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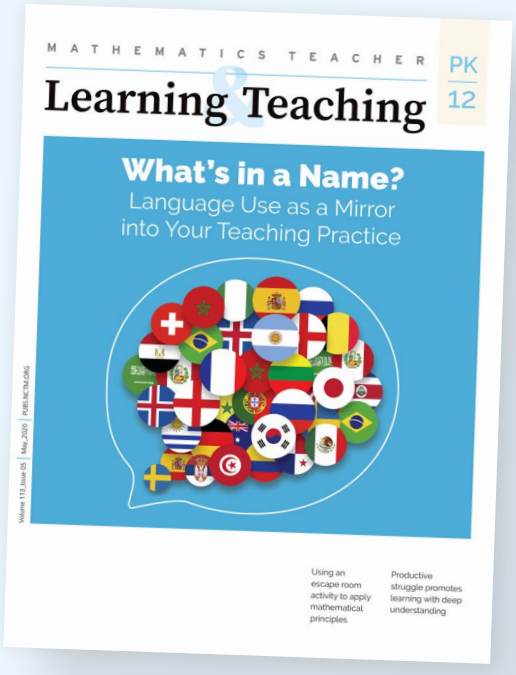

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Centering Empathy in a Mathematics Classroom

We introduce the "Notice-Wonder-Deeply Care About" routine, coupled with data talks, designed and implemented for teaching mathematics for social justice. This routine prioritizes critical civic empathy as a means of aligning the teaching of mathematics concepts with students' lives and societal implications.

Eunhye Flavin and Jennifer Suh

Mathematics educators and researchers have increasingly integrated social justice-oriented tasks into their classrooms. Teaching mathematics for social justice (TMfSJ) aims to help students develop mathematical knowledge in ways that promote students' abilities to critique the communities of which they are members (Ellis & Malloy, 2007; Gutstein, 2006). Kokka (2022) specified affective pedagogical goals in TMfSJ to address feelings, emotions, and well-being by centering relationships and healing. Gutiérrez (2018) advocated for rehumanizing mathematics, emphasizing the need for every student to have opportunities where the curriculum serves as both a window to the world and a mirror of themselves. This approach aims to accurately reflect and reveal both the multicultural world and the student's own identity (Style, 1996). To connect to children's lived experiences, Aguirre et al. (2022) described an instructional strategy called "Mathematizing the World," a routine that uses photo elicitation to develop students' noticing and wondering skills and asks why

and who cares about the issues (Arnold et al., 2022). In a parallel vein, Kahn et al. (2022) expanded a "Notice and Wonder" routine (National Council of Teachers of Mathematics, 2021) to emphasize emotions, praxis, and imagination to advocate for learners with opportunities to feel, act, and reimagine.

Drawing upon this theoretical shift toward the affective turn and aiming to create an explicit heuristic for TMfSJ, we propose a "Notice-Wonder-Deeply Care About" routine. This routine prioritizes building students' empathy while unveiling their profound concerns. Our approach amplifies the power of TMfSJ by enhancing critical civic empathy, which nurtures students' empathy beyond surface-level kindness for positive societal change (Mirra, 2018). We argue that centering critical civic empathy in mathematics classrooms has the potential to align mathematical concepts, students' lives, and broader societal implications. We seek to inspire students and teachers to see mathematics as a rehumanizing experience, during which mathematics is coupled with connection, joy, and belonging (Guiterrez, 2019) and serves as a way to analyze and take action (Zavala & Aguirre, 2023).

CLASSROOM CONTEXTS

We provide details about a lesson that was part of a community-based summer mathematics program in a gentrifying town of a northeast metropolitan area. The program included eight Haitian students, ranging from rising third to seventh grades. During the early stages of the program, a conversation emerged, during which some students suggested that working harder could resolve income disparities in their community compared with neighboring suburbs. In addition to these individual efforts, the lead author and the teacher of the program

Figure 1 Standards for the Task Used With the "Notice-Wonder-Deeply Care About" Routine

Social Justice Anchor Standards

1. Students will reorganize unfairness on the individual level and injustice at the institutional or systemic level.
2. Students will analyze the harmful impact of bias and injustice on the world, historically and today.
3. Students will recognize that power and privilege influence relationships on interpersonal, intergroup, and institutional levels and consider how they have been affected by those dynamics.

