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# Intersectionality in Inclusive Science Classrooms: Enhancing Student Performance via Multimedia Teacher Professional Development

**Lindsay M. Griendling[1], Victoria J. VanUitert[1], Michael J. Kennedy[1], Wendy J. Rodgers[2], John Elwood Romig[3], Hannah Morris Mathews[4], and Katherine N. Peeples[5]**

**Abstract**

Student achievement disparities in inclusive science classrooms are concerning, as knowledge about science, technology, engineering, and mathematics (STEM) is increasingly important for upward mobility. When students identify with multiple marginalized sociocultural groups, progress becomes more troubling, as the interplay among these factors is rarely accounted for in quantitative intervention research. The purpose of the present study, therefore, was to evaluate performance on measures of science vocabulary and general science knowledge among students with intersectional identities (i.e., students with disabilities from marginalized racial/ethnic groups, $n = 33$; and students with disabilities from low SES households, $n = 167$) following teacher participation in a multimedia professional development (PD) process. Using a series of multilevel models, results suggest students who learned from teachers who participated in the multimedia professional development process experienced greater gains than peers with the same intersectional identities in comparison classrooms across all measures. Implications and future directions are discussed.

**Keywords**

intersectionality, professional development, vocabulary instruction, students with disabilities, culturally and linguistically diverse students, science education

## Intersectionality in Inclusive Science Classrooms: Enhancing Student Performance via Multimedia Teacher Professional Development

A frequent concern across educational research, policy, and practice in the United States pertains to the academic underperformance of marginalized sociocultural groups, including students with disabilities, marginalized racial/ethnic populations, or students from low socioeconomic status (SES) households. Attention toward such concerns, however, tends to focus on within-group comparisons (e.g., race/ethnicity *or* disability status *or* SES; Artiles et al., 1997; Pugach et al., 2019, 2021. The problem with this approach is that findings and recommendations of researchers and policymakers prompted by singular group performance comparisons neglect to account for the nuanced educational experiences of students who identify with multiple marginalized sociocultural groups (Grant & Zwier, 2011; García & Ortiz, 2013). This disregard to multiple disenfranchised group identification, a concept referred to as *intersectionality* (Beal, 1969; Combahee River Collective, 1977; Crenshaw, 1989; 1991), can stymie attempts to improve educational experiences and achievement among students served in K-12 public institutions.

## Intersectionality Theory

Intersectionality is a theoretical framework for understanding the ways in which multiple social identities (e.g., race, gender, SES, and disability status) intersect with one another at the

[1]School of Education and Human Development, University of Virginia, Charlottesville, VA, USA
[2]Virginia Commonwealth University, Richmond, VA, USA
[3]University of Texas at Arlington, Arlington, TX, USA
[4]University of Florida, Gainesville, FL, USA
[5]Illinois State University, Normal, IL, USA

**Corresponding Author:**
Lindsay M. Griendling, School of Education and Human Development, University of Virginia, 417 Emmet Street South, Charlottesville, VA 22903, USA.
Email: lmc8ff@virginia.edu

individual (micro) level to reflect systems of privilege and oppression at the social-structural (macro) level (American Psychological Association [APA], 2020; Bowleg, 2012). The term intersectionality was coined by Kimberlé Crenshaw (1989; 1991); however, the concept can be traced back to the work of Black women scholar-activists of the 1960s and 1970s (Beal, 1969; Combahee River Collective, 1977). Rather than conceptualizing the social identities of individuals as subgroups of a broader, or more dominant group, intersectionality deliberately calls attention to the concurrent sociocultural identities of individuals who are often placed at the margins. A Black student with a disability from a low SES household, for example, would be considered an individual with an intersectional identity as two or more of the singular sociocultural groups with whom they identify (i.e., their race/ethnicity, ability, and SES) are groups that have been oppressed or marginalized due to social-structural systems that extend certain privileges to the dominant groups of the United States (i.e., individuals who identify as White, middle- or upper-class, non-disabled, and male). Intersectionality theory contends that the individual who identifies with multiple oppressed groups experiences different, yet interlocking forms of marginalization that result in compounded negative experiences and outcomes.

