resultados de los estudiantes, y se necesitan afrontar en todas las áreas de la formación del profesorado, incluyendo los cursos de matemáticas. El texto descrito en este manuscrito ejemplifica el trabajo que se puede hacer en cuanto a los contenidos de los cursos para maestros/as de infantil y primaria. Los/as futuros/as maestros/as usan las matemáticas para investigar estereotipos negativos que existen en el barrio. A través del trabajo en el texto, muchos/as maestros/as empezaron a cuestionarse sus estereotipos sobre la comunidad. Debido a su interés, y a que aparecieron algunos estereotipos problemáticos en sus reflexiones, se detecta la necesidad de usar tests similares en otros cursos, para que los futuros/as maestros vean los puntos fuertes de la comunidad, y no solo sus debilidades.

Palabras clave: PSTs, educación infantil y primaria, justicia social, creencias del déficit

According to projections, the 2014–2015 school year is the first in which Caucasian students are no longer the majority in the United States public schools: the National Center for Education Statistics (NCES, 2014) has estimated that Caucasian students represented 49.7% of the school population in 2014, and predicts that this percentage would decrease to 45% by 2023 (NCES, 2013). In addition to becoming more ethnically diverse, schools are also becoming more socioeconomically disadvantaged: it is estimated that approximately half of all public school students receive free or reduced lunch (Southern Education Foundation, 2013).

Unfortunately, the increasing ethnic and socioeconomic diversity of the student body is reflected neither in the teaching force nor in the school curriculum. According to a teacher survey from 2011 (NCES, 2011), 84% of public school teachers were Caucasian, whereas, as mentioned earlier, the majority of students are non-Caucasian. Similarly, though not as pronounced, a significant difference can be observed between students' and teachers' socioeconomic status (Zumwalt & Craig, 2005). Meanwhile, school curricula favor the experiences of White, middle-class children, while excluding those of others. West-Olatunji, Behar-Horenstein, Ryant, and Cohen-Phillips (2008) state that culturally diverse students face the following main difficulties that Caucasian students generally do not: the centrality of Western, Eurocentric values, lack of cultural sensitivity, lack of materials representing different cultures, and segregation (p. 27). The centrality of Western, Eurocentric values is particularly prevalent in mathematics, which is usually taught as if it were solely the product of White, European male thought, dismissing the sizeable contributions of other cultures (Felton, 2010; Joseph, 2000). Mathematics textbooks and standardized tests infrequently represent different cultures in a meaningful way and instead favor the experiences of White and/or middle-class students (Tate, 1994). Teachers contribute to the problem, overlooking the experiences of diverse students and seeing their backgrounds as lacking (Castro, 2010; Cruz, 1997; Ladson-Billings, 2006; Villegas, 2007).

To address these issues, all areas of teacher education programs should be tasked with preparing *culturally responsive teachers*, who will view their students' backgrounds as assets and create curriculum that will reflect their lives (Gay, 2000; Ladson-Billings, 1995). Research has identified traits of teacher education programs successful in this endeavor, recommending

particularly that preservice teachers (PSTs) receive exposure to diverse communities, coupled with ample opportunities for reflection on these experiences. However, not all teacher educators can fully implement these recommendations. For example, an instructor may be committed to preparing teachers to teach for diversity, yet not be supported at the institutional level. S/he may teach courses outside of the education department and can therefore only make an impact through her/his individual course. A salient question to ask in this situation is: *How can such courses be informed by research and adapted in ways that honor both the research recommendations and context? In particular, how can this be done in a mathematics content course for PSTs?*

This manuscript describes a mathematics assignment that took place in a mathematics content course for preservice K-8 teachers, and allowed PSTs to investigate their relationship with a diverse community. Namely, PSTs were required to visit a campus event that explores various issues of social justice, and to write a mathematics report about one of the featured scenes. Many PSTs were impacted by a scene that explored the uneasy relationship between their campus and the surrounding community, and decided to investigate it further. The assignment provided a unique opportunity for PSTs to reflect on their misconceptions while using mathematics to make sense of them. I will share excerpts from the PSTs' reflections and final reports, and discuss the challenges and opportunities that arose from the assignment. I will also share implications for future work.