Common Core State Standards for Mathematics Content

3.MD.B.3. Solve one-and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.

6.SP.A.2. Understand that a set of data collected to answer a statistical question has a distribution, which can be described by its center, spread, and overall shape.

6.SP.B.5. Summarize numerical data sets in relation to their context.

6.RP.A.3. Use ratio and rate reasoning to solve real-world and mathematical problems.

Note. Sources: Learning for Justice, 2022, and National Governors Association Center for Best Practices (NGA Center) & Council of Chief State School Officers (CCSSO), 2010.

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wanted students to explore how other structural drivers, such as interpersonal, institutional, and systemic factors, may affect immigrants' income. With this goal in mind, we designed data talks titled "Mismatch in the Labor Market for Immigrants." We identified relevant social justice anchor standards and common core state standards for mathematics for this lesson (see Figure 1).

NOTICE-WONDER-DEEPLY CARE ABOUT ROUTINE

A "Notice-Wonder-Deeply Care About" routine consists of four steps (see Figure 2): (1) set up a prompt; (2) present an opening activity; (3) facilitate students' noticing, wondering, and deeply caring about; and (4) reflect and plan.

The routine initiates with Step 1, where a teacher selects a prompt that aligns with both social justice anchor standards and mathematics standards. Taking student experiences into account, the teacher creates a prompt that is grounded in reliable and valid evidence, allowing students to verify or expand their perspectives.

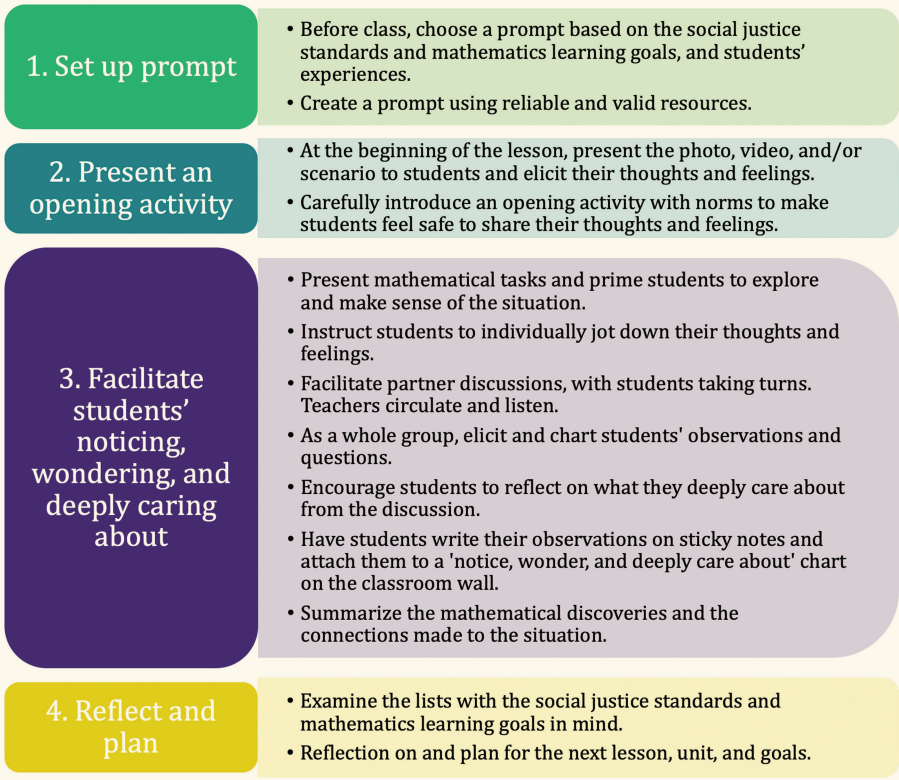
Once the teacher prepares the prompt, the teacher proceeds to Step 2 and presents a photo, video, and/or scenario to elicit students' thoughts and emotions. This activity is important to set the tone of the lesson and help students feel safe in sharing their ideas and feelings.

Step 3 marks the transition to the core mathematical tasks. Students will be iteratively involved in a "Notice-Wonder-Deeply Care About" model. The teacher allows students to have sufficient time to think individually and in pairs. During a whole-group discussion, the teacher can use talk moves such as restating, pressing for reasoning, and revoicing to make students' thoughts and feelings visible (Jacob et al., 2022).