Regarding negative outcomes among students experiencing multiple forms of marginalization, researchers assert that students with intersectional identities face an increased likelihood of experiencing psychological distress (i.e., symptoms of depression, anxiety, and anger; Cuevas et al., 2010; Shanahan et al., 2008). In school environments, these experiences of psychological distress negatively impact students' motivation, engagement, relationships with peers and adults, and overall academic achievement (Cholewa & West-Olatunji, 2008; Tortura et al., 2014). Unfortunately, regardless of these assertions, attention toward the compounding challenges faced by students who identify with multiple oppressed groups is scarce. Furthermore, while science is not the only content area in which performance discrepancies exist, the way in which intersectionality impacts students in inclusive science classrooms is particularly concerning as knowledge about science, technology, engineering, and mathematics (STEM) is increasingly important in today's world (Vilorio, 2014).

## The Importance of Science Achievement

National occupational trends in STEM-related fields suggest substantial opportunities for employment and economic gains—both of which are important for the upward mobility of historically underserved populations such as students with disabilities, marginalized racial/ethnic groups, and individuals of low SES. The U.S. Bureau of Labor Statistics, (2020) anticipates employment in STEM fields to increase at a faster rate (8.8%) than non-STEM occupations (5.0%). The National Center for Education Statistics (NCES, 2016) also reports that individuals who receive a bachelor's degree or higher in STEM-related fields have higher median earnings than those who earn degrees in non-STEM fields. Moreover, science provides an avenue through which students develop skills in problem-solving, analyzing and discussing data, and developing arguments with supporting evidence—all of which are also valued skills outside of STEM careers (National Research Council, 2012).

To support greater access to such employment opportunities, steps must be taken to ensure that students with intersectional identities are receiving high quality instruction that supports engagement and achievement in science coursework. Yet, this does not appear to be the case as current science achievement trends among isolated student subgroups reveal widening discrepancies among students with disabilities and their non-disabled peers, as well as consistent discrepancies between students from marginalized racial/ethnic groups and their peers who identify as White (U.S. Department of Education, 2019). Further, although nationwide trends in science achievement are not disaggregated by SES, there is evidence suggesting that the SES of children's early environments impact areas of cognitive ability (i.e., executive functioning, language ability, relational reasoning) that are critical to later achievement in STEM-related coursework (Blums et al., 2017). While current trends among singular student subgroups are troubling, this narrow viewpoint substantiates the question upon which the intersectionality framework is based: When students identify with multiple disenfranchised sociocultural groups, how do these attributes simultaneously interact to exacerbate challenges? Further, how can challenges be mitigated to promote greater achievement and outcomes?

## Challenges to Achievement in Science Courses

Science education researchers and practitioners advocate for all students, regardless of their current achievement and ability levels, to successfully engage in inquiry-based investigations with scientific discourse (National Research Council, 2012; Villanueva et al., 2012). However, the language of science involves complex terms that often lack relevance to students' lives, as many terms are rarely encountered outside of science classrooms (e.g., mitosis; Harmon et al., 2005; Mason & Hedin, 2011). In addition, many science terms hold different meanings when used in other content area contexts (e.g., solution; Rice & Deshler, 2018).

Further complicating matters, successful engagement in inquiry-based activities and discourse requires knowledge of specialized science terminology and concepts (Jackson & Ash, 2012; Parsons & Bryant, 2016). Yet, science educators do not consistently provide evidence-based vocabulary instruction due to: (a) believing students will learn term meanings while engaging in investigations and related discourse (Lee et al., 2005); and (b) being unprepared to offer such instruction (Johnson & Massey, 2012). An observational study of secondary science teachers, however, notes specific challenges with providing equitable access to content (i.e., supporting academic language, relevance, and differentiation) and content discourse (i.e., justifying reasoning with evidence) due to the recurrent need for language supports (Nava et al., 2019).

