Promoting Equitable Practices in Mathematics Education

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Investigating the Manifestations of Bias in Professional Noticing of Mathematical Thinking among Preservice Teachers

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ABSTRACT This study examines potential bias with respect to perceived gender and ethnicity in preservice teachers' professional noticing of children's mathematical thinking. The goal of the study was to explore how, and to what extent bias emerges within pre-service teachers' professional noticing of children of differing perceived races and genders. Our findings suggest that bias tends to emerge in the interpreting phase of professional noticing; however, such emergence did not appear to vary in conjunction with the perceived ethnicity and gender of the student. Further, our findings suggest that the inclusion of visual imagery (i.e. photos) influence the manifestation of bias among preservice teachers to some degree when professionally noticing in the context of a written case.

KEYWORDS *equity, professional noticing, teacher noticing, numeracy, preservice teachers*

Equity concerns in mathematics have been pervasive for decades (Breslich, 1941; Diversity in Mathematics Education Center for Learning and Teaching [DiME], 2007; National Council of Teachers of Mathematics [NCTM], 2014), but there has been renewed attention to how mathematics classroom environments can support students from diverse backgrounds. Research has shown that students experience school differently because such experiences are informed by their racial and gender identities (Boaler, 1997; Gutierrez & Dixon-Roman, 2011). This is especially evident in STEM disciplines such as mathematics where students from non-dominant groups may have received implicit and explicit messages from an early age that they are not capable or do not belong (Goffney et al., 2018; Museus et al., 2011). In some cases, students have inequitable experiences because their teachers have lower expectations for them or do not consider their culture in their practice (Savage et al., 2011; Zavala, 2014).

We view teaching mathematics for equity as providing opportunities for all students "to learn rigorous mathematics in culturally specific, meaningful ways that seek to improve the economic and social conditions of marginalized individuals and groups, and that work toward reduc[ing] deficit-oriented beliefs about who is or is not 'good' at mathematics" (Leonard & Evans, 2012, p. 100). In order to make mathematically appropriate decisions in a classroom, the framework of *professional noticing of children's mathematical thinking* (hereafter, *professional noticing*) is used to guide teachers' understanding of children's knowledge (Jacobs et al., 2010). Teachers' beliefs about who is and is not "good" at mathematics represents an intersection of professional noticing and equity. The process of professional noticing describes teachers' *perceptions* of student thinking. There are, however, opportunities for manifestations of bias inherent in such a process. The purpose of this study was to explore how and to what extent bias emerges within pre-service teachers' professional noticing of children of differing perceived races and genders.

Professional Noticing of Children's Mathematical Thinking

The professional noticing framework used in this study incorporates three interrelated components: attending, interpreting, and deciding (Jacobs et al., 2010). The first component of professional noticing, *attending,* is to observe and identify children's words and actions when

engaging in mathematical activity. Next, *interpreting,* is to relate what is attended to, with what is known about development in mathematics knowledge in order to determine what the child understands. Finally, *deciding,* is decision making based on what is interpreted in order to ensure a student is learning in a way that best fits their current understanding of mathematics.

Professional noticing and related practices (e.g., teacher noticing, professional vision) have captured the attention of mathematics education researchers for decades (Goodwin, 1994; Mason, 2002; Schack et al., 2017; Sherin et al., 2011). Researchers in the past have considered forms of observation and interpretation such as *professional vision* (Goodwin, 1994), *teacher noticing* (Sherin et al., 2011), or simply the *discipline of noticing* (Mason, 2002). Building upon these conceptions, Jacobs and colleagues (2011) conjectured a third, interrelated component, *deciding,* thus creating the phrase *professional noticing* (of children's mathematical thinking). While professional noticing may seem somewhat intuitive, Jacobs et. al (2010) determined that focused practice (rather than simply years of teaching experience) was predictive with respect to noticing quality.

