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Typologizing Teacher Practice: How Teachers Integrate Culturally Responsive, Ambitious, and Traditional Teaching Approaches

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As states and districts expand their goals for equitable mathematics instruction to focus on cultural responsiveness and rigor, it is critical to understand how teachers integrate multiple teaching approaches. Drawing on survey data from a larger study of professional learning, we use mixture modeling to identify seven unique ways that middle school mathematics teachers integrate ambitious, traditional, and culturally responsive (CR) mathematics instruction. The resulting typology is driven almost exclusively by variation in CR teaching. About half of teachers reported rarely engaging in CR teaching. Teachers who emphasized CR teaching tended to be teachers of color and have high CR teaching self-efficacy. Findings suggest that tailoring teacher development to how teachers blend multiple approaches may best support equitable mathematics instruction.

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Introduction

In recent years, an increasing number of states, districts, and mathematics education organizations have recognized that high-quality mathematics instruction not only centers conceptual rigor, but also equitable and culturally responsive (CR) instructional practices. For instance, the National Council of Teachers of Mathematics' (NCTM)'s 2021 position statement on access and equity emphasizes the need for teachers to be "responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge" as a means to support "a culture of access and equity" in mathematics teaching (NCTM, 2021, np). Similarly, California's most recent mathematics framework dedicates a chapter to equity and engagement in mathematics, offering examples for how to "utilize and value students' identities, assets, and cultural resources" in mathematics instruction (CDE, 2021, p. 3). These frameworks align with the tenets of CR teaching—pedagogy that leverages students' cultural identities as "conduits for teaching the more effectively" (Gay, 2002; p. 106).

These calls occur amid the ongoing push for ambitious mathematics instruction of the last several decades, which has emphasized a shift from solely traditional instructional practices—e.g, a focus on fluency with mathematical procedures—to instruction that balances procedural fluency with conceptual rigor—e.g., active learning, mathematical discussion, understanding of underlying principles, and multiple solutions (Author, 2005; NCTM, 2000; Stigler & Hiebert, 1999). Thus, conceptions of high-quality mathematics instruction integrate conceptual rigor with procedural fluency, while being responsive to students' racial, ethnic, and cultural backgrounds (Civil et al., 2019).

Integrating multiple teaching approaches into instructional practice is complex. When policy requires teachers to shift their pedagogy, they do not simply abandon prior practices, rather they integrate new instructional strategies with existing practices (Cohen, 1990). Research emphasizes a range of factors that influence teachers' instructional choices, such as beliefs about instructional approaches and curricula, self-efficacy with particular practices, and aspects of school context (Coburn, 2005; Remillard & Bryans, 2004; Remillard & Heck, 2014; Spillane & Jennings, 1997; Tschannen-Moran et al., 1998). Given the evolving goals of mathematics education to balance conceptual understanding with procedural fluency in culturally responsive ways, it is important to understand how teachers integrate these approaches in service of student learning. Yet, how teachers integrate ambitious, traditional, and CR instructional practices, and what drives how teachers balance these approaches, is not well documented.

The purpose of this study is to describe how mathematics teachers bring together ambitious, traditional, and CR instructional practices. We do so by examining typologies of teacher practice based on self-reports from 205 middle school mathematics teachers across five racially, ethnically, and linguistically diverse school districts in four states. Typologizing teacher practices across ambitious, traditional and CR approaches allows us to identify key patterns in how teachers integrate aspects of these three approaches into their instruction. It also allows us to identify particular practices that are more and less common. Additionally, creating typologies allows us to examine factors, such as teacher characteristics, beliefs, and curricular use, that describe patterns in these instructional approaches, which informs how to best support teachers to engage in rigorous mathematics instruction. We address the following research questions:

1. In what ways do mathematics teachers engage with and integrate ambitious, traditional, and CR teaching approaches?

2. Do teachers' characteristics, beliefs about CR teaching, self-efficacy for CR teaching, views of the mathematics curriculum, and curriculum use describe differences in the ways teachers integrate aspects of these three instructional approaches (ambitious, traditional, and CR teaching)?

Overall, we find that teachers in our sample comprise seven unique teacher types based on how they integrate CR, ambitious, and traditional teaching approaches into their mathematics teaching. This typology suggests that teachers integrate these practices in unique but categorizable ways and emphasize certain practices more than others. The teacher types in our typology differ greatly in their use of CR teaching specifically. We find that teacher race, experience levels, self-efficacy for CR teaching, and beliefs about CR teaching describe differences in these teacher types. Specifically, teachers who emphasize CR teaching tend to be teachers of color and to have high self-efficacy for CR teaching.

Study Context

In this study, we examine middle school mathematics teachers' reported beliefs and practices in a set of five school districts (Table 1). Each participating school district was engaged in a professional learning (PL) partnership initiative funded by a prominent education philanthropy organization. The funder required districts to serve 50% or more Black, Latino/x, English learners, and/or low-income students. In these initiatives, districts partnered with external organizations, such as PL providers and curriculum developers, to enact curriculum-embedded PL focused on middle school mathematics in order to promote enhanced student learning, particularly for historically marginalized students. Thus, this study's sample offers a depiction of the mathematical instructional practices of teachers across a set of equity-oriented,

racially and linguistically diverse public school districts, and provides a unique description of teacher beliefs and practices related to equitable mathematics instruction.

[Table 1 here]

Conceptual Framework and Review of the Literature

Our conceptual framework is grounded in literature on mathematics education and CR teaching. First, we conceptualize that high-quality mathematics instruction incorporates procedural fluency, conceptual understanding, and authentic application of mathematical concepts and does so through the use of ambitious and CR instructional approaches. Building on a review of mathematics education and CR teaching literatures, we theorize that teachers may vary in how they blend traditional, ambitious, and CR teaching. Finally, we theorize that teachers' personal characteristics, beliefs about instruction, self-efficacy with instructional practices, and their use of curricular and supplemental materials inform the ways in which they integrate these different approaches. We review the literature on each of these aspects of our framework in turn.

Supporting Students By Blending Ambitious and Traditional Practices

Over the last several decades, the field of mathematics education has had a consistent focus on shifting teacher practice from an emphasis on calculation, rote computation, and practice to instruction that balances traditional practices that emphasize procedural fluency with conceptually rigorous and student-centered learning (Author, 2005; Stigler & Hiebert, 1999). Mathematics reform advocates of the 1990s and 2000s critiqued traditional "stand-and-deliver" modes of instruction that focused on teaching discrete mathematical procedures and computation (e.g., see Stigler & Hiebert, 1999) and instead advocated for an increase in conceptually rigorous practices (e.g., cognitively demanding tasks and student mathematical discussion) and real-world

application of mathematical concepts (Author, 2005; Lampert, 1992). These shifts manifested in the Common Core State Standards for Mathematics, which led to adoption of new instructional standards and mathematical practices largely aligned with the Common Core in all 50 states (Author, 2019; NGA/CCSSO, 2010). The conception of mathematics instruction in these new instructional standards elevates ambitious mathematical teaching while simultaneously attending to traditional practices, such as emphasis on procedural fluency (Author, 2018; Choppin et al., 2020; National Mathematics Advisory Panel, 2008).

Despite these calls, scholarship examining the mathematics practices of large samples of teachers in urban US districts has suggested that teachers' mathematical practices tend to emphasize routine mathematical procedures, rather than conceptually rigorous practices (e.g., Author, 2005; Author, 2010; Author, 2018; Author, 2020; Boston & Wilhelm, 2017; Hiebert et al., 2005). Nationally representative data has shown that while conceptually-focused instruction is associated with better achievement, students receive predominantly traditional mathematics instruction in both elementary and middle school (Author, 2005; Author, 2010). Further, in their observation study of 114 middle school mathematics teachers across four large, urban districts, Boston and Wilhelm (2017) found low conceptual rigor in lesson implementation. In their study of over 326 elementary teachers across five US districts, Authors (2018) highlighted that the "format of instruction" in mathematics classrooms has remained relatively traditional—teachers tend to dominate classroom discussion and teach in a directed way, and collaborative and group formats are limited (Weiss et al., 2003). Likewise, in a study of 108 9th-grade algebra lessons across five districts, originally collected through the Measures of Effective Teaching study, Author (2020) concluded that a majority of lessons were teacher-directed with few opportunities for student inquiry. Yet within these more traditional instructional formats, researchers have

found evidence of modest take-up of more conceptually-focused instructional practices—for example supporting students to develop mathematical explanations and link across mathematical representations (e.g., Author, 2018; Author, 2020).

Equitable Mathematics Instruction and CR Teaching

At the same time, conceptions of high-quality mathematics instruction have expanded to more explicitly center equity and cultural responsiveness. While scholars have focused on equity in mathematics education for some time (e.g., see Civil et al., 2019 for a review; also Gutstein et al., 1997; Gutierrez, 2012), recent research has begun to identify specific instructional practices that serve equity goals while also engaging students in conceptually oriented mathematics instruction. For instance, Wilson and colleagues (2019) identified several practices that successful teachers of African American students engaged in more frequently, such as being responsive to students' local context in instruction, positioning students as having mathematical authority, coaching students to meet social and mathematical expectations in the classroom, and building community in the classroom. These authors argue that the field must better understand equitable mathematics teaching as not only attending to students' access to high-quality resources and mathematics achievement, but also as instruction that addresses issues of identity and power in mathematics—what Gutiérrez (2012) refers to as the "critical axis" of equity.

CR teaching is one such approach—it encourages the use of "cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (Gay, 2002; p. 106). CR teaching scholarship documents ways in which mathematics instruction affirms students' cultural identities and addresses social issues relevant to students' lives (for a review, see Abdulrahim & Orosco, 2020). Adaptations teachers can make to standardized curricular resources, which are not designed with racially/ethnically diverse

students in mind (Gay, 2018), include attending to local issues pertinent to students' lives (e.g., Wilson et al., 2019), relying on modes of communication and expression in students' cultures as educational resources (e.g., Love, 2015), and facilitating instructional activities that build on how students' cultures engage with the content (e.g., Kisker et al., 2012; Savage et al., 2011).

Notably, however, the scholarship on CR teaching typically focuses on key moves enacted by exemplary teachers and small-N qualitative studies that offer rich depictions of CR practices (e.g., see Bonner, 2014; Choi, 2013; Ladson-Billings, 1995; Martell, 2013). Less common are studies of a broad range of teachers' CR practices and their relation to ambitious and traditional teaching approaches.