### Study Purpose

To mediate barriers thwarting access to and achievement in science classrooms, identifying and evaluating interventions that support students' understanding and performance is imperative. However, identifying and evaluating interventions for singular student groups is insufficient due to the increased prospect of detrimental psychological effects associated with intersectionality, which may impact student motivation, engagement, and overall academic achievement (Cholewa & West-Olatunji, 2008; Tortura et al., 2014). Further, findings that neglect the multiple, concurrent sociocultural identities of students present an oversimplified understanding of target populations and the true effects of interventions (García & Ortiz, 2013; Grant & Zwier, 2011). As such, the purpose of this study is to determine, via secondary data analysis, if teacher participation in a multimedia professional development (PD) process supported increased performance among students with intersectional identities (i.e., students with disabilities from marginalized racial/ethnic backgrounds and students with disabilities from low SES households) within inclusive middle school science classrooms.

### The CAP-PD Process

The Content Acquisition Podcast Professional Development (CAP-PD) process is a multimedia intervention that emerged from cognitive apprenticeship theory (Brown et al., 1989; Collins et al., 1988). The theory of cognitive apprenticeship posits that learning is a process of enculturation, and for individuals to learn the tools of a trade, they must enter the culture of that community. Similar to children learning speech and language processes by observing and imitating fluent adults, cognitive apprenticeship theory suggests that learners can master domain techniques through opportunities to observe and imitate the skills used by experts in authentic contexts, while gradually fading the level of support provided. Aimed at teaching the factual and conceptual processes experts use to handle complex tasks, cognitive apprenticeship methods further support learning by enabling individuals to acquire, develop, and use knowledge and skills in authentic activity (Brown et al., 1989; Collins et al., 1988). In keeping with this theory of *in situ* learning, the CAP-PD process comprises three core components (see Kennedy et al., 2018 for primary study), described in the following sections.

### Instruction in Evidence-Based Practices: CAP-TVs

One component of the CAP-PD intervention process includes a series of multimedia instructional vignettes called Content Acquisition Podcasts for Teachers with Embedded Modeling Videos (CAP-TVs). To support both factual and conceptual knowledge of instructional practice as called for in cognitive apprenticeship methods (Brown et al., 1989; Collins et al., 1988), each CAP-TV is structured in the same way. They begin with a concise, explicit introduction to an instructional practice, followed by steps for implementing the practice, and finally, an exemplar teacher using the practice in an authentic classroom setting. CAP-TVs have demonstrated effectiveness in supporting teachers' knowledge of evidence-based instructional practices, as well as their implementation fidelity, frequency, and amount of practice use across several studies (Ely et al., 2015; Kennedy et al., 2017).

### Coaching and Feedback

Another component of CAP-PD comprised coaching emails with specific feedback on teachers' implementation of newly learned instructional practices. The level of specificity provided in the coaching emails was facilitated by data collected via a low-inference, web-based observation instrument called the Classroom Teaching (CT) Scan (see Rodgers et al., 2019 for a description of this tool). The coaching component also supports cognitive apprenticeship methods, in that teachers were provided opportunities to practice newly learned instructional skills with support from field experts that was gradually faded over time. Further, findings from prior studies suggest that when a coaching component was combined with CAP-TVs, teachers frequency and quality of practice implementation increased over time (Kennedy et al., 2017; Peeples et al., 2018), and students were significantly more engaged during class observations (Kennedy et al., 2017).

### Student Instructional Materials: CAP-S

As several studies have shown PD is more effective when it is linked to teachers' content area curriculum and pedagogical practice (Cohen & Hill, 2001; Fishman & Krajcik, 2003; Penuel et al., 2007; Van Driel & Berry, 2012), a final component of the CAP-PD process comprised pre-made instructional slides called Content Acquisition Podcasts for Students (CAP-S). The provision of instructional materials remains aligned with cognitive apprenticeship theory, as individuals become enculturated in a domain when they learn the tools of a trade as practitioners use them (Brown et al., 1989). Further, researchers have shown that when students with disabilities learn content area vocabulary with CAP-S, they demonstrate greater knowledge of term meanings and ability to apply knowledge of key terms in open-ended responses (Kennedy et al., 2014, 2015; VanUitert et al., 2020).