Concluding the tasks in Step 4, the teacher reflects on whether the lesson led students to accomplish learning goals and plans for the next lesson, unit, and goals.

We recommend using a "Notice-Wonder-Deeply Care About" chart to guide discussions (see Figure 3). A teacher can set up this chart on a wall where

Figure 2 Four Steps of the "Notice-Wonder-Deeply Care About" Routine and Teacher Actions



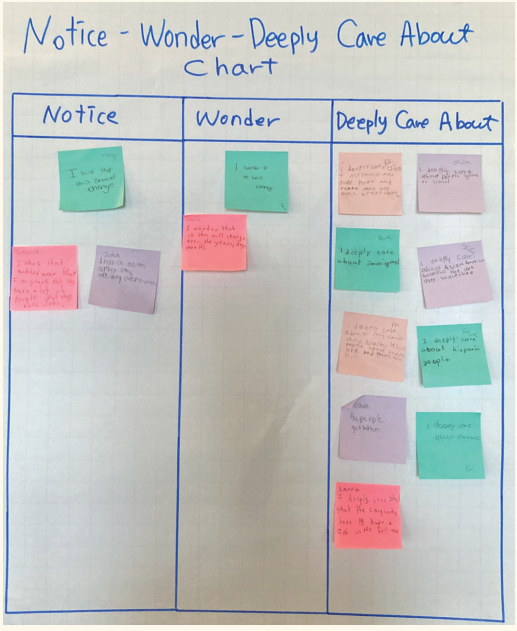
Note. Adapted from Rumack and Huinker, 2019, and Byrd et al., 2023.

students can write their ideas and feelings on sticky notes and attach them to the chart. Alternatively, the teacher can include this chart in worksheets, on which students individually record their thoughts and emotions.

MISMATCH IN THE LABOR MARKET FOR IMMIGRANTS PROMPT

This prompt consisted of an opening activity including a question, photograph, and scenario (Figure 4),

Figure 3 A "Notice-Wonder-Deeply Care About" on the Classroom Wall



followed by one bar chart (Figure 5) and two stacked-bar charts (Figures 7 and 9).

Step 1: Set Up a Prompt

To meet the learning goals, we carefully selected reliable data to be used for the data talks. We found two peer-reviewed journal articles: one that compared education and job skills mismatch by nativity (Li & Lu, 2023), and another that detailed mismatch within U.S. immigrant groups (Pivovaraova & Powers, 2022). We used the former article to examine the discrepancies by reviewing the descriptive statistics (see Table 1). The results of their analysis, which used a random-effect model, also showed that immigrants with foreign degrees are significantly more likely to experience job mismatches compared with their native-born counterparts.

The second article presented data in the form of a frequency table, which we transformed into three charts for the data talks: Figures 5, 7, and 9. The first graph is a ***bar chart*** (Figure 5) that highlights the disparity between the educational attainment of U.S. immigrants and the educational requirements of labor market occupations. Within this chart, a categorical variable has three categories: overmatch, correctly match, and mismatch. To help students see the complexities regarding the education-job mismatch, we created two more ***stacked-bar charts*** (Figures 7 and 9) that incorporated two associated factors: immigration generation status and race/ethnicity, respectively.

Step 2: Present an Opening Activity

To initiate a conversation, our prompt begins with an opening scenario (see Figure 4) and a photo that shows several hundreds of Haitians gathered at the

Table 1 Percentage of Education-Occupation Mismatch by Nativity

	By Nativity Status			
	Overall	Native-born	U.S.-Educated Immigrants	Foreign-Educated Immigrants
Vertical mismatch	26.2	25.6	23.3	35.4

Notes. Adapted from Li & Lu, 2023, p. 213. Vertical mismatch pertains to disparities between an individual's education level and the educational level typically needed for their occupation, indicating underutilization (undermatch) or overqualification (overmatch).

Directorate of Immigration and Emigration located in Port-au-Prince, Haiti, after President Joe Biden's announcement of the Humanitarian Parole program. Our opening was designed to set norms with rights of the learner (Kalinec-Craig, 2017) with the right to be confused; claim a mistake; speak, listen, and be heard; and represent only what makes sense. These norms allow for a democratic mathematics classroom (Ellis & Malloy, 2007) that creates a "forum for open discussions of mathematical and social issues and ideas, because, through such discussions, students are able to create, clarify, and re-evaluate their ideas and understand the ideas of others" (p. 161). We also highlighted mutuality between a teacher and students by disclosing their own histories (Osibodu et al., 2023).