Layering Ambitious, Traditional, and CR Practices

Previous scholarship on the nature of instructional reform suggests that when adopting new instructional approaches, teachers integrate new practices with their preexisting ones (Cohen, 1990; Spillane & Jennings, 1997; Spillane, 1999). While mathematics education scholarship offers important depictions of how teachers use traditional and ambitious practices in the classroom, and the CR teaching literature offers rich characterizations of CR practices, these studies have not examined how teachers bring together ambitious and traditional with CR teaching approaches—an important area of study given calls that expand notions of high-quality mathematics instruction to include culturally responsive *and* ambitious mathematics practices.

Typologizing teachers offers a unique opportunity to understand broad patterns in middle school mathematics teachers' integration of traditional, ambitious, and equitable instructional practices. Scholars have leveraged a typology approach to understand practices in a variety of areas, including school leadership (e.g., Boyce & Bowers, 2016; Urick & Bowers, 2014), teachers' technology use (e.g., Graves & Bowers, 2018), and teacher leadership (e.g., Bowers et

al., 2017). Collectively, these studies highlight the value of a typology approach to studying educator practices. Understanding broad patterns (typologies) in educators' beliefs and practices can be informative for teacher educators and professional learning facilitators who aim to support improvements in teaching practice (Barkatsas & Malone, 2005).

Teacher Characteristics, Beliefs, Self-Efficacy, and Curriculum Use

If the mathematics education field's goal is to support teachers to adopt an instructional approach that balances traditional, ambitious, and equity-oriented practices, we must also understand how teachers' background characteristics, beliefs, self-efficacy, and curricular material use relate to the ways they integrate practices across these instructional approaches. Here we build on previous research which shows differences in approaches to instruction by race/ethnicity, gender, and years of experience. For example, veteran teachers are often less likely to take up ambitious instruction (Author, 2005). Teachers of color tend to engage more regularly in CR practices and have mindsets aligned with CR teaching (Blazar, 2021). Further, a robust literature base of scholarship links teachers' beliefs about and self-efficacy with their instructional practices (Cross, 2009; Phillip, 2007; Tschannen-Moran et al., 1998). This is especially true in the CR teaching scholarship. Conceptualizations of CR teaching are based on the notion that a teacher must hold particular beliefs about teaching and students—e.g., that all students are capable of academic success and that culture and race play a central role in teaching (Gay, 2018; Ladson-Billings, 1995; Parker et al., 2017). These conceptions directly combat a colorblind approach to instruction, instead promoting explicit acknowledgement of students' cultural identities to support inclusivity, respect, and belongingness in the classroom (Brown-Jeffy & Cooper, 2011; Parker et al., 2017).

Also critical to teachers' choices about instruction is how they engage with the curriculum. Teachers may vary in their views about the appropriateness of the curriculum for their students (Donnell & Gettinger, 2015; Handal & Herrington, 2003). Additionally, mathematics curricula tend not to emphasize cultural responsiveness (Polikoff, 2021) and tend to align with Eurocentric cultural practices (Rubel, 2017). Thus, a critical aspect of CR teaching is adapting curricula to reflect the cultural practices of all students, especially those not represented in the curricula (Gay, 2002).

Contribution of This Study

This study makes several key contributions. First, while recent scholarship has documented the current state of ambitious mathematics practices (e.g., Author, 2018), we are unaware of any studies that have systematically examined teachers' engagement with practices across ambitious, traditional, and CR teaching approaches, including identifying common and less common practices. In this study, we examine how teachers bring together practices from these three teaching approaches, which informs how to advance NCTM's (2021) goals of equitable and ambitious mathematics instruction. Second, we extend the robust literature on CR teaching by focusing on CR teaching in mathematics across a broad range of teachers, which complements the existing small-N CR teaching scholarship. Finally, while a typology methodological approach has been used to study a variety of phenomena in education (e.g., Bowers et al., 2017; Graves & Bowers, 2018), it has not been applied to understand the ways teachers integrate ambitious, traditional, and CR practices. Using this methodological approach enables us to discern key patterns in the ways teachers bring these practices together and examine the factors associated with those patterns.

Methods

As part of a broader study of professional learning (PL) partnerships, we administered a survey to teachers in early 2020, which allowed us to collect a rich amount of self-report data from teachers on their current beliefs and practices. Overall, our goal with this analysis was to use mixture modeling to identify (1) whether or not teachers can be classified based on their *relative emphasis* of different strands of instructional practices (ambitious, traditional, and CR teaching) and (2) whether or not teachers can be classified based on their *overall frequency* of engagement with these three teaching approaches. Once we identified teacher types, we analyzed them descriptively to identify which specific instructional practices teachers in each class use most frequently and which teacher characteristics describe variation in practices.

Data and Sample

We administered the survey between January and March 2020 (prior to Covid-19 disruptions) to teachers in seven PL partnerships. Participating teachers were compensated for their time. For this analysis, we leveraged responses from teachers in five partnerships because they focused on supporting mathematics teachers specifically. The overall response rate was 48%; two partnerships had response rates below 50% and five had response rates between 62% and 88%. The final sample consisted of 205 middle school mathematics teachers, was majority female (76%), and was racially/ethnically diverse (46% White, 32% Black, 8% Latinx, 5% Asian, 3% mixed-race, and <1% Indigenous) (Table 2). In comparison, the 2017-18 US teacher labor force was 79% White, 7% Black, 9% Hispanic, 2% Asian, 1% American Indian/Alaska Native, and 2% multiracial (Irwin et al., 2021). Though the findings presented are not generalizable to the broader teacher workforce, the sample is illustrative of public schools engaging in PL around improving instruction and provides a unique broad-based description of teacher beliefs and practices related to ambitious, traditional, and CR teaching in this context.

[Table 2 here]

Measures Used in Mixture Modeling

Our analyses draw from a survey in which we asked teachers to report on their confidence with, beliefs about, and frequency of use of various instructional practices. The key variables of interest for the mixture modeling included CR teaching, ambitious instruction, and traditional instruction scales. To further characterize the resulting teacher types, we examined teachers' background characteristics (race/ethnicity, gender, years of teaching experience), self-efficacy with engaging in CR teaching, confidence in meeting student needs, their agreement with beliefs statements related to CR teaching, their perceptions of curriculum appropriateness, and their use of curricular and supplemental materials. We describe each of these measures in turn, and we list all teaching items in Table 3.

CR Teaching Scale. We adapted items for the CR teaching scale from previously validated scales, including the multicultural efficacy scale (Guyton & Wesche, 2005), and the CR teaching outcome expectations scale (Siwatu, 2007). Teachers were asked to respond to the question stem, *In the previous marking period for math, about how often did you have students engage in the following activities?* using a 4-point frequency scale: *Never, A few lessons, About half of all lessons, Most or all lessons.* Based on Item Response Theory (IRT) analysis, three administered items in this scale showed negative discrimination, suggesting that the items did little to discriminate among teachers' responses (Assign less challenging academic assignments to students who are struggling with English; Give students assignments that you know they can do so they do not get discouraged; Give students tasks that emphasize basic academic skills before having them engage in complex learning tasks). We dropped these items from the scale. The resulting scale demonstrated excellent reliability ($\alpha = .91$).

Ambitious and Traditional Instruction Scales. Items for the ambitious instruction (α = .87) and traditional instruction scales (α = .68) were also adapted from previously validated sources, including the Rand Corporation's American Teacher Panel surveys (Opfer et al., 2017). These items ask teachers to report the frequency with which they engage in various instructional strategies aligned with ambitious and more traditional teaching approaches (Table 3). Teachers responded to questions using the stem, *In the previous marking period for math, about how often did you engage in each of the following activities?* Items were assessed on a 4-point frequency scale, *Never, A few lessons, About half of all lessons, Most or all lessons*. Two items from the ambitious scale showed negative discrimation in IRT analyses and were dropped.

[Table 3 here]

Variables Used to Characterize Teacher Profiles

Teacher Background Characteristics. To understand the resulting typologies, we examined a series of variables on teacher background characteristics: race/ethnicity—a dichotomous variable indicating 1 for teacher of color (Black, Latinx, Asian, mixed-race, Indigenous, or Middle Eastern) and 0 for White; gender—a dichotomous variable indicating 1 for female and 0 for male; and years of teaching experience—a continuous variable representing the total years of teaching experience reported by the teacher.

CR Teaching Self-Efficacy. An additional indicator variable included an 8-item measure of teacher's CR teaching self-efficacy (α = .94).. Items were adapted from the Multicultural Efficacy Scale (Guyton & Wesche, 2005) and the CR teaching self-efficacy scale (Siwatu, 2007). On a scale of 0 to 10, teachers rated their confidence in implementing CR teaching practices on items such as, "Adapting instruction to meet the needs of my students," and "Using my students'

cultural backgrounds to help make learning meaningful." On average, teachers reported high self-efficacy for CR teaching (8.08 out of 10) (Table 2).

Confidence Meeting Student Needs. This 6-item scale (α = .93) was constructed using items adapted from the Center on Standards, Alignment, Instruction and Learning (C-SAIL; see c-sail.org) to assess teacher's confidence, measured on a scale of 0 to 10, in using the curriculum to meet the needs of students who were performing on grade level, below grade level, above grade level, those with individualized education plans, those from low socioeconomic households, or those designated as English Language learners. Items included "Teaching the curriculum to students performing on grade-level in math," and "Teaching the curriculum to students who are from low-income families." On average, teachers reported moderately low confidence for meeting student needs (6.36 out of 10) (Table 2).

CR Teaching Beliefs. Teacher beliefs items were adapted from sources like the CR teaching outcome expectations scale (Siwatu, 2007) and teacher perceptions of CR teaching (Phuntsog, 2001). This scale consisted of seven items measured on a 5-point likert scale (*Completely disagree, Mostly disagree, Slightly disagree, Slightly agree, Mostly agree, Completely agree*), such as "Culturally responsive practice is essential for creating an inclusive classroom environment" and "Encouraging respect for cultural diversity is essential for creating an inclusive classroom environment." The scale demonstrated reliability of α = .56. Given this lower-than-ideal alpha, we examined the alphas for each of the resulting teacher types in our typology; these ranged from 0.46 to 0.89.