**How CAP-S support student learning.** The formatting and presentation of CAP-S emerged from Mayer's (2020) cognitive theory of multimedia learning (CTML). The CTML posits that multimedia presentations should be formatted and presented in a way that supports students' ability to process content through visual and auditory channels connected to the brain's working memory system. In working memory, new information is connected to prior knowledge and stored in long-term memory for later retrieval (Smith et al., 2016). Further, a set of 13 design principles emerged from the CTML; some examples of which include: (a) placing related large, clear images and text in proximity to one another to support visibility; (b) using a clear voice in narration; (c) segmenting information into smaller chunks; and (e) using generative activities (e.g., summarizing, cognitive routines) to support information retention (Mayer, 2020).

Additionally, CAP-S embeds practices that are centered upon foundational elements of explicit instruction (see Archer & Hughes, 2011) effective for students with disabilities and other struggling learners. CAP-S instructional elements include: (a) a clear introduction to the new term; (b) an overview of the lesson parts ahead; (c) a review of background knowledge, including other key terms and concepts that will support students' understanding of the new term; (d) a student-friendly definition of the new term; (e) a range of examples and, when applicable, clear non-examples of the term; (f) analysis of the term's morphological word parts, when possible; and (g) explicit cues and opportunities to respond using of cognitive routines (e.g., "How does this topic relate to other topics discussed?") throughout the lesson. A sample CAP-S can be found at https://cap-s.link/Sample_CAP-S.

Regarding the intersections of race/ethnicity and SES with disability status, some overlap is seen in the structure and instructional practices currently comprising CAP-S, and instructional recommendations for enhancing learning among students from marginalized racial/ethnic backgrounds, as well as students from low-income households. For example, researchers have found that strategies such as activating prior knowledge, breaking down complex skills into smaller parts, using cognitive routines, and providing morphological instruction have been effective in supporting vocabulary development and overall academic achievement among students from marginalized racial/ethnic groups (Gay, 2002; Hammond, 2015; Lesaux et al., 2010). Similarly, evidence suggests that strategies including direct instruction in term definitions and morphology, building background knowledge, and presenting material in smaller chunks also supports vocabulary acquisition among students from low SES households (Kieffer, 2008; Kieffer & Lesaux, 2007).

## *Hypothesis and Research Questions*

In science classrooms, students face an abundance of complex vocabulary terms and concepts that may impact their ability to engage in inquiry-based activities and discourse with peers (Harmon et al., 2005; Parsons & Bryant, 2016). Yet, many science educators do not believe, or feel prepared in providing evidence-based vocabulary instruction to better support students in inclusive classroom settings (Lee et al., 2005; Johnson & Massey, 2012). The CAP-PD intervention process was intentionally developed to provide teachers with the knowledge and tools needed to deliver evidence-based vocabulary instruction to students with disabilities in inclusive science classrooms. Thus, as anticipated, student-level results from the primary study revealed that, when students with disabilities received instruction from teachers who participated in the CAP-PD intervention process, they significantly outperformed their peers with disabilities across all measures of science vocabulary knowledge and general science knowledge (see Table 1 for these results; Kennedy et al., 2018).

**Table 1.** Primary Study: One-Way ANOVA Results for Students with Disabilities Across All Measures (Kennedy et al., 2018).