Figure 4 "Mismatch in the Labor Market for Immigrants" Prompt Generated the "Notice-Wonder-Deeply Care About" Routine

Opening scenario

One way of understanding how the U.S. is favorable for immigrants to live well is to see if immigrants are able to find jobs that match their education and experiences. When immigrants end up in jobs that do not fully use their education, and skills, we call it an education-job mismatch. Today, we will investigate education-job mismatches among U.S. immigrant workers.

Step 3: Facilitate Students' Noticing, Wondering, and Deeply Caring About

This section provides an illustration of Step 3, which involved three distinct but interrelated data talks regarding one bar chart (Figure 5) and two stacked-bar charts (Figures 7 and 9).

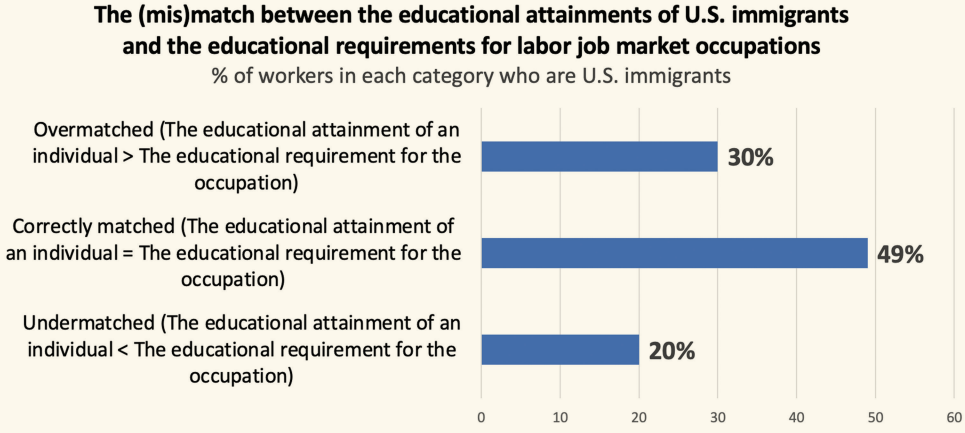
Data Talk 1 With a Bar Chart: Education-Job Mismatch

The lead author guided students to observe and wonder about information provided by the elements of the chart (e.g., title, *x*-axis, category, and variable). Each student had individual time to analyze the chart and then shared their thoughts with their partners. Through this initial conversation, the students refined the meaning of the three categories: overmatch, correctly match, and undermatch. For example, David made sense of a case of *overmatch* as someone who completed their undergraduate degree in Haiti. However, the job they aspire to get in the States does not credit that degree, so they have to reattend college here.

During the whole-group discussion, the lead author focused on key elements of the graph to clarify mathematical concepts. The following questions were used to serve that goal:

- What does the *x*-axis represent? What does the *y*-axis represent?

Figure 5 The mis(Match) Between Educational Attainments of U.S. Immigrants and the Educational Requirements for Labor Job Market Occupations



Note. Source: Pivovaraova & Powers, 2022.

- What is the category with the highest number of immigrants among the overmatched, correctly matched, and undermatched groups? What does this difference signify?
- What does a percentage mean? How is it different from frequency?

All the students noticed that 49% of the studied immigrants obtained jobs matching their previous education levels. This observation showed that students understood what the *x*-axis, *y*-axis, and bars represent. I asked another question aligned with the third-grade standards (NGA Center & CCSSO, 2010, 3.MD.B.3), "How much higher is the percentage of immigrants in the overmatched group compared to the percentage in the undermatched group?"

I also addressed the meaning of percentages. Although students used terms like 49%, 30%, and 20%, they did not fully grasp the distinction between count and percentage. Therefore, I provided an example: "We have four Haitian Americans and one Korean here. What percentage of Koreans are in this group?" Initially, the students responded with 1%, which simply counted one person and added a '%' sign. After clarifying the meaning of percentage, they realized that the correct percentage was actually 20% (one out of five people).