Use of Curriculum and Supplemental Materials and Curriculum Appropriateness. We measured the use of curricular and supplemental materials (α = .91 and α = .92, respectively) using items adapted from the The National Evaluation of Curriculum Effectiveness survey

(Blazar et al., 2019). For both curricular and supplemental material use, teachers responded to a 4-point frequency scale addressing the extent to which they used materials for assignments and assessments—for example, "To choose the objectives for your lessons" and "To create the activities for your lesson." The curriculum appropriateness scale (α = .76) was derived using adapted items from the Center on Standards, Instruction, Alignment, and Learning (C-SAIL; see Author, 2019; Authors, in press) and Marsh and colleagues' (2005) curriculum and instruction scale. On a 5-point likert scale (*Completely disagree, Mostly disagree, Slightly disagree, Slightly agree, Mostly agree, Completely agree*), teachers responded to the extent to which they perceived that they had the resources and flexibility to fully implement the mathematics curriculum pertinent to their students' capabilities. The scale consisted of items such as "I need to supplement the curriculum to meet the needs of my students" and "is too rigorous for most of the students I teach."

Analytic Approach

Our analytic approach included four sequential components (Figure 1): (1) latent profile analysis (LPA) to identify underlying groups of teachers based on their *relative emphasis* of each teaching approach; (2) latent class analysis (LCA) to identify underlying groups of teachers based on their *overall frequency* of engagement with all teaching approaches; (3) cross-tabulations of the resulting groups from the LPA and LCA to identify *teacher types* that represent both their relative emphasis of each teaching approach and their overall frequency of engagement with all teaching approaches; and (4) descriptive analyses of each resulting profile to characterize typology membership.

LPA and LCA. We derive our teacher typology from two forms of mixture modeling: latent profile analysis (LPA) and latent class analysis (LCA). LPA and LCA are procedures that

identify underlying groups of individuals based on patterns in their observed data (Jung & Wickrama, 2008; Múthen, 2002; Oberski, 2016; Samuelsen & Raczynski, 2013; Vermunt & Magidson, 2004). LPA and LCA are "person-centered" approaches to analysis that allow for the grouping of individuals based on some characteristic(s), rather than "variable-centered" approaches like factor analysis (Jung & Wickrama, 2008, p. 303). The person-centered nature of mixture modeling makes it an especially appropriate approach for this study given our interest in identifying unobserved groups of teachers based on their ambitious, traditional, and CR instructional practices. LPA is used for continuous variables, whereas LCA is used for dichotomous or categorical variables (Oberski, 2016).

Given that our primary interest was to identify the ways that teachers integrate teaching approaches, we first ran an LPA with our 34 teaching survey items (16 ambitious, 6 traditional, and 12 CR teaching), with each teacher's survey items centered around that teacher's global mean among all 34 items. Centering the items allows the LPA to identify teacher clusters based on which sets of items teachers emphasize abstracted from their overall level of emphasis. The centered items essentially function as a teacher fixed-effects model applied to LPA, leveraging within-teacher variation across items to identify a given teacher's relative emphasis of each teaching approach, regardless of overall frequency of use across items.

We used the tidyLPA package in R to conduct the LPA (Rosenberg et al., 2020). LPA first cycles through a series of models to estimate the relative fit of each. The estimated models vary in terms of the covariance matrix structure across profiles and the number of profiles (in our case, we tested one through six profiles) (see Pastor et al., 2007 and Rosenberg, 2021 for more detail on the covariance matrix structures). We used the most constrained covariance matrix structure (equal variances and covariances set to 0) to maximize degrees of freedom. The

program then compares the relative fit of each estimated model using the Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Nylund et al., 2007; Vermunt & Magidson, 2004). We found minor discrepancies in our results between the BIC and AIC indicators; we privileged the criterion indicator (i.e., the lowest BIC) that identifies the fewest number of profiles, leading us to select a three-profile solution.[1] After selecting the appropriate model specification, we then ran the selected model structure to generate predicted probabilities and profile assignments for each teacher in our sample.

We are also also interested in teachers' overall frequency of use of these teaching approaches. Results from the LPA group teachers based on their relative emphasis of different teaching approaches but, by construction, ignore differences in overall levels of emphasis. Thus, two teachers that emphasize CR instruction but differ in how often they implement CR instruction will be classified into the same profile using these data. To address this, we ran an LCA using the *uncentered* form of the same 34 teaching items, which were ordinal in nature. These uncentered items allowed us to identify underlying groups of teachers based on overall frequency of use of these three teaching approaches. We used the poLCA package in R (Linzer & Lewis, 2011).[2] Like LPA, the poLCA program iterates through models that vary by numbers of classes (though not by covariance structure given that the variables are not continuous) and produces an AIC and BIC value for each model. The LCA also produced discrepant results

[1] A 3-profile solution was identified as best according to BIC (15329.76). A 6-profile solution was identified as best according to AIC. However, the differences in the statistics between the 6- and 3-profile solution were small (14829.14 and 14871.18, respectively).

[2] Because LCA is used for dichotomous or categorical variables and our items are ordinal in nature, we also ran these same models using the MLCIRTwithin package in R as a robustness check. MLCIRTwithin takes into account IRT parameters of the items and also correctly treats the items as ordinal. When restricting the class structure to match the LCA results, we generated nearly identical class assignment probabilities among teachers.

between AIC and BIC; we selected the model that had both low BIC and AIC values, resulting in a three-class solution.[3]

Finally, to examine whether differences in use of specific practices within teaching approaches drive the profile and class assignments from the LPA and LCA, we estimated a random-effects model, which decomposes the variance into between- versus within-trait variance. High between-trait variance would indicate that more variance in profiles can be explained by differences *across* teaching approaches. High residual variance would indicate that more variance can be explained by differences in use of practices *within* teaching approaches.

Cross-Trait Teacher Type Identification. To generate teacher types that represent both teachers' *relative emphasis* on different instructional approaches and their *overall frequency* of engagement with these teaching approaches, we cross-tabulated group assignments from the LPA and LCA. This cross-tabulation resulted in seven teacher types based on the relative emphasis on each teaching approach and their overall frequency of engagement in these practices.

Descriptive Analyses Resulting Teacher Types. To better understand differences between the profiles, we engaged in a series of descriptive models using OLS regression with robust standard errors. First, we regressed each variable for characterizing teacher types described above (e.g., race/ethnicity, gender, years of teaching experience, CR teaching self-efficacy, confidence meeting student needs, beliefs about CR teaching, and supplemental curriculum use) onto the seven teacher types that emerged from our teacher type identification process. We used these results to characterize our seven teacher types.

[3] A 2-class solution was identified as best according to BIC (15892.4), and a 5-class solution was best according to AIC (14598.24). The next best model according to BIC was a 3-class solution (BIC: 15965.85). The differences in AIC for the 5-class versus 3-class solution were marginal (14598.24 and 14942.37, respectively). Given the small differences in indicator values between the first and second options, and that a 3-class solution was a strong solution for both, we selected the 3-class solution.

Based on our resulting teacher types, which showed that a substantial number of teachers de-emphasized CR teaching, we analyzed more closely the teachers who de-emphasized CR teaching, with the goal of understanding whether there was meaningful variation among the teachers who de-emphasized CR teaching that could inform policy and practice. To do this, we first used OLS regression analysis to compare CR teaching de-emphasizers to other teacher types (emphasizers and non-discriminators). Then, given that CR teaching self-efficacy differed across teacher types, we conducted one additional LCA (following the same procedures above) of just the teachers who de-emphasized CR teaching using the CR teaching self-efficacy survey items. Finally, we examined the clustering of the teachers who de-emphasized CR teaching in schools to understand whether school context might have played a role in teachers' decisions to de-emphasize CR teaching.

[Figure 1 here]

Results

Overall, we found that teachers in our sample make up seven unique teacher types based on how they integrate practices from CR, ambitious, and traditional teaching approaches. Notably, these teacher types mostly differ in their use of CR teaching specifically. For this reason, the discussion of our results primarily focuses on differences in CR teaching practices among teachers. We find evidence that teacher race, experience (i.e., novice versus veteran teachers), CR teaching self-efficacy, and beliefs about CR teaching describe differences in these teacher types.

We describe these results in more detail in the sections that follow. We first describe the results of the LPA and LCA, which classified teachers based on their relative emphasis and overall level of use of practices in each teaching approach. We then describe the resulting

typology of seven teacher types created by cross-trait teacher type identification. Throughout this section, we use the terms "practices" and "items" when referring to individual teaching practices—i.e., survey items that asked about specific teaching practices. We use the terms "trait" and "teaching approaches" when referring to the three teaching approaches as a whole: CR, ambitious, and traditional teaching.

Teachers' Relative Emphasis on Ambitious, Traditional, and CR Teaching

Based on our LPA, which categorized teachers' based on their relative emphasis on different practices, we found three latent profiles—these profiles represent three distinct ways in which teachers emphasize practices across teaching approaches, regardless of the frequency with which they enact these practices (Figure 2). We refer to these three groups as high-variance (solid line in Figure 2), middle-variance (dashed line), and low-variance (dotted line). High-variance teachers are those that spend much more of their time on certain, specific instructional practices than they do on others. For instance, we see wide variation in these teachers' relative emphasis on engaging in grade-level mathematics and applied mathematics to solve real-world problems (item 13) and engaging in hands-on activities in mathematics (item 28). Middle-variance teachers allocate their effort more equally across instructional practices but still vary their effort. Notably, the specific instructional practices that middle- and high-variance teachers emphasize and de-emphasize are almost exactly the same. The key difference between the middle- and high-variance teachers is that the high-variance teachers also de-emphasize nearly all of the CR instructional practices whereas the middle-variance teachers only de-emphasize three CR instructional practices: revise instructional materials to include better representation of cultural groups, identify cultural biases in textbooks or other instructional materials, and design a lesson that shows how different cultural groups use math.

We refer to the third class of teachers as the low-variance teachers (the dotted line in Figure 2). Low-variance teachers allocate their time almost uniformly among the instructional practices. These are teachers who reported relatively similar frequency of use across all practices, which is evident in the stability of their item-level mean scores.

Importantly, in these LPA results, there is always more variation within traits (e.g., variation across practices within the ambitious trait) than between traits (e.g., variation between CR teaching and ambitious teaching), but CR practices explain the most variation both between and within traits (see Table 4 panel A).

[Figure 2 here]

The LPA categorized teachers based on the specific instructional practices they used relative to that teacher's own level of use—i.e., the items subtracted the teacher-specific mean scores. These LPA categorizations, however, did not take into account teachers' overall frequency of use of the instructional practices—i.e., whether teachers use practices very frequently or less frequently. The consequence of this is especially relevant for the low-variance profile of teachers, which combines teachers who do not vary in their effort but report high frequencies for all items and those that do not vary but report low frequencies for all items. As such, we next turn to our LCA, which focuses on teachers' overall level of use of instructional practices.