| | *N* | *M* | *SD* | *MS* | *F* | *df* | *p* | *D* |
|---|---|---|---|---|---|---|---|---|
| **Vocabulary CBM 1** | | | | | | | | |
| CAP-PD | 127 | 10.3 | 3.5 | 85.3 | 6.5 | (1. 240) | .011 | 0.33 |
| Comparison | 115 | 9.1 | 3.5 | | | | | |
| **Vocabulary CBM 2** | | | | | | | | |
| CAP-PD | 125 | 11.9 | 3.4 | 389.1 | 31.5 | (1. 239) | .001 | 0.73 |
| Comparison | 116 | 9.3 | 3.6 | | | | | |
| **Vocabulary CBM 3** | | | | | | | | |
| CAP-PD | 125 | 13.0 | 3.5 | 388.6 | 28.2 | (1. 228) | .001 | 0.70 |
| Comparison | 105 | 10.4 | 3.5 | | | | | |
| **MOSART pretest** | | | | | | | | |
| CAP-PD | 132 | 17.8 | 6.9 | 24.9 | 0.52 | (1. 249) | .473 | |
| Comparison | 119 | 18.5 | 6.7 | | | | | |
| **MOSART posttest** | | | | | | | | |
| CAP-PD | 132 | 23.3 | 7.4 | 578.7 | 9.8 | (1. 238) | .002 | 0.54 |
| Comparison | 108 | 20.1 | 8.0 | | | | | |

However, with the realized overlap in several instructional practices effective for students with disabilities, CLD students, and students from low SES households (e.g., morphology instruction; Garwood & McKenna, 2020; Kieffer, 2008; Lesaux et al., 2010) incorporated in the student instructional materials (i.e., CAP-S), we became curious about the impact that this intervention might have on performance of students with two or more of these marginalized identity attributes. To move beyond the typical focus on within-group outcomes seen in intervention research (Artiles et al., 1997; Pugach et al., 2019; 2021), the goal of the present study is to conduct a secondary data analysis to determine whether gains were still achieved when accounting for the intersecting sociocultural identities of students in inclusive science classrooms. Thus, the research team analyzed performance among students with intersecting identities including disability, marginalized racial/ethnic status, and low SES to answer the following research questions:

(RQ1) Do students with intersectional identities who received instruction facilitated by CAP-PD demonstrate greater gains on curriculum-based measures of science vocabulary knowledge when compared to peers with the same intersectional identities in comparison classrooms?
(RQ2) Do students with intersectional identities who received instruction facilitated by CAP-PD demonstrate greater gains on a standardized measure of general science knowledge when compared to peers with the same intersectional identities in comparison classrooms?

## Method

### Participants

The Internal Review Board (IRB) Human Subjects Committee of the first author's university, the participating school districts' research review boards, the administrators of each participating school, and parents of all students permitted teachers' and students' participation.

### Teachers

There were 26 teachers from 11 middle schools located in the southeastern United States who participated in the present study. All were general education science teachers with master's degrees, serving students in inclusive classroom settings (i.e., classes comprised of students with and without disabilities) across sixth, seventh, and eighth grade. There were 13 teacher participants randomly assigned to the CAP-PD treatment group, which received all three components of the intervention (i.e., CAP-TVs, CAP-S, and coaching emails). The other 13 teachers were randomly assigned to the comparison group, which only received the instructional materials (i.e., CAP-S).

### Students

A total of 1779 students participated in this study; however, 19 cases were dropped due to missing pretest data, making the final sample 1760 students. Among them, 251 students were identified as students with disabilities, 254 students identified with a marginalized racial/ethnic group, and 1058 students were from low SES households, as determined by qualifying for free or reduced-price lunch. However, students with intersectional identities comprised: (a) 22 students with disabilities from low SES households *and* marginalized racial/ethnic backgrounds; (b) 33 students with disabilities from marginalized racial/ethnic groups; and (c) 167 students with disabilities from low SES households. Unfortunately, we were unable to analyze performance of the group of students with all three intersecting identity attributes, as described in the data analysis section below. Therefore, analysis was focused on students with disabilities from marginalized racial/ethnic groups and students with disabilities from low SES households. Table 2 provides demographic information pertaining to teacher and student participants.

### Measures

Multiple measures were used to assess student performance following vocabulary instruction provided by teachers in the CAP-PD and comparison conditions. To strengthen the reliability and validity of evidence related to student performance, two types of measures were used, including: (a) researcher-developed curriculum-based measures (CBMs) assessing students' vocabulary knowledge; and (b) a standardized measure called the Misconceptions-Oriented Standards-Based Assessment Resources for Teachers (MOSART), which assessed students' general science knowledge.