Review of the Literature

Beliefs about Diverse Communities

Many PSTs enter teacher education programs with little prior contact with diverse communities; yet they will be called to teach an increasingly diverse student population. Because of their limited experiences and inaccurate perceptions, PSTs may view their future students and their communities negatively. In a review of literature on preservice teacher views about diversity, Castro (2010) cites repeated evidence of stereotyping and even intolerance of diverse students. Ladson-Billings (2006) documents PSTs' eagerness to attribute students' lack of academic success and engagement to culture: "Whenever students seem not to be able to explain

or identify with students, they point to students' culture as the culprit" (p. 105). In a review of previous research on PST's beliefs, Villegas similarly finds a common theme of deficit beliefs and low expectations, noting that "prospective teachers generally enter teacher education believing that cultural diversity is a problem to be overcome and that students of color are deficient in some fundamental way" (p. 374). Yet these deficit beliefs are directly linked to academic success: according to Kitchen, Roy, Lee, & Secada (2009), "[l]ow expectations are believed to be at the root of ineffective pedagogy with students of color and the poor" (p. 57). Another related belief commonly held by PSTs is that students, especially urban students, whose environments are seen as dangerous, malnourishing, and directly responsible for their underachievement (Castro, 2014), are in need of saving. It is not uncommon for teachers to see themselves as "saviors," akin to those portrayed in Hollywood films, who can single-handedly change the culture of a school and turn around the lives of otherwise apathetic and perhaps even dangerous students (Castro, 2014; Gilbert, 1997; Scull & Peltier, 2007).

It is the responsibility of teacher education programs to address these misconceptions and challenge the deficit beliefs held by PSTs. This is not an easy task to accomplish, as many PSTs are resistant toward teaching for diversity, either due to ideological or pedagogical disagreement, or to lack of confidence and skills (Rodriguez, 2005). Research has identified some successful strategies for challenging PSTs' negative beliefs about their future students and their communities. For example, field placements into schools in diverse communities have consistently been found to be effective, particularly when there is a strong reflection component to the placement (Cruz, 1997; Dunn, 2005; Ladson-Billings, 2000). Teacher education programs have successfully infused their curriculum with opportunities to learn about students and their communities through authentic relationships with community members (Sleeter, 2001; Zeichner, 2010). In other words, PSTs must have opportunities to interact with communities they will teach, challenge their own deficit beliefs, and learn to see the communities as resilient and resourceful rather than deficient. It is important to note that not all exposure to multicultural issues is effective or even productive, especially if it is sporadic and brief. Sleeter (2001) cites examples of programs and courses that had no effect on the PSTs, or whose effect was reversed as quickly as within a month.

Teaching Mathematics

PSTs frequently also hold limiting beliefs about mathematics. Many enter their mathematics content courses with the belief that mathematics is a set of fixed rules, and that to teach it, one only needs to transfer these rules to students (Ambrose, 2004). In their prior instruction PSTs learned to view mathematics as an objective subject that always yields the correct answer, and they do not expect to deal with issues of multiculturalism or beliefs about students in a mathematics class (Kitchen et. al., 2009). However, mathematics is not objective or neutral: decisions are constantly made about where mathematics comes from; who is good at it; whose knowledge is privileged; and what types of questions are answered (Felton, 2010; Gutstein & Peterson, 2013). The mathematics curriculum as seen in textbooks and most classrooms is built around the experiences of students who are considered to be the norm, typically White, middle-class students (Frankenstein, 2009; Tate, 1994).

In opposition to the belief that marginalized students' backgrounds have little to offer to the curriculum, culturally responsive mathematics pedagogy proposes that all students bring unique knowledge and experiences to the classroom: specifically referred to as *funds of knowledge* (Civil, 2007). Ladson-Billings has long documented practices of successful mathematics teachers of African-American children: while there is no easy fix or "magic bullet" (Ladson-Billings, 1995, p. 159), teachers must possess cultural competency and cultural awareness, must have high expectations of all students, and strive for collective, not individual empowerment.

Culturally responsive pedagogy uplifts the mathematical knowledge not typically valued in mathematics instruction. These ideas are closely tied to the ideas of teaching mathematics for social justice. Gutstein (2006) discusses three types of mathematical knowledge: classical, community, and critical. Classical knowledge is prevalent in mathematics courses, including those for future teachers. Community knowledge corresponds to funds of knowledge, and includes competencies that students gain in their communities, as well as the knowledge they possess about their world. Critical mathematical knowledge incorporates what Gutstein (2006) and Frankenstein (2009) refer to as "reading the world with mathematics," based on the work of Paulo Freire. This knowledge requires "understanding the sociopolitical, cultural-historical conditions of one's life, community,

society, and world” (Gutstein, 2006, p. 25). According to social justice pedagogy, all three knowledge bases should be equally valued in a mathematics class.