In their explorations of teacher noticing, Sherin and van Es (2009) used teacher video clubs as a way to analyze student thinking. Participants provided videos of their own classrooms and analyzed the videos through a noticing lens during the professional learning sessions. They found that focusing on noticing children's thinking impacted the teachers' instructional practices in a positive way.

When authentic classroom experiences are not available for instructing preservice teachers, classroom videos are commonly used for those instructional purposes. We used video vignettes to improve the professional noticing skills of elementary preservice teachers and found positive changes within one semester of instruction focused on professional noticing (Fisher et al., 2018). Using a wider lens for analysis, Stockero et al. (2017) used classroom video to gain practice in identifying key opportunities for pedagogical action within a mathematics lesson. Referred to as Mathematically Significant Pedagogical Opportunities to Build on Student Thinking (MOST), these incidences may be thought of as teachable moments (Stockero et al., 2017). In this instance, professional noticing may be thought of as a narrowing practice aimed at filtering instruction to find key points of leverage. Conversely, other portrayals of professional noticing describe the practice more as a net aimed at gathering all pertinent information within a moment and leveraging such information for interpretations and decisions (Schack et al., 2013).

Equity

Examination of professional noticing through the lens of equitable teaching practice has been the focus of recent studies (Jong, 2017). Specifically, professional noticing has been interwoven with equity constructs and frameworks to better understand how teachers' activity in the moment influences students' participation and positioning (broadly construed) in the mathematics classroom. Examining the relationship between professional noticing and equity concerns, Louie (2018) makes a case that strict cognitive orientations of professional noticing can often miss important cultural and ideological dimensions of children's mathematical activity. Louie describes a teacher who challenges historical/traditional views of intelligence in mathematical contexts. By positioning students from underrepresented cultures/races as mathematically capable, these students are able to assume more positive mathematics identities. This type of positioning also espouses an asset-based perspective where students' backgrounds and their contributions are valued. Similarly, Harper (2010) presents an anti-deficit framework of research on students of color in STEM by shifting questions to focus on assets. For example, rather than asking why there are so few African American females who succeed in mathematics, the issue is reframed such that teachers focus on promoting mathematical success among Black females. While subtle, the reframing of questions, challenges, and issues in mathematics education is consistent with asset-oriented perspectives regarding particular research initiatives.

Further, Jackson et al. (2018) integrated professional noticing with four dimensions of equity (i.e., access, achievement, identity, power) put forth by Gutierrez and Dixon-Roman (2011) to create an equitable noticing framework for the investigation of equitable presence within each component of noticing. Jackson et al. (2018), write:

> Classroom episodes are complex; it is inevitable that individuals choose, consciously or subconsciously, what they notice, or attend to, and use the interpretations of these events to make instructional decisions....Teachers may attend to equitable issues in the classroom as a process or a product....Seeing equity as a process means treating all students equally without regard to race, ethnicity, or economic background. On the other hand, seeing equity as a product means differentiating instruction based on students' needs; implementing equitable approaches that are respectful of students' ethnic, racial, and economic background and promoting equal learning outcomes. (pp. 266–267)

The application of an equity lens to the practice of professional noticing provides space to consider how, and to what extent, mathematics teachers are considering and responding to such difference in the moment (e.g., racial, ethnic, gender, socio-economic, etc.) among students.

Kalinec-Craig (2017) also provides another example of the intersection between professional noticing and equity concerns. To examine the role of race in professional noticing, she examined how three Mexican American preservice teachers considered their own, in-the-moment teaching practices. Interestingly, two of the three subjects engaged in more detailed professional noticing of status and participation when the background of their students differed from their own. This suggests that culture, experiences, and biases influence, to some extent, the manner in which teachers use professional noticing in the mathematics classroom. In summary, intersections between noticing and equity concerns are of rising prominence in the mathematics education literature.

Methodology

Survey Design

To examine the emergence of bias (i.e., asset/deficit perspectives), an electronic survey was constructed. The primary element of this survey was an adaptation of a video-based professional noticing measure from a study of preservice teachers' (PSTs) professional noticing capabilities (Schack et al., 2013). Specifically, rather than using a video-recording as the anchor for professional noticing measurement, we substituted a transcription of the video recording. Prior iterations of this study only included a transcription of the video with various names of perceived ethnicities and genders. In this study, there was an additional feature added to the survey—pictures attached of students which appear to match the race and gender of the child's name.