Students were also asked what they wondered about. Most of their statements were about in/equities they observed in this graph: Daniel said, "I wonder if the U.S. government can change this so that immigrants can get good work," and Henry said, "I wonder *why* immigrants can't have jobs that they used to have in the States."

Finally, students explicitly stated why they deeply care about the certain aspects of Figure 5. They identified the unfair treatment of immigrants as a problem by pointing out that a significant percentage (51%) of immigrants had a job that did not match their education levels. One student shared his parent's story, saying, "My mom used to be a police officer in Haiti, but when she came to America, she had to start her education all over again. It cost a lot of money." Following his account, another student responded, "I wonder if we can change it so that immigrants' previous skills get credited here." Figure 6 shows some examples of what students wrote on the "Notice-Wonder-Deeply Care About" chart.

Data Talk 2 Using Stacked-Bar Chart 1: Variations by Immigration Generation

All students in our study—except for two—mentioned that they had not seen a stacked-bar chart before. The stacked-bar chart serves as a tool to compare multiple sets of information across different categories of a variable on the *x*-axis or *y*-axis. It enables direct comparisons within the same chart based on immigration generation, race/ethnicity, gender, or any other desired comparison.

The mismatch between education and job is a complex issue where there are variations within the immigrant groups. While our data talks focused on two associated factors (i.e., immigration generation and race/ethnicity), we wanted to begin the discussion by hearing students' perspectives on possible factors. The lead author asked, "What factors may influence whether immigrants find jobs that align with their education?" The students generated a variety of factors; for example, Nadège addressed neurodiversity and behavioral traits.

The lead author then directed students to Figure 7. The students understood the definitions of

Figure 6 Examples of the Students' Accounts Regarding Figure 5

What do you notice?	What do you wonder?	What do you deeply care about?
• 30% of U.S. immigrants are overmatched. 49% of them are correctly matched and the other 20% are under matched. • There are 10% more immigrants who are overmatched than those undermatched.	• What does variable mean? • I wonder if they (the U.S. government) can change this so that they (U.S. immigrants) can get good work.	• They (U.S. immigrants) are being treated well. • I care about the lives of people that don't get fair treatment. • I deeply care about people getting a job that makes people's lives better.

first-generation and second-generation immigrants by relating them to their birthplace.

I asked students to delve into subgroup comparisons. This task is inherently challenging because in a stacked-bar chart, baselines are constantly fluctuating for the second variable, which in our case, was the education-job match. The students devised a strategy by themselves. As shown in Figure 8, one third-grader honed in on her sensemaking to determine variability by finding the difference between the sub-bar lengths using addition and subtraction. She figured out the differences between the same-colored bars. For example, the difference in correctly matched individuals between the two groups (orange bars) is 8%.

Throughout the conversation, students articulated their observations as follows:

- Both first-generation and second-generation immigrants have a larger proportion of individuals in the "correctly matched" category than in the "undermatched" or "overmatched" categories.

Figure 7 Variations in the Job Mismatch Among U.S. Immigrants by Immigration Generation