Mathematics is a powerful tool for reading the world: it strengthens arguments and sheds light on issues in a manner that purely qualitative information never can. For example, mathematics can help us determine if “stop and frisk” policies should be considered racial profiling; if the number of liquor stores in the vicinity of a school complies with city code; or if minimum wage provides a living wage (Gutstein & Peterson, 2013). The use of mathematics can also help PSTs gain better understanding of diverse students and their communities. By choosing relevant contexts, instructors in content courses can challenge PSTs’ perceptions about their future students while also strengthening their ability to engage meaningfully with mathematics.

Context

The Mathematics Content Courses

I teach two mathematics content courses for preservice K-8 teachers at a medium-sized liberal arts university in the United States. The first course focuses on algebraic and number sense, while the second covers the other strands of school mathematics: geometric sense, measurement, probability, and statistics. The primary goal of the courses is to deepen the PSTs’ conceptual understanding of K-8 mathematics, or their classical mathematical knowledge. It is also important to me that the PSTs improve their relationship with mathematics and begin to see it as deeply relevant to their lives and the lives of their future students. I am especially interested in helping them expand their definition of mathematics to include critical and community knowledge. As the primary instructor for the course I have freedom in choosing curriculum; however, due to time constraints I am unable to give the community and critical aspects of mathematics the amount of attention that classical knowledge receives. Furthermore, PSTs take my courses either before entering the education program or in their first semester upon entering, and I do not know whether they will encounter these topics again. Because of these circumstances, I frequently ponder the

question posed in the introduction: given my limited area of influence, how can I maximize the impact of the experience on the PSTs?

A partial answer to this question is provided in modeling culturally responsive pedagogy in my own teaching. I have posed numerous problems to the PSTs over the years to help develop their critical mathematical knowledge, for example: How much waste do discarded water bottles produce? Can sweatshop laborers be paid a living wage? Is the U.S. minimum wage a living wage? However, though helpful for understanding the world, these topics were not necessarily relevant to the PSTs. They were often far removed from their current experience, and while I firmly believe that mathematics problems should provide information about the world outside of our immediate environment, I also know that the PSTs will be more likely to respond to a curriculum that addresses their own interests. A way to reconcile the two is to provide contexts that I deem important, while also allowing PSTs to seek topics they can identify with or find compelling. The Tunnel of Oppression, the event described below, provides such a context.

Tunnel of Oppression

Tunnel of Oppression (which I will refer to as “the Tunnel” throughout), first conceived at Western Illinois University in 1993, takes place every year at a number of college campuses around the United States, and is typically organized by student groups. It consists of scenes that investigate different forms of oppression and injustice faced by individuals, groups, communities, and the Earth. Some scenes are acted out, others contain audio and video recordings, and yet others consist of written information displayed on posters. Students go through the Tunnel in groups, guided by docents who help visitors make sense of the scenes, though the docents’ involvement is minimal. It takes between 30 minutes and one hour to experience all the scenes. At the end students have a choice to write about their impressions, and attend a debrief session facilitated by staff and faculty members. The experience can be emotional, and occasionally students have to leave before the end.

Tunnel of Oppression Assignment

I have been a debrief facilitator for the Tunnel for four years. After the first year, I was struck by the amount of quantitative data that was either present in or conspicuously missing from the Tunnel, and decided to create an assignment around it. I knew that the assignment would be closely aligned to my goals to prepare PSTs to work with diverse students, as many of the scenes featured in the Tunnel successfully portray discrimination faced by marginalized groups, from women to people of color to the LGBTQ population, thus raising the PSTs' awareness of the issues they may encounter in the future. PSTs in my spring classes attend the Tunnel and write reflections about the event and their experience attending it. The reflections include a description of the event, personal impressions, the mathematics explicitly or implicitly present in the event, and instances in which mathematics was absent but could have been beneficial. Often these reflections contain the seed of the report whose first draft will be due within two weeks. For example, a PST may comment that a scene impacted her due to a personal connection; another may indicate that he would like to learn more about an issue; and a third may observe that a scene could easily have been improved with some mathematical or statistical data. In either case, I encourage the PST to explore the topic further. This increases the PSTs' investment in the assignment and makes it more relevant to them, especially if a personal connection exists.