Similar to Schack et al. (2013), PSTs were asked to respond to three prompts; however, in the current study, the picture was also visible. Each prompt aligned with a particular component skill of professional noticing:

1. Please describe in detail what [Student Name] did in response to the problem. (attending)

2. Please explain what you learned about [Student Name]'s understanding of mathematics. (interpreting)
3. Pretend that you are [Student Name]'s teacher. What problems or questions might you pose next? Provide a rationale for your answer. (deciding)

Additionally, PSTs were prompted to provide some basic demographic data (i.e., gender, ethnicity, age, home state) as well as their familiarity with professional noticing. However, demographic questions were asked at the end of the survey to alleviate any priming effects. Specifically, posing demographic questions (i.e., race, gender) at the onset may prime participants to more consciously consider such constructs in subsequent items thus distorting measurement of unconscious forms of bias (Lavrakas, 2008).

The affordance of using a transcript rather than a video recording was that it allowed us to easily modify the perceived gender and race of the student in question. As such, we generated transcripts featuring the names and pictures of four different students with the aim of each student eliciting different perceptions of gender and/or race. The transcript case names were *Margaret* (perceived white female), *William* (perceived white male), *Shaquan* (perceived African American male), and *Miguel* (perceived Latino male). We acknowledge that the previous iteration of this study assumes that participants perceived the intended race solely based on names, which is why we eliminated the limitations of assumption based solely on the name by adding a visual representation paired with the stereotypical names (see Figure 1). Note, we staged these case photos such that student and

Figure 1

Case Visuals

Latino Male

White Male

African American Male

White Female
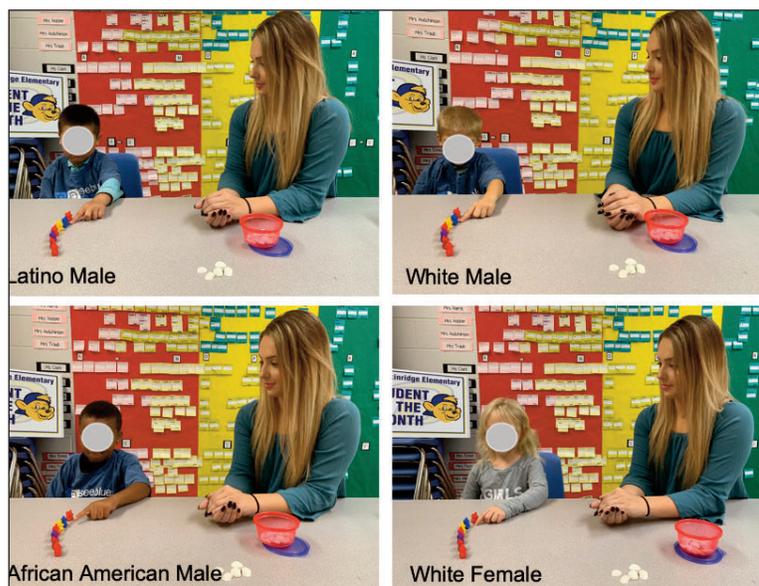
teacher poses were as close to identical as possible, and the clothing was similar (i.e., child wearing the same t-shirt) in three of the photos. We limited the situations to these four cases since we wanted to maximize opportunities to examine differences across gender (i.e., male/female—William/Margaret) and race (i.e., African American/Latino/white—Shaquan/Miguel/William). While more cases would have allowed for additional comparisons (e.g., Latino Female/Latino Male), they would also have necessitated a much larger data set to ensure that each case had an adequate number of survey respondents.