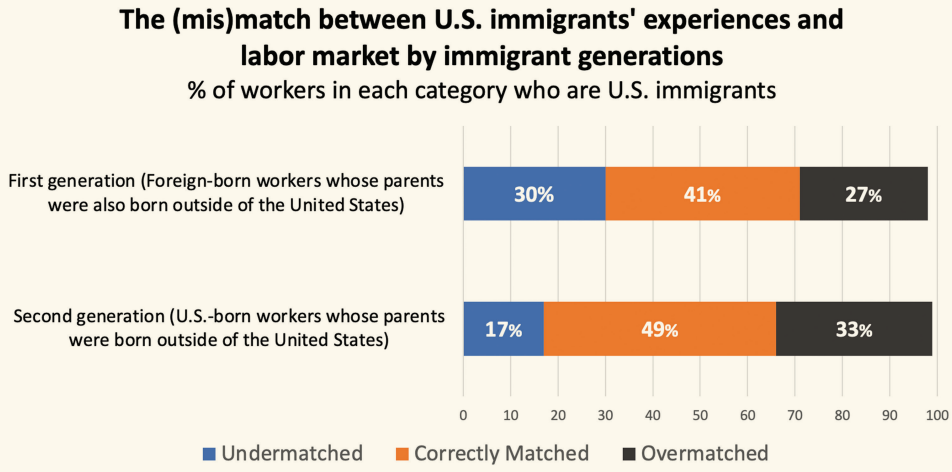
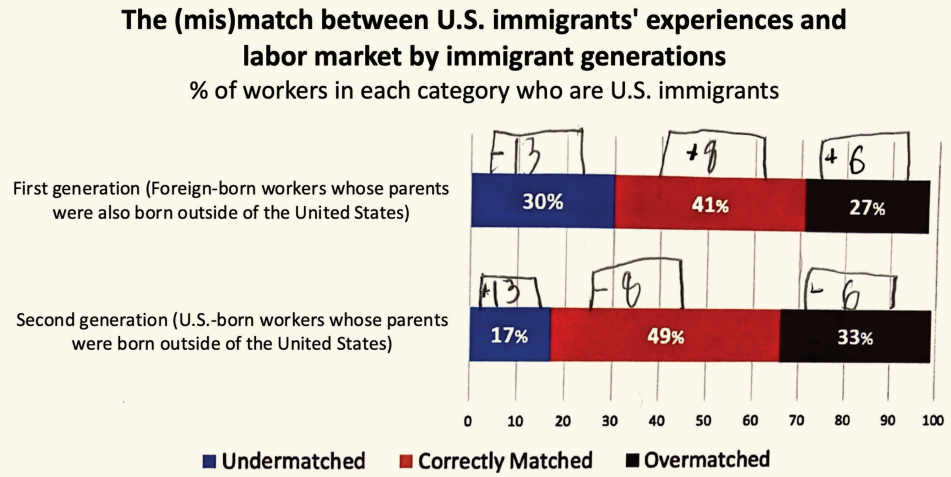


Figure 8 A Third-Grader Comparing the Percentages of the Category of Education-Job Mismatch by Immigration Generation Status



- 57% of first-generation immigrants have jobs that do not align with their education level, while 40% of second-generation immigrants face the same mismatch.
- First-generation immigrants are more likely to be in a situation where their job does not match their education compared with second-generation immigrants.
- Among the different racial/ethnic groups, approximately half of them have jobs that align with their education, while the other half do not.
- Asian immigrants show the highest percentage in the overmatched group.
- The percentages of correctly matched and undermatched individuals are relatively similar for white and Black immigrants.

While examining the stacked-bar chart, some students suggested exploring multiple variables that influence the education-job match, leading to a multivariate analysis. For example, David expressed that the education degree level needs to be considered, stating, "Being smart (what he means is 'going to college') is what counts. Even if you were not born here, you can still be correctly matched." Despite the inherent complexity of the stacked-bar chart, this topic consistently captivated the interest of students involved in a rich mathematical discussion.

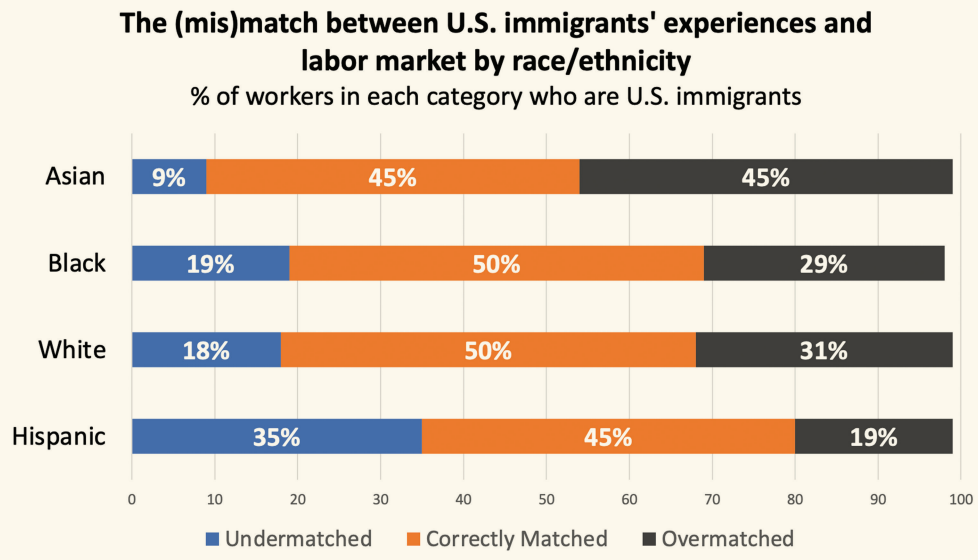
Data Talk 3 Using Stacked-Bar Chart 2: Variations by Race/Ethnicity