### Vocabulary CBMs

The research team administered a total of nine researcher-developed vocabulary curriculum-based measures (CBMs; i.e., three for each grade level) to students nested within teachers' classrooms following each of the three post-baseline observations. Each CBM consisted of 20 multiple-choice items that assessed students' knowledge of science vocabulary terms that were randomly drawn from each grade level's respective curricula. To support validity, the vocabulary CBMs were developed to align with best practice in structure and administration procedures as described by Espin, Shin, & Busch (2005). Cronbach's alpha was used to assess overall reliability of each vocabulary CBM across all grade levels. The Cronbach's alpha values for the CBMs were CBM1 = .84; CBM2 = .83; and CBM3 = .84.

### MOSART

Students also completed the Astronomy/Space Science, Physical Science, and Life Science MOSART developed for grades 5–8. In the present study, combined averages were calculated to reflect one pretest total and one posttest total score for each student participant. For all three assessments, validity was established via expert assessment of test items, matching test items to the National Research Council (NRC) standards and the American Association for the Advancement of Science (AAAS) benchmarks, as well as alignment with other test instruments (Sadler et al., 2010, 2013a, 2013b). Cronbach's alpha was used to assess the overall reliability of the MOSART pre- and posttests and were .73 and .77, respectively.

### Intervention Procedure

A cluster-randomized design was used to determine the effects of teachers' participation in CAP-PD on science vocabulary and general science knowledge among intersectional students with disabilities. Teachers were randomly assigned to

**Table 2.** Demographic Characteristics of Teacher and Student Participants.

| | Teachers | | Students | |
|---|---|---|---|---|
| Factors | *Total* | Factors | *Comparison* | *CAP-PD* |
| Age in years, *M* (*SD*) | 37.04 (9.57) | Gender, *n* (%) | | |
| Gender, *n* (%) | | Male | 473 (26.9) | 454 (25.8) |
| Male | 4 (15.4) | Female | 414 (23.5) | 419 (23.8) |
| Female | 22 (84.6) | Race/Ethnicity, *n* (%) | | |
| Race/Ethnicity, *n* (%) | | Black/African American | 45 (2.55) | 58 (3.30) |
| Asian/Pacific Islander | 1 (3.8) | Hispanic/Latino | 52 (2.95) | 70 (3.98) |
| White/Caucasian | 25 (96.2) | Asian/Pacific Islander | 11 (0.63) | 18 (1.02) |
| Grade level, *n* (%) | | White/Caucasian | 779 (44.3) | 727 (41.3) |
| 6th grade | 8 (30.77) | Grade level, *n* (%) | | |
| 7th grade | 8 (30.77) | 6th grade | 351 (19.9) | 204 (11.6) |
| 8th grade | 10 (38.46) | 7th grade | 218 (12.4) | 362 (20.6) |
| Degree type, *n* (%) | | 8th grade | 318 (18.1) | 307 (17.4) |
| Master's degree | 26 (100) | Disability status, *n* (%) | | |
| Years teaching, *M* (*SD*) | 11.77 (7.85) | Students with disabilities | 119 (6.76) | 132 (7.5) |
| | | Students without disabilities | 761 (43.2) | 741 (42.1) |
| | | Students with intersectional identities, *n* (%) | | |
| | | Students with disabilities from marginalized racial/ethnic groups | 14 (42.4) | 19 (57.6) |
| | | Students with disabilities from low SES households | 80 (47.9) | 87 (52.1) |
| | | Students with disabilities from marginalized racial/ethnic groups and low SES households | 11 (50) | 11 (50) |