Participants

The electronic survey was fielded nationwide among PSTs who were in various stages of their respective teacher education programs at their institutions of higher learning. To increase the probability of PST response rates, we leveraged professional connections to mathematics teacher educators as the mechanism for fielding this survey. We sent the survey (along with some brief recruitment text) to 31 teacher educators across 18 states. These individuals were within the professional networks of the authoring group. Our reasoning for these invitations was that these individuals would be more likely to field the survey given such professional connection. These individuals were then asked to forward the instrument to PSTs in their mathematics and/or mathematics methods courses. The survey had 315 total respondents; however, 145 of the respondents only answered preliminary questions regarding familiarity with professional noticing and then exited the survey without completing the remainder of the questions focused on responding to the transcript as well as the demographic questions at the end of the survey. The incomplete surveys were manually discarded during evaluation of the data which left a total of 170 completed responses. Among the 170 participants, as one might expect of a preservice teacher sample (McFarland et al., 2019), the largest gender and ethnic demographic was 18–24-year-old white females. Additionally, we used an electronic apportioning tool to ensure a relatively equivalent distribution of cases across respondents. That is, the survey tool selected a particular case (Margaret, Miguel, etc.) for a given respondent and ensured that each pool of respondents by case was relatively similar in number. Note, though, that incomplete responses rendered this distribution marginally unequal. See Table 1 for response apportionment across cases.

A prior iteration of this study involved a fielded survey that was identical in every way but *did not include a photo.* That prior survey was sent to 30 teacher educators

across 17 states, and these individuals were asked to forward the instrument to PSTs in their mathematics and/or mathematics methods courses (Thomas et al., 2019). The survey had 214 total respondents; however, 63 of the respondents only answered demographic questions and then exited the survey without completing the remainder of the questions focused on responding to the transcript. The incomplete surveys were manually discarded during evaluation of the data which left a total of 151 completed responses.

Table 1

Response Apportionment Across Survey Types and Cases

Case	# Respondents (Photo)	# Respondents (No Photo)
Margaret	44	38
Miguel	39	45
Shaquan	45	32
William	42	36
Total	170	151

Analysis of Professional Noticing Skills

Each response was scored for quality of responses using the same flow-process tool (American Society of Mechanical Engineers [ASME], 1947) developed for the professional noticing study upon which this inquiry is based (Schack et al., 2013; 2015). The flow-process tool featured a series of yes/no choice-points for raters regarding the perceived quality of the three components of professional noticing. In order to ensure there was no bias within the raters regarding the child's perceived race or gender, data were blinded and combined into one list per component. Each component (attending, interpreting, deciding) was scored with individual scoring tools by two raters. Based on the previous studies (Schack et al., 2013; 2015), benchmarks were established for the ranked responses for each component resulting in four ranks for attending (Score 1-4), three ranks for interpreting (Score 1-3), and three ranks for deciding (Score 1-3). The *attending* component warranted an additional rank as the researchers agreed that there were mathematical actions beyond the key components of the mathematical activity that merited an additional rank. After scoring, the raters combined data and negotiated any discrepancies in scoring. This resulted in interrater reliability (i.e., rate of agreement) above 70% for each pair of raters before the negotiation of discrepancies.

Analysis of Asset/Deficit in Professional Noticing

The asset/deficit perspectives of the participant responses to the three questions were evaluated using a different flow-process tool (AMSE, 1947). Rather than score for the quality of the response as in the previous study, the scoring tool for this part of the study scored the presence or absence of asset-oriented or deficit-oriented language describing the child. Each response was ultimately ascribed one of four different codes—asset, deficit, both [asset and deficit], and neutral. We refer to these codes as *bias categories* in subsequent sections. Note, neutral responses contained no asset/deficit-oriented descriptions of the child's thinking/activity. See Figure 2 for example responses, by category, in the interpreting component of professional noticing.