Students observed various aspects of Figure 9, which depicts disparities in education and job matching by race/ethnicity:

I asked the students to reflect on the meaning of these observations and express any questions they had ("wonder"). Students relied on their pre-existing perceptions to make sense of the data. James said that there are differences by race/ethnicity because of stereotypes. Kelly expressed confusion regarding why for both white and Black immigrants, the percentages for correctly matched, overmatched, and undermatched were similar.

Finally, the students proceeded to share what they deeply care about. They expressed their general concerns for immigrants across racial/ethnic groups. Some students emphasized their care for Asian immigrants because of their high level of overmatching. Some mentioned the undermatching experienced by Hispanic immigrants. The students discussed the importance of fairness and equity, advocating for equal treatment of immigrants (see Figure 10).

Figure 9 Variations in the Job Mismatch Among U.S. Immigrants by Race/Ethnicity



Note. Although we understand the difference between race and ethnicity, in line with the categorization used in the table from Pivovarova and Powers, 2022, we grouped race/ethnicity into Asian, Black, White, and Hispanic categories.

Step 4: Reflect and Plan

We analyzed the process and outcomes of a series of data talks, considering both social justice anchor standards and mathematics learning goals. Students recognized the social dynamic, such as the link between transnational migration and the recognition of an individual's education credentials. Students also expressed concerns based on the experiences of their families and communities. This dialogue served as a powerful motivator for them to delve into the data, even when they encountered the inherent mathematical complexities of stacked bars.

As the data talks progressed, students made progress toward their mathematics learning goals. The consecutive discussions on data facilitated their mastery of mathematical concepts. As one student stated, "The statistics in (stacked) bar charts reveal so much that we didn't know from the first bar chart." The teacher also noticed that students gained a better understanding of the graphs when the teacher prompted them to elaborate on how they made sense of the data.

Through engaging in dialogues with their peers and teacher, students collectively developed a sense of critical civic empathy. This collaborative process not only supported mathematical discussions but also facilitated conversations about taking action. One student's inquiry sparked a conversation: "I wonder if these things will change. Let's say, in 2026, will the situation be different and better?" Other students responded, stressing the importance of challenging stereotypes and implementing policy changes to minimize education-job mismatch. This case demonstrates the seamless integration of the instructional routine, wherein the production of mathematical knowledge intertwines with the collective construction of critical civic empathy.

CONCLUSION

The TMfSJ approach is deeply rooted in cultural-historical contexts and necessitates a careful examination of power dynamics and tensions. The data talks described in this study serve as an example of the advantages associated with the "Notice-Wonder-Deeply Care About" routine for historically marginalized students. Through this routine, some students saw aspects of themselves reflected back (mirror), while others developed awareness and views of worlds outside of their own (windows). Engagement in mathematical tasks that explicitly address structural issues and interpret them through a lens of critical civic empathy can spark a newfound insight (Kokka, 2020). This new perspective has the potential to assist students from any background in envisioning themselves as allies, actively contributing to social transformation instead of perpetuating harmful narratives. Teachers can support students in taking action, and this critical action can take many different forms. One example is that, based on students' discoveries of the education-job mismatch, they can create an infomercial and also write a letter to the U.S. Bureau of Labor Statistics (link online) to share their concerns based on their analysis of the data. We conclude that the implementation of the "Notice-Wonder-Deeply Care About" routine has the capacity to serve as a tangible educational resource for students to deepen and broaden their action possibilities as change-makers within and for society.

Figure 10 Examples of the Students' Accounts Regarding Figure 9

What do you notice?	What do you wonder?	What do you deeply care about?
• Asian immigrants are overmatched a lot. • Hispanic people are undermatched.	• I wonder if this will change over the years. • If they (the U.S. government) can look for ways to let them (U.S. immigrants) be the same.	• I deeply care about immigrants here having a job in the future. • I deeply care about Asian people overmatching. • People are treated fairly no matter their race is.

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