The general requirements for the report are similar for both classes, though the mathematical content required for each will differ. In both cases, PSTs are required to provide: (1) at least three mathematical facts that were not in the Tunnel, from at least two different outside sources; (2) at least one mathematical argument combining the numbers they found; and (3) an explanation to the organizers about how more mathematics could have strengthened their argument, with concrete examples given. I have recently provided sample assignments from previous years to give examples of successful mathematical arguments, as this is the most difficult part of the assignment for the PSTs.

Neighborhood Setting

The green, quiet campus of Northwest College (NWC)¹ where I teach is located in a diverse, low-income suburb of a medium-sized city in the Northwestern United States. I will call this suburb Middletown. The majority of the NWC students are from the state but not from the vicinity of the campus. Many live, eat, and socialize on campus, which they seldom leave. The relationship between the campus and surrounding community of Middletown is an uneasy one. The negative stereotypes about the community, especially its youth, are persistent at NWC, and often include derogatory terms. The school district surrounding the campus has the highest rate of students receiving free or reduced lunch in its county, 68%. There are one high school, one middle school, and four elementary schools within one-mile radius of the university. Though field placements favor other school districts, PSTs are likely to volunteer in surrounding schools through other courses and mentoring programs offered on campus. Middle school and high school students walk through the campus and use the facilities, especially the basketball courts, but they are hardly welcomed.

Featuring the Neighborhood in the Tunnel of Oppression

The first scene in the 2014 Tunnel of Oppression consisted of two large word walls. The first featured words that the college students used to describe Middletown, and the other contained words used by the middle and high school students in Middletown to describe college students at NWC. The scene was simple yet powerful because the contrast between the words was immense. The middle and high school students described the campus community as safe, prosperous, smart, and educated; but the college students described the surrounding community as poor, lacking future, scary, and sketchy.

The scene had an impact on the majority of the PSTs. Approximately 2/3 of the 33 reflections discussed this particular scene from the Tunnel, and we had an impassioned classroom discussion about it. Eventually, eight PSTs chose to explore this scene for their final reports, more than any other. These eight assignments are discussed in more depth.

Student Work

Reflections about the Scene

The reflections mentioning the scene conveyed the feeling of discomfort. For some PSTs, this was the first time they questioned their negative beliefs about the neighborhood, like the one that wrote, “I myself have thought negative things about Middletown and I began to wonder if my thoughts were justified.” Many admitted having used similar negative terms for the neighborhood in the past, while also not knowing much about it. One PST wondered why she and her peers were “quick to jump to conclusions about the area.”

Those from the community were impacted in a different way. One PST mentioned the lasting impact the scene had had on her. She lamented the treatment of middle school and high school students by some members of our community, concluding that she found it “very unfortunate that NWC students would complain so much about students just trying to have a good time and hang out with friends in a place that they felt safe.” Another PST from the community reported being irritated by the scene. She felt she and her friends were stereotyped, and argued that the negative perceptions are a consequence of a lack of knowledge:

Sure, not all kids are innocent and some of the kids I went to high school and middle school with are punks, but they have also been through a lot. Abuse of all kinds, death, deployed parents, working parents, raising their siblings, you name it.

She then proceeded to critique the inaction of the campus community, asking, “If people have such an issue with it, then why don’t they *change* it?” Other reflections echoed that sentiment. Only one considered the strengths of the community while others focused instead on ways to improve or help it. Rather than question their own beliefs or complicity in the status quo, they assumed that the community was in need of help, which they were uniquely positioned to offer. One PST saw in the opposing views on the posters a “desperate need and hope for the community,” and suggested that NWC students should be the first to reach out, but did not explain how. Another suggested educating our students about the

community and making efforts to connect the two. No concrete plans of action were given and no PST expressed interest in taking up the cause.

Mathematics in the Scene

When answering the question about how more mathematics could have benefited the scenes, almost all those who mentioned the neighborhood scene in their reflections noted that, while powerful, it would have been strengthened with some mathematics and statistics. A few PSTs thought that it would have been beneficial to show the difference in economic status between the college students and students from the community. Another argued that data should be used to argue that:

The poverty and diversity are things that should be talked about, should be recognized, but most of all, the diversity that surrounds NWC as a part of Middletown and the diversity that is a part of NWC in general is something that should be celebrated.