treatment (i.e., CAP-PD, all components) or comparison (i.e., CAP-S only) conditions. Following three baseline observations, teachers assigned to the CAP-PD treatment were provided with CAP-TVs to learn about evidence-based vocabulary instructional practices. The CAP-TVs developed and implemented in the present study focused on five practices, including: (a) providing student-friendly definitions; (b) using examples and non-examples; (c) breaking terms down by morphological parts; (d) highlighting semantic relationships among and between words; and (e) supporting rich discussions among students (Kennedy et al., 2018). CAP-PD teachers were asked to view these videos independently once provided and could review certain CAP-TVs as needed thereafter. Regarding Interobserver Agreement (IOA), a second observer was either present in the classroom or watched a video recording of the lesson to double code 20% of the observations. IOA for the percentage of teachers' use of specific vocabulary practices learned via CAP-TVs was 92%, and disagreements were resolved via discussion.

As randomization occurred at the teacher level, the comparison group was provided CAP-S to keep observers blind to teachers' condition assignment and control for potential attrition. Approximately 100 science vocabulary terms were covered across the CAP-S developed by the research team. Each CAP-S incorporated the evidence-based practices teachers learned about through the CAP-TVs to support implementation of newly learned instructional routines. Teachers could download and customize the CAP-S slides to use when providing vocabulary instruction, granting them flexibility in applying their content area expertise when teaching key terms and concepts from their respective grade level curricula (Kennedy et al., 2018). While all teachers were provided the CAP-S materials, the research team did not provide comparison teachers with any explanation or directions for their use.

Following three post-baseline observations, CAP-PD teachers were provided with the coaching component of the CAP-PD intervention, which included specific feedback via email correspondence. The email correspondences following each post-baseline observation included data outputs generated by the CT Scan (Rodgers et al., 2019), specific coaching comments guided by that data, and references back to specific

CAP-TVs and CAP-S when improvements in certain instructional practices were needed (Kennedy et al., 2018). Observers wrote the coaching emails immediately following each observation and sent them to a third party who had the list of teachers' condition assignment. That individual either sent it along or withheld it, depending on each teacher's condition.

## Data Analysis

The initial intent for this secondary data analysis focused on students with intersectional identities was to conduct a series of multilevel random coefficient models, as this model allows one to account for unique variance between students within classrooms. However, this was unsuccessful as multicollinearity occurred due to decreased student sample size when accounting for students' intersecting identity attributes. Instead, a series of multilevel random intercept models were used across all assessments (i.e., CBM1, CBM2, CBM3, and MOSART Posttest). However, multicollinearity persisted within this model when analyzing performance among students with all three intersecting identity attributes (i.e., students with disabilities from low SES households and marginalized racial/ethnic backgrounds; $n = 22$). Thus, we evaluated performance among the student groups that comprised two intersecting identity attributes (i.e., students with disabilities from marginalized racial/ethnic backgrounds, $n = 33$; and students with disabilities from low SES households, $n = 167$).

As an alternative to including that third intersecting identity attribute, dichotomous variables for SES (i.e., low SES = 1; average SES = 0) and marginalized race/ethnicity (i.e., marginalized race/ethnicity = 1; White = 0) were grand mean centered around teacher clusters and included as covariates to account for the proportion of low SES students and students from marginalized racial/ethnic backgrounds in teachers' classrooms. Further, as students' prior general science knowledge is likely related to their performance on all measures administered, the MOSART pretest score was centered within-teacher clusters and used as an additional covariate across all models. Since the research team sought to compare performance of students with the same intersectional identity attributes in CAP-PD and comparison classrooms, individuals who did not identify with these intersectional groups in their respective model analyses were excluded. The models are further defined below.

**Students with Disabilities from Marginalized Racial/Ethnic Backgrounds.** The model used for all outcome measures completed by students with disabilities from marginalized racial/ethnic backgrounds is described as follows:

$$L1: Y_{ij} = \beta_{0j} + \beta_{1j}\text{Group}_{ij} + \beta_{2}j\text{Pretest}_{ij} + \beta_{3j}\text{SES}_{ij} + e_{ij}$$
$$L2: \beta_{0j} = \gamma_{00} + u_{0j}$$

where $Y_{ij}$ represents all outcome measures that were evaluated (i.e., CBM1, CBM2, CBM3, and the MOSART posttest). $\beta_{0j}$ represents the level 2 predictor of teachers. The level 1 Group predictor (i.e., $\beta_{1j}$) accounts for teachers' assignment to the CAP-PD condition versus the comparison condition. $\beta_{2j}$ represents the centered within-teacher clusters pretest covariate and $\beta_{3j}$ represents the grand mean centered SES covariate included across all models for students with disabilities from marginalized racial/ethnic groups.