Teachers' Frequency of Use of Ambitious, Traditional, and CR Teaching

The LCA allowed us to identify groups of teachers based on their overall frequency of use of the three teaching approaches. From this analysis, we again found three latent classes—these classes represent three distinct levels of use of instructional practices across teaching approaches (Figure 3). The item-level mean scores and the global means for the three classes are

shown in Figure 3. We refer to these classes as high-, middle-, and low-frequency classes, based on the global means across items for each group, indicated by the horizontal lines of each color. The high-frequency class (dotted line in Figure 3) consists of teachers who, on average, reported the highest frequency of use across all three teaching approaches. The middle-frequency class (dashed line) consists of teachers who reported the next highest average frequency of instructional practices across teaching approaches, and the low-frequency class (solid line) reported the lowest frequency of use across teaching approaches. As in the LPA, there is always more variation within traits than between them. For the LCA, the traditional teaching trait explains more variation than CR or ambitious teaching both between and within traits (see Table 4 Panel B).

[Figure 3 here]

Notably, the teachers that belong to a specific class here do not necessarily belong to the same numbered profile from the LPA (Figure 2); Figure 2 summarizes teachers' relative use of instructional practices while Figure 3 summarizes teachers' overall level of use. This said, we found that all 76 teachers in the low-frequency class in Figure 3 are in the high-variance profile from Figure 2. Put another way, of the 101 high-variance teachers in Figure 2, 76 of them are also low-frequency teachers, meaning that only 25 additional teachers are high-variance but not low-frequency. This overlap explains why the patterns among the low-frequency class of teachers in Figure 3 are very similar to the patterns among high-variance teachers in Figure 2. We focus on these combinations of variance and frequency below, aggregating from the item- to the trait-level.

Finally, our LCA results showed that certain practices within and between teaching approaches are more common than others. For example, across all classes, teachers reported less

frequently designing lessons to show how different cultural groups use mathematics (item 12) and working on extended learning activities (item 28), compared to other instructional practices.

Given the variation in teachers' emphasis and frequency of use within teaching approaches, we examined whether differences in use of specific practices within teaching approaches drive the profile and class assignments from the LPA and LCA using a random-effects model (Table 4). As mentioned, we found that in each case, a large percentage of the variance is explained by differences in use of practices *within* teaching approaches (indicated by high residual variance relative to between-trait variance). Thus, profiles are not explained by teachers emphasizing ambitious more than other approaches, but rather, by the choices they make about emphasizing practices *within* CR, ambitious, and traditional teaching.

[Table 4 here]

Resulting Teacher Typology: Seven Teacher Types and Their Characteristics

To characterize teachers' integration of these three teaching approaches as a whole, we aggregated our results to the trait level (i.e., CR teaching, ambitious, and traditional). As mentioned, it is possible for a teacher to be classified as, for example, low-variance and high-frequency or low-variance and low-frequency. We cross-tabulated the three classes from the LPA and the three classes from the LCA to create seven unique groups of teachers that represent different relative emphasis and total frequency across teaching approaches. (Only seven are identified because two of the nine possible cells contained no teachers or just a single teacher.[4])

In Table 5, we summarize our key takeaways about each of our seven teacher types and how confidence, self-efficacy and demographic factors distinguish them, and we describe the results that led us to these characterizations in the sections that follow.

[4] For the analysis moving forward, our analytic sample is 204 teachers.

[Table 5 here]

Teachers' Integration of Teaching Approaches: CR Teaching Drives Teacher Types

Based on mean levels of use by teacher type across the three teaching approaches, our results showed that differences in CR teaching distinguished these teacher types. In Figure 4, we show the average self-reported frequency with which teachers used each teaching approach. The use of ambitious and traditional instruction is relatively constant within teacher types. In contrast, usage of CR teaching approaches differs fairly noticeably within each type, with a stark decrease or increase in CR teaching relative to ambitious and traditional instruction. Two of the resulting teacher types emphasize CR teaching, but differ in the frequency with which they report enacting CR teaching practices (N=42 teachers in total); three types de-emphasize CR teaching (N=101 in total) and vary in how frequently they enact CR teaching at all; and two do not emphasize any particular trait over and above the others (N=61), differing in the frequency with which they use all types of teaching practices. Thus, at the trait level, the variability in emphasis on teaching approaches across teacher types is driven almost exclusively by varied levels of emphasis on CR teaching, with lower emphasis on CR teaching being most common.

[Figure 4 here]

Characterizing the Seven Teacher Types

Next, we examined the characteristics of teachers in these seven teacher types, which we summarize in Table 4 above. Regarding teacher background characteristics, we found differences across teacher types based on race and teacher experience: teachers of color are much more likely to emphasize CR teaching relative to white teachers, and novice teachers tend to use the three teaching approaches at consistent levels compared with more experienced teachers (Table 6). More specifically, both High- and Mid-Frequency CR Teaching Emphasizers—i.e.,

teachers who emphasize CR teaching practices more than they emphasize ambitious and traditional—have greater percentages of teachers of color than Low-Frequency CR Teaching De-emphasizers. Furthermore, the Mid-Frequency CR Teaching De-emphasizers type has a greater percentage of white teachers compared to the Low-Frequency CR Teaching De-emphasizers type (though both of these groups have higher percentages of white teachers than all other groups - see Table 6). Non-Discriminators (both high- and mid-frequency) have greater percentages of novice teachers compared to the Low-Frequency CR Teaching De-emphasizers teacher type. We found no differences among teacher types by gender.

[Table 6 here]

To further understand differences among teacher types, we examined the differences in confidence, beliefs, and curricular use among types (Table 7). First, we found that CR Teaching Emphasizer and Non-Discriminator Types tended to have greater self-efficacy than teachers in other types. High-Frequency Non-Discriminators had the greatest CR teaching self-efficacy and confidence in meeting student needs, on average, compared to all other teacher types (and the difference between this teacher type and the Low-Frequency CR Teaching De-emphasizers teacher type was statistically significant). Consistent with the finding that CR Teaching Emphasizers tended to be teachers of color, we also found a slight positive correlation between teachers of color and CR teaching self-efficacy (0.15).

Interestingly, though CR Teaching Emphasizers had strong CR teaching self-efficacy and used CR teaching most frequently, they expressed the lowest levels of agreement with beliefs about CR teaching (though notably, they still agreed, on average, with beliefs statements about CR teaching). Thus, while these (predominantly teachers of color) teachers implemented CR practices in their classrooms more than ambitious and procedural instruction and reported greater

self-efficacy regarding CR practices, other teachers report greater levels of beliefs in the importance of these practices than these teachers. Consistent with these findings, we also found a slight negative correlation between teachers of color and beliefs (-0.18).[5]

We find no explainable patterns regarding teachers' use of curricular and supplemental materials. Mid-frequency Emphasizers and Mid-Frequency Non-Discriminators use their curricular materials least frequently and significantly less frequently than Low-Frequency CR Teaching De-Emphasizers. All CR Teaching De-Emphasizer Types tend to use their curricular materials relatively frequently, based on their mean values, which could suggest that adherence to curricular materials supports ambitious and traditional practices, but not necessarily CR teaching. Yet, High-Frequency Non-Discriminators use their curricular materials most frequently of all groups (again based on their mean value). Patterns in supplemental curricular use are also not readily explainable. High-Frequency CR Teaching Emphasizers supplement most frequently, which is a predictable result given that CR teaching demands adaptation to curricular materials based on students' identities and backgrounds (Gay, 2018), but the next most likely type of teacher to supplement is the Mid-Frequency Non-Discriminators, a result that is less consistent with existing theory and research. Finally, teachers' perceptions of how appropriate their curriculum is for meeting their students' needs do not moderate variation in instructional practice. Importantly, our survey did not ask teachers about their reasons for using and supplementing their curricula. We interpret these lack of clear patterns as evidence that teachers use their curricula in different ways, and have different reasons for supplementing and perceiving the curriculum as appropriate.

[Table 7 here]

[5] We interpret this result with caution, however, given the lower than ideal alpha for this scale (0.56).

Deeper Dive: What Explains Some Teachers' Low Emphasis on CR Teaching?

Given that a large portion of teachers reported rarely engaging in CR teaching relative to other practices (N=101 total for CR Teaching De-Emphasizers), we next examined the CR Teaching De-Emphasizers more closely to see whether there are distinguishing characteristics of these teachers that might have implications for policy decisions or professional development approaches. We found that, compared to all other types, CR Teaching De-Emphasizers included greater percentages of white teachers and lower percentages of novice teachers (Table 8a). These teachers reported lower confidence meeting student needs and engaging in CR teaching, but higher agreement with CR teaching beliefs. They also reported more frequent use of curricular materials and less frequent use of supplemental materials for instruction. Thus, these teachers appear to be supportive of CR teaching, but have less confidence to engage in it and therefore de-emphasize it relative to other practices. Alternatively, it may be that these teachers teach in school contexts that offer limited curricular flexibility. We test these explanations below.

[Table 8a here]

Variation in CR Teaching De-Emphasizers. Given the importance of self-efficacy to the CR Teaching Emphasizers (Tables 3 and 5), we sought to understand heterogeneity in self-efficacy among CR Teaching De-Emphasizers using LCA. We found that teachers fell into two classes of approximately similar sizes: those who reported quite high self-efficacy for CR teaching (mean of 8.8 out of 10; N=54) and those who reported much lower self-efficacy for CR teaching (mean of 6.3 out of 10; N=47). For context, the mean CR teaching self-efficacy among High-Frequency CR Teaching *Emphasizers* was 8.5 (Table 7)—thus, about half of the CR Teaching De-Emphasizers reported very high self-efficacy for CR teaching but do not engage in it at high levels. The other half reported much lower self-efficacy for CR teaching, a reasonable

explanation for their lack of use. Based on a series of regression models (Table 8b), we found that those teachers who de-emphasized CR teaching and reported low self-efficacy for CR teaching tended to be male, compared to high self-efficacy CR Teaching De-Emphasizers.