In contrast to this approach, another PST was interested in using data to confirm the stereotypes that already exist, and focused on the “seriousness of the situation” rather than the strengths of the community:

Some words that the NWC students have said about Middletown are “sketch”, “dirty”, “suspicious”, “dark” and “scary” [sic]. These words were very powerful, however, I felt that if some statistics were included the scene would have been much more impactful and it would have been easy to grasp the seriousness of the situation.

A few PSTs made the astute observation that the word walls were completely devoid of numbers, such as the exact number of those who contributed the words on the walls. One PST in particular argued that this was important to know, because,

[f]or example, if just few people who contributed, the perceptions given would most likely be skewed and biased. However, if there was a large group of people that contributed, the perceptions presented would probably more accurately reflect the view of the general public.

I especially appreciated this observation, as it shows that this PST is asking critical questions about the validity of the data presented to her and its potential emotional manipulation.

Final Reports

After the reflections, PSTs had a little less than two weeks to write first drafts of their reports, and another two weeks to write the final drafts, based on my feedback. All the reports focused on one or more of the following: (1) household income, (2) education, (3) crime rates, and (4) diversity. Examples of student work with brief discussion are given for each topic.

Household income and poverty levels

The majority of reports considered income as the topic to research when addressing perceptions of Middletown as “poor.” While on the one hand they were successful in finding the information and comparing it with state incomes and poverty levels, the PSTs failed to explore the topic in depth. They concluded that Middletown is, indeed, impoverished economically, but offered little insight beyond that. Their frequent use of additive comparisons (i.e. comparing two quantities through finding differences) highlights the need for increased attention to teaching multiplicative comparisons (i.e. comparing two quantities through ratios), percentage change, and other topics relevant in the real world.

Example 1. One report found that the percentage of inhabitants living below the poverty line in the community, 19.9%, is 7% above the state average. It also compared median incomes statewide and in the community, finding that former is \$12,392 higher than the latter. This is a significant difference, however the PST failed to compare this difference with the total median incomes to understand its relative size, and merely concluded that the area was “slightly less privileged than much of the rest of [the state].”

Example 2. Another report correctly noted that the difference in median incomes is substantial, and that “the addition of that income has the ability to make a huge difference in a household.” It also used a multiplicative comparison, finding that “the average household in Middletown only makes 74% of the average income of a household in [the state].” It would be worthwhile to ask this PST which comparison gives more information and

why. It may not be obvious to the PSTs that multiplicative comparisons often have the power that additive comparisons do not.

Example 3. A third report found that the median household income in Middletown was \$42,092 and the average rent of \$826 and concluded that a household would have \$2,682 a month left over for other expenses after paying rent. Though mathematically this is a good direction to take with the data, it lacks knowledge of the real-world, in particular that due to deductions, take-home pay is usually substantially less than gross income. The point she made is valid, however: “When you have a car, kids and household bills, this money isn’t going to go very far; especially since gas prices are so high and groceries are so expensive.” It would be powerful to explore this idea further and understand what an annual income of \$42,000 means for a family of four.

Educational Attainment

To explain the low median income in the community, some PSTs considered education data, in particular graduation rates from high school and college. Again, the analyses were mostly correct, but not necessarily deep.

Example 1. One PST found that the graduation rate for the school district was 55% (this number is different from official data; we will consider the issue of inconsistent data when discussing challenges of the project) and applied this number to the campus community: if NWC had such a low graduation rate, only 1,925 out of 3,500 students would graduate yearly. Using proportional reasoning to scale an issue up or down to campus size is beneficial for PSTs, as they can better understand the problem in terms of their own experience.

Example 2. Another PST misread the information she found: according to state data, 35% of adults have high school degrees and 10% have college degrees. Unaccustomed to reading data, she assumed that the categories included each other (although the percentages add up to 100%) and concluded that “[t]he average number of this 35% of students to go on and get a Bachelor’s degree drops by 25 percentage points with only 10% of the 35% having received a bachelor’s degree,” which would result with 3.5% of the population with bachelor’s degrees.

Diversity

Because comparing income data between Middletown and NWC was not necessarily encouraging, some PSTs considered the larger proportion of diversity of Middletown, which helped them see the strengths of the community. Unfortunately, the mathematics used in these comparisons was weaker than in others.

Example 1. One PST wrote: “Aside from the lesser income, graduation rates, and probability of acquiring a degree, the Middletown families are actually quite astounding.” She based this statement on the fact that 21.3% of the households spoke English as a second language and that 40% of the population was of a race other than Caucasian. This PST concluded that this was 21.6% higher than the rest of the state, and that this diversity was something that the NWC students should “highly value.”