Figure 2

Bias Category Example Responses—Interpreting

Asset	Deficit
"He understands the context of the problem and the idea that addition and subtraction are related"	"Student didn't understand the method of counting up on his fingers"

Both (asset & deficit)	Neutral
"The student understands cardinality and grouping but may not have mastered basic equations yet to make the mental leap of 11 minus 7 equals 4"	"The student used a counting strategy"

Two raters used the flow process tool to calibrate with sample data, from a previous data set, until an 80% interrater reliability was achieved. The data from the current study were again blinded and combined into one list and scored independently by the two raters. Per previous studies of professional noticing, rating discrepancies were resolved via discussion (Jacobs et al., 2010; Krupa et al., 2017).

Findings and Results

Measuring Bias in Professional Noticing

A previous study measuring equity in professional noticing, scored using the same asset/deficit scale, without a picture of a child that matches the perceived ethnicity and gender of the name, showed that bias tends to manifest significantly in only the interpreting stage of professional noticing (Thomas et al., 2019). Adding the feature of a picture of a child resulted in the same finding. The percentage of responses across perspectives with and without picture can be found in Table 2.

Table 2

Percentage of Responses Across Perspectives

		% With Picture (*n*=170)	% Without Picture (*n*=151)
Attending	Asset	19	6
	Deficit	4	5
	Neutral	75	87
	Both	2	2
Interpreting	Asset	38	31
	Deficit	13	27
	Neutral	24	12
	Both	25	30
Deciding	Asset	2	1
	Deficit	2	3
	Neutral	96	95
	Both	0	1

As evident in the table, there PSTs' bias manifestation occurs most prevalently within the interpreting component of professional noticing. Attending and deciding show that more than the majority of the pre-service teachers responding to questions in these stages tend to be neutral, meaning no bias is shown.

Results of Bias in Each Case

Bias manifesting in the interpreting stage of professional noticing is evident in the results from responses to both survey types (photo, no photo) of the children with perceived gender and ethnicities. As a result, it is necessary to show each student's responses with and without a picture to compare how having a picture may change pre-service teachers' biases (Table 3). Adding a photo to the survey and readministering the instrument with a different group of PSTs resulted in an increase in asset (positive) responses in all cases besides William (perceived white male). Deficit (negative) responses decreased with a picture in all cases.

We conducted chi-square tests to determine whether there are any relationships between case, survey type (picture, no picture), and bias categorizations (asset, deficit, neutral, both) (see Tables 4 and 5). Specifically, for each of the four cases (Margaret, William, Miguel, Shaquan), chi-square tests for independence were performed to test whether the different survey types were

Table 3

Percentages of Responses by Perceived Race/Gender

	Margaret With Picture	Margaret Without Picture	Shaquan With Picture	Shaquan Without Picture	Miguel With Picture	Miguel Without Picture	William With Picture	William Without Picture
Asset	33	26	47	41	53	29	22	31
Deficit	10	24	11	19	19	24	10	39
Neutral	35	39	13	31	13	29	35	22
Both	19	11	29	9	16	18	37	8

Table 4

Chi-square Independence for Each Survey Type Between Case and Noticing Component

Survey Type	Case vs. Attending	Case vs. Interpreting	Case vs. Deciding
No Picture	13.508 (9)	8.061 (9)	7.628 (9)
Picture	7.890 (9)	20.575 (9)*	5.719 (6)
Note. Results are reported as χ^2 (df).			
* $p < .05$, ** $p < .01$, *** $p < .001$.			

Table 5

Chi-square Independence for Each Case Between Survey Type and Noticing Component

Case	Survey Type vs. Attending	Survey Type vs. Interpreting	Survey Type vs. Deciding
Margaret	7.168 (2)*	9.025 (3)*	3.606 (3)
Miguel	0.935 (3)	4.826 (3)	0.781 (2)
Shaquan	2.430 (3)	1.204 (3)	1.506 (3)
William	7.294 (3)	14.629 (3)**	N/A
Note. Results are reported as χ^2 (df). A test of independence could not be calculated for the William case in the deciding component because all responses for this condition were categorized as "neutral."			
* $p < .05$, ** $p < .01$, *** $p < .001$.			

associated with a different distribution of attending, interpreting, or deciding bias categories. Furthermore, for each of the two survey types (picture, no picture), chi-square tests for independence were performed for each noticing facet (attending, interpreting, deciding) to test whether each case was associated with bias categorization. All chi-square tests with statistically significant results were further analyzed with post-hoc tests.