[Table 8b here]

Variation in CR Teaching De-Emphasizers Across Schools. Finally, to account for a teacher having high self-efficacy for CR teaching but de-emphasizing CR teaching practices, we examined whether CR Teaching De-Emphasizers were clustered in particular schools. Our hypothesis here relates to school context: teachers may want to engage in CR teaching and have the self-efficacy to do so, but are constrained by requirements in their school contexts. If this were the case, we would expect to see some consistency of CR teaching usage (or lack thereof) within schools. However, schools varied in the types of teachers working there and, specifically, in how much those teachers emphasized CR teaching. Among schools with at least three teachers in our sample, on average 23% of teachers in the school emphasized CR practices, 49% de-emphasized CR practices, and 28% did not emphasize or de-emphasize CR practices. In 16 of 29 schools with three or more teachers, CR Teaching De-Emphasizers represent less than 50% of the teachers in that school. Though it still could be the case that teachers in some schools feel constrained by their teaching environment, the variation in CR teaching usage we see in schools suggests that the dictates of school-level curricular alignment are not solely responsible for teacher CR practices. Instead, these results suggest that teaching decisions and curricular enactment depend on a confluence of individual and social factors (Remillard & Heck, 2014).

Limitations

Several limitations to our study should be considered. First, our analyses rely on survey data, which can be subject to respondent bias and social desirability, especially surveys about

cultural competence (Larson & Bradshaw, 2017). To alleviate some of this bias, we rely on behavior-based measures of teacher instruction for our typology, which prior work has shown to be a valid and reliable way of measuring teacher practice (Author, 2009; Mayer, 1999). Still, we acknowledge that teachers' self reports of their teaching practice may not fully or accurately reflect their classroom practice (e.g., see Parkhouse, Lu, & Massaro, 2019 regarding CR teaching specifically). Future studies might build on ours by using alternative measures.

Second, our regression analyses are not causal, and our findings are not generalizable to all middle school mathematics teachers. Our sample reflects educators in a set of five large, urban districts across the country who have made efforts to improve teaching and learning, especially for marginalized students. Despite these limitations, our focus on what factors predict teachers' use of CR, ambitious, and traditional teaching has not been done before, so we offer an important new direction for the study of mathematics teaching.

We also note that teachers were not evenly distributed by race among our PL partnerships: A majority of teachers of color in our sample taught in one district, while a majority of white teachers taught in another. Thus, our findings about the association between race and CR teaching, while consistent with prior literature (e.g., Sleeter, 2001; Ware, 2006; Young, 2010), may reflect differences in district and partnership contexts.

Finally, while we use our survey data to investigate potential explanations for teachers' behaviors in our typology, we have limited information on teachers' school contexts and other factors that may influence how they enact their curricula. Future work might examine the reasons teachers adapt their curricula.

Discussion and Implications

Our results speak to two high-level themes about how teachers integrate multiple teaching approaches. First, we found that teachers integrate CR, ambitious, and traditional practices in unique and distinguishable ways. In most cases, teachers engaged in different practices with different amounts of frequency—this was true for the CR teaching emphasizers and de-emphasizers (five of the seven teacher types), who use CR teaching more or less frequently than ambitious and traditional teaching. In other cases—namely, the non-discriminator teacher types (two total)—teachers demonstrated a more balanced approach to integrating CR, ambitious, and traditional teaching, engaging with somewhat equivalent frequency in each teaching approach.

These documented differences in how teachers bring together multiple teaching approaches are critical for understanding how teachers respond to multiple, simultaneous calls for reforming their teaching practices and evolving conceptions of effective teaching. Over the last several decades, the mathematics education field has seen a shift toward emphasizing conceptual rigor, as well as integrating equitable instructional practices, such as those that support student agency, voice, and identity (NCTM, 2021; Wilson et al., 2019). Incorporating new practices into preexisting praxis is a complex endeavor, and a key challenge in instructional policy implementation is understanding and supporting how teachers do so. Teachers regularly receive a barrage of messages about what effective instruction looks like, and not all messages align (Coburn, 2005). Thus, teachers are forced to decide how to best incorporate multiple approaches into their practice. Seminal scholarship has shown that teachers approach integrating new practices with older ones through a reliance on their preexisting knowledge, understanding, beliefs, and frameworks (Cohen, 1990; Spillane & Jennings, 1997; Spillane, 1999). As teachers

adopt new practices, "new threads [are] introduced, but old threads [are] not pulled out" (Cohen, 1990, p. 314)—nor, perhaps, should they be. Teachers constantly layer new practices with older ones, as they adapt to changing demands and iterate on their practice to improve. While mathematics education scholarship has offered important depictions of how teachers use traditional and ambitious practices in the classroom, and the CR teaching literature has offered rich characterizations of CR practices, these studies have not examined how teachers bring together ambitious and traditional teaching with CR teaching approaches—the focus of our study. We find that while teachers make decisions that lead to widely varying practice, we can typologize them. Some teachers may allocate equal time and energy to different approaches (old or new), whereas others may privilege certain approaches over others.

The second key theme we highlight with this study is that teachers' engagement in CR teaching is distinct from their engagement in ambitious and traditional teaching, and CR teaching distinguishes the teacher types in our typology from one another (Figures 2-3). Some CR teaching practices were noticeably more or less common across all teachers than others. For instance, teachers across the board were least likely to report frequently identifying cultural biases in textbooks or other instructional materials for math, or designing a lesson that shows how different cultural groups use math. This suggests that there may be specific practices related to CR teaching that are not enacted in middle school mathematics classrooms. Still, while there were some similarities across all teacher types regarding specific CR teaching practices, on the whole, we found that our teacher types were distinguishable, at the trait level, based on teachers' use of CR teaching relative to ambitious and traditional teaching. Teachers choose to emphasize CR teaching or not. This latter group was substantial. Approximately half of teachers do *not* use

CR practices—both in absolute terms and also relative to ambitious and traditional practices—despite many of these same teachers holding beliefs that CR teaching is important.

What helps to describe variation in CR instructional practices?

Our study offers possible explanations for differences in teachers' use of CR teaching. We found that teacher race, experience levels, and CR teaching self-efficacy relate to their usage of CR teaching. Teachers of color make up a large majority of CR Teaching Emphasizers (83%). As noted, teachers were clustered in districts, with a majority of the sample's teachers of color working in Springview, which, as outlined in Table 1, offered resources and PL to teachers on being culturally responsive and integrating social issues into instruction (Table 1). Thus, we cannot disentangle race from district context. Still, these findings resonate with CR teaching scholarship that suggests teachers of color bring greater multicultural knowledge to their instruction (Sleeter, 2001; Ware, 2006). Both teachers' racial/ethnic identities *and* their access to rich supports for CR teaching likely influence these teachers' emphasis on CR teaching.

Likewise, teachers who reported that they do *not* use CR practices as frequently as other practices tended to be white, more experienced, and have lower CR teaching self-efficacy. At the same time, these low-frequency CR teachers also reported relatively high stated beliefs about the importance of CR teaching. One interpretation of these beliefs results is that they speak to the social desirability of CR teaching—teachers, particularly white teachers, might be inclined to express their agreement with CR teaching despite not engaging in these practices themselves. Regardless, high stated beliefs about CR teaching suggest that these teachers may be motivated to engage more frequently in CR teaching and in PL focused on CR teaching.

Still, CR Teaching De-Emphasizers are not a homogeneous group. About half of CR teaching de-emphasizers have CR teaching low self-efficacy, which may explain why they rarely

engage in CR teaching. Yet, another half of CR De-Emphasizers have relatively *high* levels of self-efficacy. We are limited in our data to understand what might drive these teachers to de-emphasize CR teaching despite feeling self-efficacious with it, such as aspects of school context—an important area for future research.

Finally, teachers' reported use of curricular and supplemental materials did not track with our expectations. Given the importance of curricular adaptations for CR teaching (Gay, 2018), we anticipated that CR Teaching Emphasizers would use supplemental materials at much higher rates than other teacher types. We also expected CR Teaching De-Emphasizers to rely more heavily on their curricular materials (rather than supplemental materials) than would CR teaching emphasizers. While we found this to be true in some cases, results were inconsistent. Our findings suggest that teachers used their curricula and supplemental materials in different ways for different reasons. This finding resonates with conceptions of curricular enactment in the literature, which characterizes enactment as a complex process of operationalizing formal curricula in practice (Remillard & Heck, 2014). A variety of factors influence how teachers enact curriculum, including teachers' interactions with students, their beliefs about the content and the curriculum, and their beliefs about how curricula should be used in practice (Remillard & Bryans, 2004). Our data do not allow us to examine reasons why teachers use and supplement their curricula. Understanding the nuances to teachers' decision-making around curricula, especially in the context of integrating CR teaching with ambitious and traditional approaches, is an important area for future research.

Implications for Policy and Practice

The fact that teachers tended to integrate teaching approaches in a variety of different ways suggests that PL might be most productive if it builds on the ways teachers are already

taking up particular practices. In this way, PL could cater to the specific practices that teachers do not already engage in. Further, understanding how teachers already integrate multiple teaching approaches could inform productive coaching models. For instance, High-Frequency CR Teaching Emphasizers could be paired with CR Teaching De-Emphasizers to offer support that is tailored to the practices that some teachers emphasize and others do not. Such an approach focuses on the productive practices that teachers are already engaging in, and leverages that wisdom of practice in service of their colleagues' development as educators.

Furthermore, our findings suggest that rather than focus PL on only one teaching approach, teachers could benefit from PL that specifically aims to blend approaches. As more districts consider offering teachers PL on CR teaching, they should consider PL that puts CR teaching in conversation with other demands for mathematics teaching (e.g., conceptual rigor) and makes explicit how these approaches can coexist and complement one another. This implication resonates with scholarship that suggests that CR teaching in mathematics can be particularly challenging and few strong examples of CR teaching in secondary mathematics exist (Parker et al., 2017). By offering teachers explicit examples of how CR teaching integrates with rigorous mathematics instruction, districts might better support teachers to effectively blend these approaches to ensure both rigorous and equitable mathematics instruction.