Example 2. Another report, by a student who was actually from Middletown, chose to see poverty more positively, asking “why not embrace the poverty that surrounds NWC and try to learn and emerge ourselves into different cultures and different ways of living, hence broadening the lenses that we may create when at NWC.” This is a powerful perspective, though unfortunately limited to those PSTs who were already empathetic with Middletown.

Crime rates

NWC students perceive the surrounding community as a high-crime area. Because this perception is not quite true, this would have been a powerful topic to explore. Unfortunately, only two PSTs addressed it.

Example 1: The PST looked at the neighborhood crime index, and found that Middletown score was 121 (compared to the national average of 100). Although she noted that this was below the state average of 128, she still maintained that there were reasons to feel uneasy and that, because the burglary crime rate was so high (149 compared to the state average of 120) she wrote that the numbers give “little understanding to why students at NWC may not always feel the safest in Middletown.” She concluded her report in a positive manner, stating that the rape index for the neighborhood

was significantly lower than for the state, “showing the Middletown might not be as bad as some claim it to be.”

Example 2. The PST who expressed frustration in her reflection about the words her peers used about the community she was raised in created an effective argument in favor of Middletown. She chose to compare the suburb of Middletown to its neighboring city, which is generally considered safer and wealthier by the students at NWC. In comparing crime rates, she found that “the probability of becoming a victim of crime in Middletown is 1 out of 278 per 1000 residents while in [the city] the chances of becoming a victim of crime are 1 out of 125 per 1000 residents.” She conducted a similar comparison of incomes, and concluded that there was no reason to consider the city superior to Middletown. She used simple mathematics in her report to create perhaps the most powerful argument of all: if the neighboring city is viewed as safe and prosperous, then the same statistics show that Middletown deserves the same, if not improved, image.

Impact

Because PSTs tend to write what the instructor wants to hear, rather than freely share beliefs that differ from the instructor’s (Rodriguez, 2005), measuring the true impact of this assignment is difficult. While reflections about the Tunnel are always positive, the end-of-course evaluations offered more insight: in the past PSTs were more critical of the Tunnel assignment, while this time only two comments referred to it. The first read, “Essays/papers in math make no sense. The tunnel assignment seemed pointless. I didn’t feel like I learned much.” I frequently receive comments such as this one. They exemplify the resistance PSTs have to moving away from mathematics as calculations and applying algorithms (i.e. classical knowledge) and engaging with contexts that develop community and critical knowledge. The other comment showed that the assignment had an impact on at least one PST, who recommended to “[u]se Middletown statistics/examples in class with math concepts. To show Middletown isn’t ghetto.” This PST is presumably from this neighborhood. Possibly the assignment, allowing PSTs to choose to investigate topics of interests, was culturally responsive to this PST, who likely encounters daily prejudice from her peers, and who was able to use mathematics to contest the negative beliefs she encounters.

Judging by some of the reflective comments in the reports, the assignment did have an impact on the PSTs: faced with the discrepancy between the views the campus community and Middletown youth have of each other, they searched for the community's strengths and found incredible diversity, which some argued should be celebrated, like in the following comment:

The fact that there is so much diversity in this tiny area is actually quite astounding. There are a multitude languages in the area that can be found, and the racial diversity is much greater than the rest of [the state]. It is obvious the substantial differences between the Middletown community and [state] averages when they are displayed side by side, as shown below, the successful rate of graduation is much higher in the rest of [state], but the diversity in Middletown flourishes.

Though the arguments about helping the community can be problematic, they also show compassion and desire to enter the community instead of just fearing it from the comfort of the dormitory. The following comment calls for community building and also acknowledges the importance of mathematics in building new understandings:

NWC students have the opportunity to help those kids out whether it is volunteering in a classroom or during afterschool activities. Once relationships are built between the NWC and Middletown community of students, there would be a lot less bashing and a lot more helping. Mathematical facts help to kick start and inspire the desire to help. It allows for people to see the reality of what is going on in the community around them.

Given the opportunity to volunteer or student teach in Middletown, these PSTs will hopefully bring the learning from the Tunnel assignment with them and enter these experiences with high expectations and desire to learn.

Challenges

While providing a successful venue for conversation about Middletown and the role mathematics plays in understanding the world, the assignment also posed challenges, both mathematically, and through reinforcement of stereotypes.