For the survey that contained a picture of student and teacher, the results suggest a significant association between case (Margaret, William, Shaquan, Miguel) and bias categorization within the professional noticing component of interpreting. Further, the Margaret case showed a significant association between survey type and the attending bias categorization, and both the Margaret and William cases showed significant association between survey type and the interpreting bias categorization.

A review of the adjusted standardized residuals within the interpreting component revealed significant differences in specific bias categorizations for Margaret, Miguel, and William across the two survey types (see Table 6). We note a design limitation in this comparison as each survey had a different group of respondents. The first survey (no-picture) was fielded in Spring 2018 while the second survey (picture) was fielded in Spring 2019. While both respondent groups were demographically similar (i.e., predominately white females age 18-24), comparisons across surveys should be considered with caution. Nevertheless, adjusted standardized residuals (of Chi-square testing) provide some insight regarding the nature of differences across the survey types and bias categories.

When comparing bias categorization across survey types for Miguel, we see a significant increase in "asset"

Table 6

Interpreting Component Adjusted Residual Z-Scores by Bias Category

Case (Survey Type)	Asset Adjusted Residual Z-Score	Deficit Adjusted Residual Z-Score	Neutral Adjusted Residual Z-Score	Both Adjusted Residual Z-Score
Margaret (No Photo)	-.5	.9	-2.5**	2.1*
Margaret (Photo)	.5	-.9	2.5**	-2.1*
Miguel (No Photo)	-2.1*	.4	.6	1.5
Miguel (Photo)	2.1*	-.4	-.6 -	1.5
Shaquan (No Photo)	-.5	.9	-.5	.2
Shaquan (Photo)	.5	-.9	.5	-.2
William (No Photo)	.9	3.1***	-2.7**	-1.3
William (Photo)	-.9	-3.1***	2.7**	1.3
p < .05, ** *p* < .01, *** *p* < .001 for Z-score conversions.				

categorizations when a picture is included in the survey. For William, we see a significant decrease in "deficit" categorizations and a significant increase in "neutral" categorizations when a picture is included in the survey. For Margaret, we see significant increase in "neutral" categorizations and a significant decrease in "both" (i.e., responses that contain both asset and deficit perspectives) categorizations when a picture is included in the survey.

Quality of Professional Noticing

Of the 170 respondents to the (picture) survey, 31% of them reported that they were familiar with professional noticing. A breakdown of each component of professional noticing shows that the quality of professional noticing when a photo is introduced tends to be lower than measurement of such noticing sans photo (See Table 7). When comparing the means of the component processes (i.e., attending, interpreting, deciding) between the two studies, it reveals that all three components decreased when the picture was added to the transcript. However, a Wilcoxon Signed Ranks Test, a non-parametric hypothesis test used to compare two re-lated samples, was conducted to determine if any of the decreases were statistically significant. That test showed no statistical significance in the decreases.

These results show that adding a picture does not significantly impact the overall quality of professional noticing skills. However, the purpose of the study was to determine if perceived gender and/or ethnicity impacts bias (as measured through the professional noticing framework), thus a Wilcoxon Signed Ranks Test was conducted on the data from the picture survey by case and component to determine if and where bias occurred (see Table 8).