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Tables and Figures

Table 1. District Demographics and Background Information

District	Professional Learning (PL) Partner Foci	Student Enrollment	District Student Demographics	Schools in Sample and their Demographics
River Valley	● Using math language routines to support EL population ● Attention to social emotional learning ● Teacher self-reflection on identity	70,000-90,000	77% African American; 14% Hispanic/Latinx; 8% White; .8% Asian; .2% Other Race; 9% EL	N=3; 34% African American; 51% Hispanic/Latinx; 11% White; 1% Asian; 3% Other Race; Over 25% EL
Springview	● Alignment to to grade-level standards and increasing access to the content for all students ● Using instructional materials focused on relevant sociocultural issues	50,000-70,000	70% African American; 21% Hispanic/Latinx; 2% White; 4% Asian; 3% Other Race; 14% EL	N=15; 59% African American; 33% Hispanic/Latinx; 2% White; 3% Asian; 3% Other Race
Windy Rock	● Using math language routines ● Alignment with grade-level standards for all students ● Attention to social emotional learning in instruction and making learning relevant to students' interests	70,000-90,000	7% African American; 23% Hispanic/Latinx; 61% White; 3% Asian; 6% Other Race; 5% EL	N=16; 8% African American; 24% Hispanic/Latinx; 60% White; 3% Asian; 5% Other Race
Lower County	● Alignment with grade-level standards for all students ● Supporting students to develop math identity ● Discussing sociopolitical issues of equity	190,000-210,000	27% African American; 36% Hispanic/Latinx; 30% White; 3% Asian; 4% Other Race; 14% EL	N=11; 27% African American; 35% Hispanic/Latinx; 30% White; 3% Asian; 5% Other Race
Pebbletown	● Using math language routines ● Teaching for conceptual understanding ● Engaging in anti-racist instruction ● Analyzing student work focused on addressing deficit thinking and implicit bias among teachers	110,000-130,000	9% African American; 48% Hispanic/Latinx; 24% White; 9% Asian; 10% Other Race; 20% EL	N=8; 8% African American; 44% Hispanic/Latinx; 15% White; 23% Asian; 10% Other Race

Note. PL = Professional learning; EL = English learner. "Other Race" refers to all other groups (i.e., American Indian/Alaska Native, Native Hawaiian/Pacific Islander and Two or more races) with percentages lower than 10%. Source of student enrollment and demographics is the NCES Common Core of Data. Not all schools in our sample provided publicly available data on EL percentages. This table provides descriptive information on each district partnership from which our data originate.

Table 2. Descriptive Statistics

Experience level	
Years of teaching experience	12.6 (8.85)
Novice teacher (3 or fewer years of experience)	14% (n=29)
Veteran teacher	86% (n=176)
Gender	
Female	76% (n=156)
Male	19% (n=39)
Non-binary	1% (n=2)
Prefer not to say	4% (n=8)
Race/Ethnicity	
White	49% (n=100)
Black	33% (n=67)
Latinx/Hispanic	5% (n=11)
Asian/AAPI	4% (n=8)
Mixed-race	3% (n=6)
Indigenous/Native American	.5% (n=1)
Prefer not to say	9% (n=18)
Education	
Bachelor's degree	45% (n=92)
Master's degree	44% (n=90)
Professional degree	3% (n=6)
Doctorate	4% (n=8)
Other	4% (n=9)
Teaching Measures	
Ambitious Teaching	2.09 (.45)
Traditional Teaching	2.01 (.54)
CR Teaching	1.57 (.75)
Factors Influencing Teaching	
CR Teaching Self-Efficacy	8.08 (1.58)
Confidence Meeting Student Needs	6.36 (2.37)
CR Teaching Beliefs	3.65 (.88)
Use of Curricular Materials	1.92 (.84)
Use of Supplemental Curricular Materials	1.59 (.82)
Curriculum Appropriateness	2.31 (1.01)
Total Observations in Sample	205

Note. Teachers could select all racial/ethnic backgrounds that applied, so total race/ethnicity percentages will exceed 100. This table provides descriptive statistics for the teachers in our sample for experience level, gender, race/ethnicity, education level, self-reported teaching measures, and factors influencing teaching. All data originate from survey data. Descriptive statistics are reported as %(n) or M(sd).

Table 3. Teaching Items

	Item	Trait	Mean	SD
1	Have students from diverse cultural backgrounds work together	CR Teaching	2.20	0.98
2	Use a variety of grouping strategies for small-group instruction	CR Teaching	2.20	0.87
3	Use the interests of my students to make learning meaningful	CR Teaching	2.09	0.92
4	Model classroom tasks to enhance the understanding of ELs	CR Teaching	1.82	1.10
5	Use examples of my students' cultural, historic, and everyday lived experiences	CR Teaching	1.72	0.96
6	Adapt instructional methods to learners from diverse cultural backgrounds	CR Teaching	1.68	1.06
7	Use my students' cultural backgrounds to make learning meaningful	CR Teaching	1.59	1.03
8	Develop activities that increase the self-confidence of culturally diverse students	CR Teaching	1.41	1.08
9	Revise instructional materials to better represent cultural groups	CR Teaching	1.23	1.08
10	Analyze instructional materials for stereotypical/prejudicial content	CR Teaching	1.32	1.22
11	Identify cultural biases in mathematics instructional materials	CR Teaching	1.07	1.12
12	Design a lesson that shows how different cultural groups use mathematics	CR Teaching	0.80	1.03
13	Engage in grade-level mathematics for the majority of classroom time	Ambitious	2.67	0.64
14	Use mathematical language/symbols appropriately when communicating about mathematics	Ambitious	2.68	0.63
15	Apply mathematics to solve problems in real-world contexts	Ambitious	2.50	0.68
16	Focus on conceptual understanding of the mathematics they are learning	Ambitious	2.46	0.74
17	Explain their reasoning/thinking in solving a problem	Ambitious	2.32	0.78
18	Work in small groups	Ambitious	2.00	0.75
19	Make sense of problems and persevere in solving them	Ambitious	2.05	0.79
20	Look for and make use of structure (e.g., patterns in numbers)	Ambitious	2.05	0.82
21	Help other students learn content (e.g., peer tutoring)	Ambitious	2.00	0.82
22	Apply their knowledge to new situations, concepts, or problems	Ambitious	2.00	0.74
23	Critique, evaluate, or synthesize	Ambitious	2.00	0.84
24	Participate in student-led discussion	Ambitious	2.00	0.87
25	Present work to the class	Ambitious	2.00	0.89
26	Participate in self-reflection	Ambitious	1.72	0.95
27	Engage in hands-on activities	Ambitious	2.00	0.73
28	Work on extended learning activities (e.g., portfolios)	Ambitious	1.00	0.90
29	Receive direct instruction	Traditional	2.31	0.80
30	Work independently	Traditional	2.22	0.74
31	Learn or practice basic facts, concepts, and procedures related to a topic	Traditional	2.07	0.87
32	Engage in call and response	Traditional	1.97	0.90
33	Answer multiple-choice, fill-in-the blank, or true/false questions	Traditional	1.76	0.92
34	Take notes from lectures or the textbook	Traditional	1.69	0.98

Note. SD=standard deviation. This table lists and provides the mean and SD for each survey item in our ambitious, traditional, and CR teaching scales. The item numbers serve as a legend for Figures 2 and 3 and correspond to the x-axis labels on those figures. Item language has been abridged for readability.

Table 4. Between- and Within-Trait Variance

	LPA			LCA		
	CR Teaching	Ambitious	Traditional	CR Teaching	Ambitious	Traditional
Between Trait Variance	0.577	0.102	0.154	0.04	0.155	0.618
Residual Variance	0.962	0.867	0.861	0.788	0.824	0.975
Fraction of Variance Due to Traits (ICC)	0.264	0.014	0.031	0.003	0.034	0.286
Observations	204	204	204	204	204	204

Note. This table provides estimates of between-and within-trait variance for six random-effects models: one for each teaching approach (trait; i.e., CR teaching, ambitious, and traditional) grouped by profiles resulting from the LPA, and one for each teaching approach grouped by classes resulting from the LCA. Observations are 204 instead of 205 because one teacher belongs to the Low-Frequency Non-Discriminator crosstabulation from the LPA and LCA mixture models (see Figure 1) and was excluded.

Table 5. Teacher Types and Their Distinguishing Features

Teacher Type	**Use of CR Teaching, Ambitious, and Traditional Instruction (Trait-Level Comparisons)**	**Distinguishing Features**
High-Frequency CR Teaching De-emphasizers (N=10)	High frequency of use of all teaching approaches, but de-emphasized CR teaching relative to ambitious and traditional	50% teachers of color 10% novice teachers 90% female
High-Frequency Non-Discriminators (N=36)	High frequency of use across all three teaching approaches	50% teachers of color 28% novice teachers 69% female High CR teaching self-efficacy High confidence meeting student needs
High-Frequency CR Teaching Emphasizers (N=24)	High frequency of use of teaching approaches, and emphasized CR teaching above ambitious and traditional	83% teachers of color 13% novice teachers 79% female High CR teaching self-efficacy Lower agreement with beliefs about the importance of CR teaching Frequent use of supplemental materials
Mid-Frequency CR Teaching De-emphasizers (N=15)	Middle frequency of use of teaching approaches, but de-emphasized CR teaching relative to ambitious and traditional	13% teachers of color 13% novice teachers 73% female Relatively frequent use of supplemental materials
Mid-Frequency Non-Discriminators (N=25)	Middle frequency of use across all three teaching approaches	52% teachers of color 24% novice teachers 84% female High CR teaching self-efficacy Less frequent curricular use than others Frequent use of supplemental materials
Mid-Frequency CR Teaching Emphasizers (N=18)	Middle frequency of use of teaching approaches, and emphasized CR teaching above ambitious and traditional	83% teachers of color 17% novice teachers 56% female Lower agreement with beliefs about the importance of CR teaching Lowest frequency of curricular use
Low-Frequency CR Teaching De-emphasizers (N=76)	Low frequency of use of teaching approaches, but still de-emphasized CR teaching relative to ambitious and traditional	41% teachers of color 5% novice teachers 80% female Low CR teaching self-efficacy Relatively frequent use of curricula Low frequency of use of supplemental materials

Note. This table provides a synthesis of the resulting typology of teachers. Distinguishing features are based on descriptive statistics of each teacher type sample and results from regression models shown in Tables 6-8b.

Table 6. Descriptive Statistics By Profile

	(1)	(2)	(3)
	Female	White teacher	Novice teacher
High-Frequency CR Teaching D-emphasizers (N=10)	0.097	-0.092	0.047
	(0.107)	(0.171)	(0.100)
High-Frequency Non-Discriminators (N=36)	-0.108	-0.092	0.225**
	(0.091)	(0.102)	(0.080)
High-Frequency CR Teaching Emphasizers (N=24)	-0.011	-0.425***	0.072
	(0.096)	(0.096)	(0.073)
Mid-Frequency CR Teaching De-emphasizers (N=15)	-0.069	0.275*	0.081
	(0.125)	(0.106)	(0.093)
Mid-Frequency Non-Discriminators (N=25)	0.037	-0.112	0.187*
	(0.088)	(0.117)	(0.091)
Mid-Frequency CR Teaching Emphasizers (N=18)	-0.247	-0.425***	0.114
	(0.128)	(0.106)	(0.093)
Constant (Low-Frequency CR Teaching De-emphasizers, N=76)	0.803***	0.592***	0.053*
	(0.046)	(0.057)	(0.026)
N	204	204	204
R-squared	0.039	0.144	0.062
Equal	0.224	0.000	0.587

Note. This table provides results from three ordinary least squares regression. The reference group for each model is Low-Frequency CR Teaching De-Emphasizers. Model 1 regresses the indicator variable female on the six other teacher types. Model 2 regresses the indicator variable white teacher on the six other teacher types. Model 3 regresses the indicator variable novice teacher on the six other teacher types. Robust standard errors are in parentheses. Coefficients can be interpreted as the difference in percentage of female, white, or novice teachers in the teacher type compared to the Low-Frequency CR Teaching De-Emphasizers. Observations are 204 instead of 205 because one teacher belongs to the Low-Frequency Non-Discriminator crosstabulation from the LPA and LCA mixture models (see Figure 1) and was excluded.