Mathematical Challenges

As PSTs were trying to make sense of the mathematics, they looked for information on the Internet. The numbers they obtained varied depending on websites they chose. For example, one PST found the district graduation rate to be 55% according to one website, though official information places it at 78%. A possible way to address issue is to require each figure to be cross-checked through two sources of data, and for all discrepancies to be discussed. PSTs should also be encouraged to find data from official, more trusted sources. This example also provides an opportunity for mathematical problem solving, through answering questions such as: How are graduation rates calculated? Can both 55% and 78% be correct?

Being unaccustomed to dealing with real-world data, PSTs sometimes missed discrepancies in the numbers they had obtained. For example, one report claimed that one in sixteen 18-24 year olds and one in five children ages 6-12 were living in poverty, which would mean a drop in poverty rates from 20% to 6% between these two age groups. This drop is possible if college students are included in the Middletown population and impossible otherwise, but the PST just cited the numbers without checking their reasonableness. All interactions with real-world data should include the question, "Is this reasonable?" in order to teach PSTs to question the data they collect and the conclusions they make.

The assignment also showed the PSTs' lack of experience with reading and understanding data, for example when misreading information and confusing individual and household income. Other times they failed to capitalize on the mathematical potential of the data, like when comparing median incomes by finding differences instead of ratios. This preference for additive instead of multiplicative (or proportional) reasoning is common for K-12 students and PSTs alike, and can be addressed through exposure to contexts like these, with explicit discussions about the advantages and

disadvantage of both approaches. For example, what does it mean to say that Middletown's median income is \$12,392 below that of the state, versus saying that it is 74% of the state's median?

Some PSTs had good mathematical ideas but were unable to execute them due to lack of information. As just one assignment in one class, the assignment did not carry enough weight for PSTs to explore their chosen topics in-depth. For example, one PST was struck by the description of the campus community as "privileged" and wished to show, through scholarship data, that NWC students are in need of financial aid and therefore not privileged. However, scholarship data is difficult if not impossible to obtain, and she was unable to complete her mathematical argument. In the future, more incentive should be given to PSTs to conduct in-depth investigations, through changes in the structure of the assignment.

Reinforcing Stereotypes

PSTs were successful at identifying the shortcomings of the neighborhood, but not always able to identify its strengths. They were quick to jump to conclusions and assume the position of "savior," assuming that the community's problems could be solved through greater involvement of the university, or that schoolchildren needed them as role models because they had no others. Certainly, greater PST involvement in schools is an asset both for the PSTs and the schools, but only if PSTs enter schools as learners, understanding that communities have valuable assets. Some PSTs were able to come to that conclusion in their reports, as many zeroed in on diversity as being the community's greatest asset. By focusing the assignment on the community's strength in the future, more PSTs could begin to see it in a different light. The discussion should also not end there, and the next question for the PSTs should be: Now that you see diversity as an asset, how will you use it in teaching mathematics?

Future Work and Implications for Teacher Education

Mathematics content courses for preservice K-8 teachers can and should contribute to PSTs' better understanding of communities in which they will teach. Mathematics provides a unique tool for questioning the validity of our beliefs: though it may not necessarily pinpoint the cause of poverty or

lower graduation rates, it can challenge stereotypes about a neighborhood being dangerous and lacking potential. This assignment honors research recommendations through giving PSTs opportunities to learn about the community and reflect on their stereotypes. Ideally the contact with the community would be first-hand and sustained over the entire semester, which I am unable to provide due to limitations of my course. Instead, the assignment follows research recommendations to the extent possible in this context.

This particular scene will not occur in the Tunnel again, so I will not have the word walls to provide an entry point to a mathematics lesson about Middletown. However, the interest the scene generated and the polarized statements that were written make it clear to me that there is a need for PSTs to investigate the community that surrounds them through a similar assignment. To ensure that it does not reinforce their deficit beliefs about the community, the assignment will explicitly focus on aspects of Middletown that PSTs may not be familiar with: the language and cultural diversity; lower than expected crime rates; or recent successes of the school district.

The Tunnel of Oppression is an excellent venue for having conversations about mathematics and social justice, but it is not the only one. Teacher educators have an abundance of events to draw from in their own communities and create mathematics lessons meaningful to PSTs that also challenge their perceptions of the world.

Notes

¹ All names are pseudonyms

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