The asset and deficit responses were calculated through the interpreting component as that was the component where bias was present. When comparing the interpreting scores between cases, there is only a significant difference between the PSTs' scores who received the Shaquan and William cases. Consequently, Shaquan and William are the two cases with the greatest difference between asset perspectives in interpreting (47% with asset perspective on Shaquan and 22% with asset perspective on William). While interpreting was the only component where asset and deficit perspectives

Table 7

Descriptive Statistics and Wilcoxon Signed Ranks Test by Component

	Without Picture Mean	With Picture Mean	Z-Score	*p*
Attending (Range 1-4)	2.03	1.96	-.956	.339
Interpreting (Range 1-3)	1.41	1.35	-.823	.410
Deciding (Range 1-3)	1.58	1.44	-1.940	.052
Sum (Range 3-10)	5.03	4.74	-1.896	.058

Table 8

Wilcoxon Signed Ranks Test Comparing Cases and Components

		Miguel	Shaquan	William
Margaret	Attending	$Z = -1.048$ $p = .295$	$Z = -.948$ $p = .338$	$Z = -.843$ $p = .399$
	Interpreting	$Z = -1.237$ $p = .216$	$Z = -.557$ $p = .577$	$Z = -1.864$ $p = .062$
	Deciding	$Z = -2.077$ $p = .038*$	$Z = -.158$ $p = .874$	$Z = -2.168$ $p = .030*$
	Sum	$Z = -1.849$ $p = .064$	$Z = -.096$ $p = .924$	$Z = -2.009$ $p = .045*$
Miguel	Attending		$Z = -.129$ $p = .897$	$Z = -.123$ $p = .902$
	Interpreting		$Z = -1.758$ $p = .079$	$Z = -.922$ $p = .356$
	Deciding		$Z = -2.101$ $p = .036*$	$Z = -.206$ $p = .837$
	Sum		$Z = -1.742$ $p = .081$	$Z = -.253$ $p = .800$
Shaquan	Attending			$Z = -.464$ $p = .643$
	Interpreting			$Z = -2.015$ $p = .044*$
	Deciding			$Z = -2.646$ $p = .008*$
	Sum			$Z = -1.743$ $p = .081$
* $p < .05$				

were prevalent, when comparing the attending, deciding, and sum scores between the cases, there are other statistically significant results to note. In particular, the deciding component revealed that the PSTs who received the Shaquan and Margaret cases constructed responses which scored significantly higher than those receiving the Miguel and William cases. Additionally, when comparing the sum of the professional noticing components, only those PSTs' receiving the Margaret case scored significantly higher than those with the William case.

Finally, a comparison of professional noticing quality across the component processes was made between survey responses sans photo and the current responses from surveys that included a photo. The results of that comparison (Table 9) show that there is no statistically significant difference between the results of the two studies.

Table 9

Wilcoxon Signed Ranks Comparing Component and Case Between Survey types

	Margaret	Miguel	Shaquan	William
Attending	$Z = -.442$ $p = .658$	$Z = -.195$ $p = .845$	$Z = -.163$ $p = .870$	$Z = -0.23$ $p = .982$
Interpreting	$Z = -.662$ $p = .508$	$Z = -.906$ $p = .365$	$Z = -.784$ $p = .433$	$Z = -.851$ $p = .395$
Deciding	$Z = -.672$ $p = .502$	$Z = -.863$ $p = .388$	$Z = -1.496$ $p = .135$	$Z = -.663$ $p = .507$
Sum	$Z = -.355$ $p = .722$	$Z = -1.919$ $p = .055$	$Z = -1.444$ $p = .149$	$Z = -1.176$ $p = .240$

Discussion

The purpose of this study was to explore how and to what extent bias emerges within pre-service teachers' professional noticing of children of differing perceived races and genders. First and foremost, we find that manifestations of bias predominately occur within the interpreting component of professional noticing. Further, our findings suggest that the inclusion of visual imagery (i.e. photos) influence the manifestation of such bias among PSTs to some degree when professionally noticing a written case.

Turning to the professional noticing of cases that do not involve imagery, but rather just rely on a student's name, there is a significant literature base suggesting that individual names may provoke individual biases. Indeed, such biases may be manifested across a range of professional decision-making processes (e.g., resume screening/hiring, apartment rental decisions, etc.), and perceptions of ethnicity tend to provoke more negative decisions or outcomes (Bertrand & Mullainathan, 2004; Hanson et al., 2016). For example, Bertrand and Mullainathan found that "white sounding names (such as Emily Walsh or Greg Baker)" resulted in 50% more employer callbacks than "African American sounding names (such as Lakisha Washington or Jamal Jones)" when such names were randomly assigned to identical fictitious resumes. Thus, we concur with Gaddis (2017) that, "the research base clearly shows that race can be signaled through names and that using names as a signal of race can successfully capture some version of racial discrimination" (p. 470).