Table 7. Teacher Survey Items By Profile

	(1) Confidence Meeting Student Needs	(2) CR Teaching Beliefs	(3) CR Teaching Self-Efficacy	(4) Curricular Use	(5) Supplemental Use	(6) Perceptions of Curricular Appropriateness
High-Frequency CR Teaching De-emphasizers (N=10)	1.263	0.142	0.957	-0.147	0.441	0.244
	(0.766)	(0.301)	(0.502)	(0.304)	(0.278)	(0.340)
High-Frequency Non-Discriminators (N=36)	1.610**	-0.080	1.554***	0.024	0.391*	0.229
	(0.487)	(0.176)	(0.212)	(0.171)	(0.152)	(0.212)
High-Frequency CR Teaching Emphasizers (N=24)	0.992	-0.677**	0.988**	-0.368	1.008***	-0.137
	(0.533)	(0.228)	(0.358)	(0.208)	(0.174)	(0.238)
Mid-Frequency CR Teaching De-emphasizers (N=15)	-0.076	0.022	0.191	-0.252	0.603***	-0.439
	(0.581)	(0.182)	(0.361)	(0.233)	(0.161)	(0.273)
Mid-Frequency Non-Discriminators (N=25)	0.266	-0.098	0.772*	-0.433**	0.892***	-0.459
	(0.523)	(0.191)	(0.316)	(0.161)	(0.157)	(0.242)
Mid-Frequency CR Teaching Emphasizers (N=18)	0.643	-0.796***	-0.154	-0.801***	0.360	-0.012
	(0.681)	(0.234)	(0.596)	(0.176)	(0.189)	(0.206)
Constant (Low-Frequency CR Teaching De-emphasizers, N=76)	5.820***	3.818***	7.543***	2.118***	1.188***	2.373***
	(0.260)	(0.084)	(0.181)	(0.096)	(0.096)	(0.115)
N	204	204	204	204	204	204
R-squared	0.071	0.110	0.152	0.094	0.204	0.051
Equal	0.126	0.006	0.000	0.005	0.003	0.094

Note. This table provides results from six ordinary least squares regression. The reference group is Low-Frequency CR Teaching De-Emphasizers (N=76). Model 1 regresses the continuous variable confidence meeting student needs on the six other teacher types. Model 2 regresses the continuous variable CR teaching beliefs on the six other teacher types. Model 3 regresses the continuous variable CR teaching self-efficacy on the six other teacher types. Model 4 regresses the continuous variable curricular use on the six other teacher types. Model 5 regresses the continuous variable supplemental use on the six other teacher types. Model 6 regresses the continuous variable perceptions of curricular appropriateness on the six other teacher types. Robust standard errors are in parentheses. Coefficients can be interpreted as the difference in the mean survey scale value of the teacher type compared to the mean value of the Low-Frequency CR Teaching De-Emphasizers. Robust standard errors are in parentheses. Observations are 204 instead of 205 because one teacher belongs to the Low-Frequency Non-Discriminator crosstabulation from the LPA and LCA mixture models (see Figure 1) and was excluded.

Table 8a. Descriptive Statistics and Teacher Survey Items: CR Teaching De-emphasizers Versus All Others (Non-Discriminators and Emphasizers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Female	White teacher	Novice teacher	Confidence Meeting Student Needs	CR Teaching Beliefs	CR Teaching Self-Efficacy	Curricular Use	Supplemental Use	Perceptions of Curricular Appropriateness
CR Teaching De-emphasizers (N=101)	0.074	0.265***	-0.144**	-0.857**	0.366**	-0.811***	0.270*	-0.518***	0.024
	(0.059)	(0.068)	(0.048)	(0.328)	(0.121)	(0.216)	(0.116)	(0.109)	(0.142)
Constant (CR Teaching Emphasizers and Non-Discriminators) (N=103)	0.728***	0.359***	0.214***	6.791***	3.470***	8.477***	1.796***	1.839***	2.307***
	(0.044)	(0.048)	(0.041)	(0.241)	(0.097)	(0.153)	(0.081)	(0.073)	(0.101)
N	204	204	204	204	204	204	204	204	204
R-squared	0.008	0.070	0.043	0.033	0.043	0.066	0.026	0.101	0.000

Note. This table provides results from nine ordinary least squares regression. The reference group is teachers in CR teaching emphasizers and non-discriminator teacher types (N=103). Model 1 regresses the indicator variable female on all teachers in CR Teaching De-Emphasizer types. Model 2 regresses the indicator variable white teacher on all teachers in CR Teaching De-Emphasizer types. Model 3 regresses the indicator variable novice teacher on all teachers in CR Teaching De-Emphasizer types. Model 4 regresses the continuous variable confidence meeting student needs on all teachers in CR Teaching De-Emphasizer types. Model 5 regresses the continuous variable CR teaching beliefs on all teachers in CR Teaching De-Emphasizer types. Model 6 regresses the continuous variable CR teaching self-efficacy on all teachers in CR Teaching De-Emphasizer types. Model 7 regresses the continuous variable curricular use on all teachers in CR Teaching De-Emphasizer types. Model 8 regresses the continuous variable supplemental use on all teachers in CR Teaching De-Emphasizer types. Model 9 regresses the continuous variable perceptions of curricular appropriateness on all teachers in CR Teaching De-Emphasizer types. Robust standard errors are in parentheses. For Models 1-3, coefficients can be interpreted as the difference in percentage of female, white, or novice teachers in the teacher type compared to the Low-Frequency CR Teaching De-Emphasizers. For Models 4-9, coefficients can be interpreted as the difference in the mean survey scale value of the teacher type compared to the mean value of the Low-Frequency CR Teaching De-Emphasizers. Robust standard errors are in parentheses. Observations are 204 instead of 205 because one teacher belongs to the Low-Frequency Non-Discriminator crosstabulation from the LPA and LCA mixture models (see Figure 1) and was excluded.

Table 8b. Descriptive Statistics and Teacher Survey Items Among Two Classes of CR Teaching De-emphasizers: High and Low Self-Efficacy

	(1) CR Teaching	(2) CR Teaching Self-Efficacy	(3) Female	(4) White teacher	(5) Novice teacher	(6) Confidence Meeting Student Needs	(7) CR Teaching Beliefs	(8) Curricular Use	(9) Supplemental Use	(10) Perceptions of Curricular Appropriateness
Low Self-Efficacy CR Teaching De-Emphasizers (N=47)	-0.193**	-2.464***	-0.187*	0.147	-0.010	-0.785	-0.091	0.262	-0.203	-0.103
	(0.056)	(0.182)	(0.080)	(0.096)	(0.051)	(0.433)	(0.147)	(0.164)	(0.161)	(0.197)
Constant (High-Self-Efficacy CR Teaching De-Emphasizers) (N=54)	1.257***	8.813***	0.889***	0.556***	0.074*	6.299***	3.878***	1.944***	1.415***	2.380***
	(0.039)	(0.108)	(0.043)	(0.068)	(0.036)	(0.338)	(0.093)	(0.121)	(0.119)	(0.152)
N	101	101	101	101	101	101	101	101	101	101
R-squared	0.105	0.656	0.055	0.023	0.000	0.031	0.004	0.025	0.015	0.003

Note. This table provides results from ten ordinary least squares regression. The reference group is high self-efficacy CR Teaching De-Emphasizers (N=54). Model 1 regresses the continuous variable CR teaching on the low self-efficacy CR Teaching De-Emphasizers. Model 2 regresses the continuous variable CR teaching self-efficacy on the low self-efficacy CR Teaching De-Emphasizers. Model 3 regresses the indicator variable female on the low self-efficacy CR Teaching De-Emphasizers. Model 4 regresses the indicator variable white teacher on the low self-efficacy CR Teaching De-Emphasizers. Model 5 regresses the indicator variable novice teacher on the low self-efficacy CR Teaching De-Emphasizers. Model 6 regresses the continuous variable confidence meeting student needs on the low self-efficacy CR Teaching De-Emphasizers. Model 7 regresses the continuous variable CR teaching beliefs on the low self-efficacy CR Teaching De-Emphasizers. Model 8 regresses the continuous variable curricular use on the low self-efficacy CR Teaching De-Emphasizers. Model 9 regresses the continuous variable supplemental use on the low self-efficacy CR Teaching De-Emphasizers. Model 10 regresses the continuous variable perceptions of curricular appropriateness on the low self-efficacy CR Teaching De-Emphasizers. Robust standard errors are in parentheses. For Models 3-5, coefficients can be interpreted as the difference in percentage of female, white, or novice teachers in the teacher type compared to the high self-efficacy CR Teaching De-Emphasizers. For Models 1-2 and 6-10, coefficients can be interpreted as the difference in the mean survey scale value of the teacher type compared to the mean value of the high self-efficacy CR Teaching De-Emphasizers. Robust standard errors are in parentheses. Observations are 204 instead of 205 because one teacher belongs to the Low-Frequency Non-Discriminator crosstabulation from the LPA and LCA mixture models (see Figure 1) and was excluded.