However, from our findings, the mere changing of names (e.g., Shaquan, William, Margaret, Miguel) does not appear to provoke the directly negative biases observed in other studies. For example, William's percentage of deficit responses (39%) on the no-picture survey is far higher than that of the other students while Shaquan's percentage of deficit responses (19%) is the lowest. We note, however, that this finding, while somewhat counter to extant literature, could indicate a pattern of *bias inversion* where respondents elevated their expectations for William and lowered their expectations for Shaquan. Another plausible explanation, given the relatively balanced bias (i.e., asset, deficit, neutral, both) percentages among all four cases is that merely changing the student names on identical cases was not sufficient to provoke measurable response bias among the responding preservice teachers. This is intriguing as it opens the possibility that noticing, as a practice, may mediate biases that emerge quite consistently in other professional contexts with this level of provocation. A less plausible but possible explanation is that the PSTs sampled for this study were, in some manner, less prone to exhibit bias in the context of approximated professional noticing.

Regarding the manner in which such biases may impact teaching practice, Rudman (2004) describes the relationship between individuals' implicit and explicit biases as connected but somewhat distant. One's explicit biases exist downstream of one's implicit biases in that unconscious bias flows toward and informs conscious biases. As such, conscious biases are inherently more malleable by the individual given their conscious awareness of said bias or belief. For example, "even when people are truthful, self-reports can only reflect what they believe about their orientations, whereas implicit measures [e.g., the Implicit Associations Test, etc.] bypass this limitation" (Rudman, 2004, p.133). Nevertheless, Rudman continues, "judgments and behavior may be influenced by implicit orientations without intention or awareness. That is, the *application* of implicit biases may be nonconscious" (p.134). With respect to teacher noticing, implicit biases may (and likely do) influence teacher decision-making (i.e., deciding) and the genesis of such biases appears to be within the interpreting component. As such, when approaching professional noticing with PSTs, discussions of equity concerns and issues of bias may be naturally joined with interpreting.

For this discussion, we primarily focus manifestations of bias rather than professional noticing quality. From our results, the only bias manifestations within the interpreting component of professional noticing were statistically significant via the chi square test. Interestingly enough, with the inclusion of a photo, the asset perspective increased in every single demographic, except for the white male student. Instead, William's asset perspective decreased when a photo was included with the survey. From existing literature, one would anticipate William's asset response to be elevated with respect to other cases. However, it may be that this decrease is related to an increase in William's "both" bias category (See Table 6). It is also plausible that some manner of respondent compensation is manifesting here. As equity concerns become more prominent in the field of teacher education (AMTE, 2015), it is conceivable that one's awareness of bias rises and conscious desire to consider and counteract such bias rise in concert. This sort of *bias compensation* (i.e., conscious consideration of one's biases which influences subsequent activity), we argue, would signify a positive step for the field.

Regarding directions for future research, investiga-

tions of PST demographics (e.g., race, gender, age etc.) with respect to manifestations of bias would further illuminate the varied enactment of professional noticing. Is, for example, the practice of professional noticing—and the explicit focus on the mathematical thinking of children—a space that mediates, in some manner, one's biases or is such noticing a mere channel or conduit for one's biases? Given that focused experiences engaging in professional noticing results in more sophisticated practice (Jacobs et al., 2010), might such manifestations of bias change as teachers become more adept at such noticing? More broadly, probing conjectures of bias compensation and bias inversion would also likely be fruitful avenues for study. Indeed, we ponder whether or not an increase in experience of professionally noticing children's mathematical thinking translates to professionally noticing of ethnicity and gender. These are but a few areas where future research may provide a better understanding of interplay between noticing and bias.

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