Figure 1. Analytic Approach

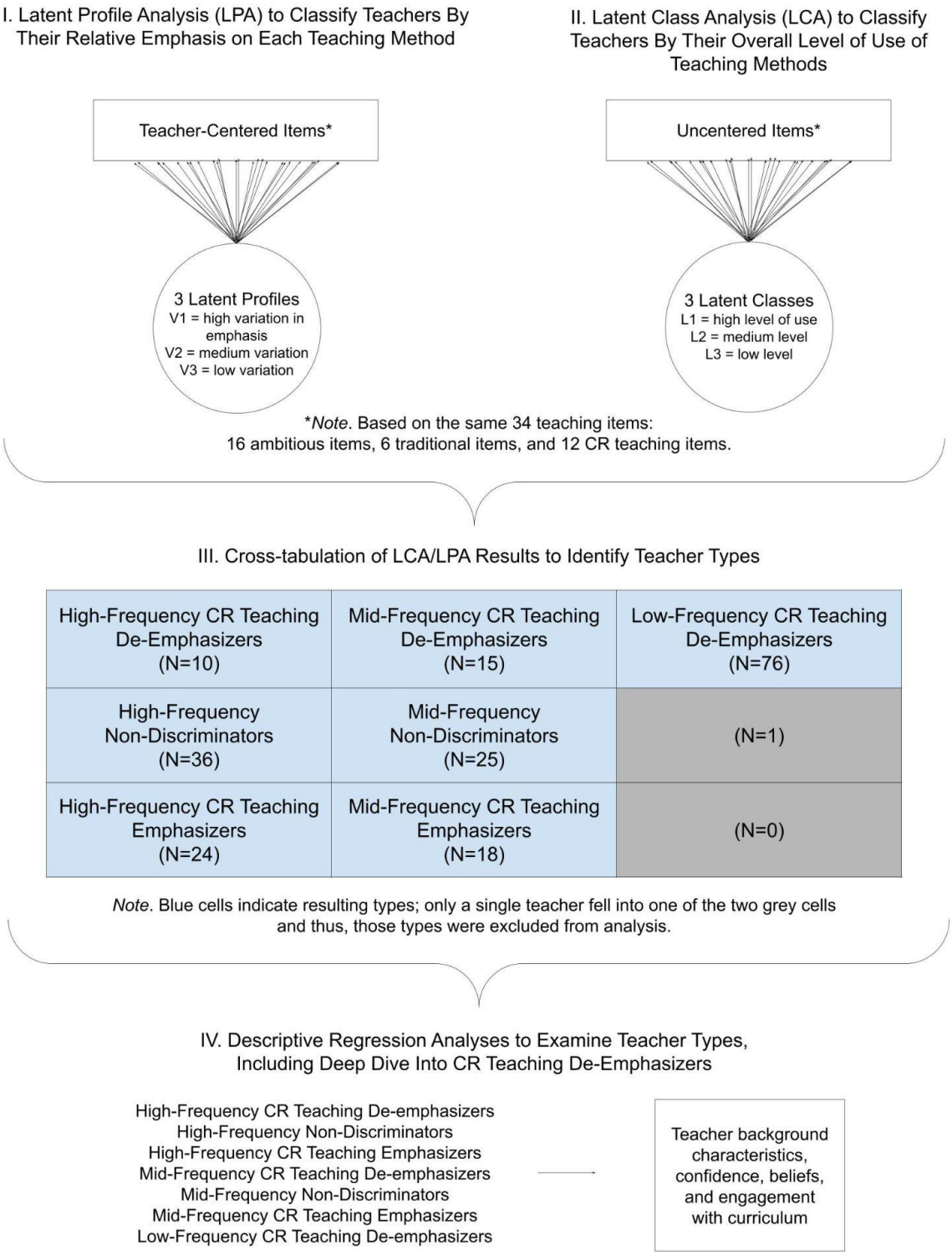
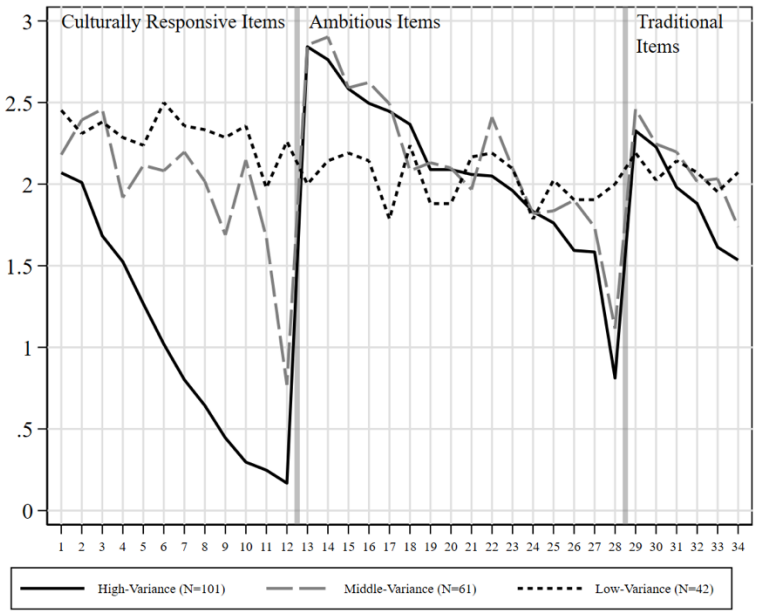
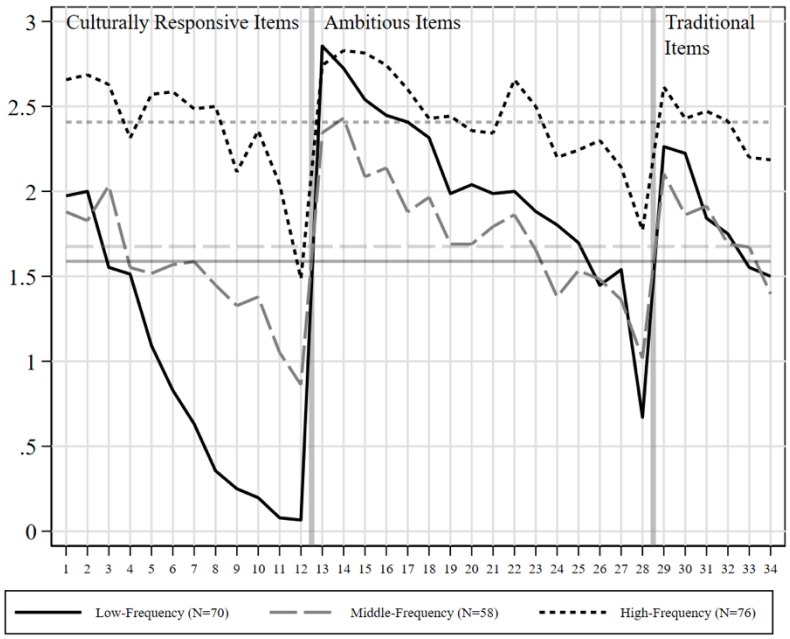


Figure 2. Item-Level Plot of Latent Profile Analysis Results: Classification of Teachers' Relative Emphasis on Each Teaching Approach



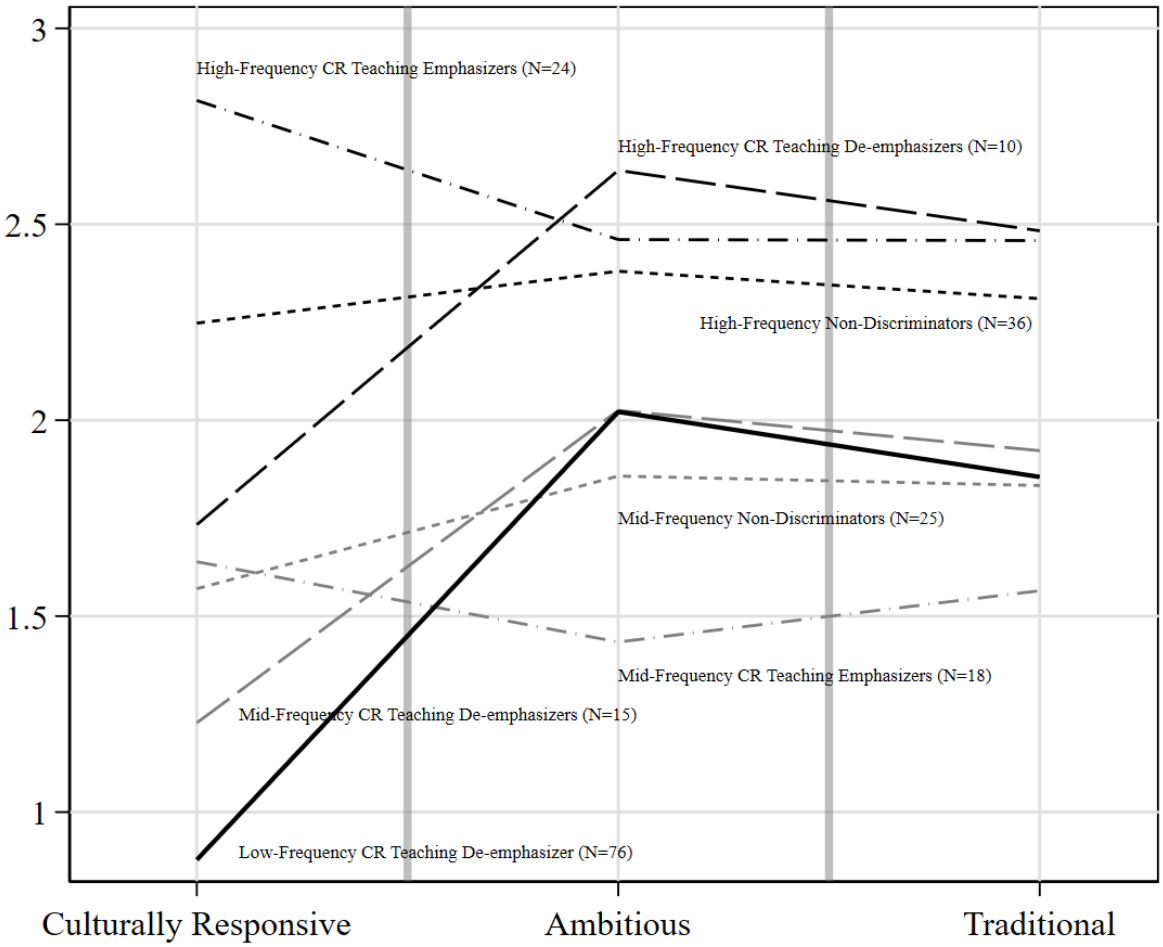
Note. X-axis labels represent individual items/practices and correspond to the list in Table 3. Y-axis represents the unweighted average for each item.

Figure 3. Item-Level Plot of Latent Class Analysis Results: Classification of Teachers' Relative Frequency of Use of Teaching Approaches



Note. X-axis labels represent individual items/practices and correspond to the list in Table 3. Y-axis represents the unweighted average for each item.

Figure 4. Trait-Level Plots of Resulting Teacher Type



Note. X-axis labels the construct (Table 3). Y-axis represents the unweighted average of the items in each construct.