**Students with Disabilities from Low SES Households.** The model used for all outcome measures completed by students with disabilities from low SES households is described as follows:

$$L1: Y_{ij} = \beta_{0j} + \beta_{1j}\text{Group}_{ij} + \beta_{2}j\text{Pretest}_{ij} + \beta_{3j}\text{Marginalized\_Groups}_{ij} + e_{ij}$$
$$L2: \beta_{0j} = \gamma_{00} + u_{0j}$$

where $Y_{ij}$ represents all outcome measures that were evaluated (i.e., CBM1, CBM2, CBM3, and the MOSART posttest). $\beta_{0j}$ represents the level 2 predictor of teachers. The level 1 Group predictor (i.e., $\beta_{1j}$) accounts for teachers' assignment to the CAP-PD condition versus the comparison condition. $\beta_{2j}$ represents the centered within-teacher clusters pretest covariate and $\beta_{3j}$ represents the grand mean centered marginalized racial/ethnic group covariate included across all models for students with disabilities from low SES households.

# Results

Descriptive statistics, including the means, standard deviations, significance values, and effect sizes across all dependent measures are provided for each student group in Table 3. The results of the multilevel random intercept models are described below, as they pertain to each research question and student group.

## RQ 1: Performance on Vocabulary CBMs

*Students with disabilities from marginalized racial/ethnic backgrounds.* **CBM 1.** Results of the overall random intercept mixed model for CBM 1 were significant ($p = .02$). The weighted grand mean was 8.46, after adjusting for the average MOSART pretest score and the proportion of students from low SES households. On average, students with disabilities from marginalized racial/ethnic backgrounds in the CAP-PD group performed 0.57 points higher than their peers with the same intersectional identities on CBM 1. However, this difference was not significant ($p = .53$). Additionally, approximately 18% of the variance in CBM 1 scores is accounted for at the teacher level (see Table 4).

**CBM 2.** Results of the overall random intercept mixed model for CBM 2 were significant ($p < .001$). The weighted grand mean for CBM 2 was 13.59, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from low SES households. On average, students with disabilities from marginalized racial/ethnic backgrounds in the CAP-PD group

**Table 3.** Descriptive Statistics for Dependent Measures.

| Dependent Measure | CAP-PD *M* (*SD*) | Comparison *M* (*SD*) | *p* | *d* |
|---|---|---|---|---|
| *Students with Disabilities from Marginalized Racial/Ethnic Groups* | | | | |
| CBM 1 | 9.68 (3.02) | 9.00 (1.96) | .03 | 0.26 |
| CBM 2 | 11.67 (3.38) | 7.93 (2.43) | <.001 | 1.24 |
| CBM 3 | 12.76 (3.91) | 9.31 (3.59) | <.001 | 0.91 |
| MOSART posttest | 24.11 (8.36) | 13.54 (6.29) | <.001 | 1.39 |
| *Students with Disabilities from Low SES Households* | | | | |
| CBM 1 | 10.39 (3.95) | 9.06 (3.74) | 0.44 | 0.35 |
| CBM 2 | 11.59 (3.60) | 9.19 (3.45) | .001 | 0.68 |
| CBM 3 | 12.74 (3.64) | 9.60 (3.78) | .02 | 0.85 |
| MOSART posttest | 24.00 (7.00) | 19.25 (7.88) | <.001 | 0.64 |

performed significantly better on CBM 2, earning 3.92 points higher than their peers in the comparison condition ($p < .001$). Further, an increase in teacher-level variance occurred, with approximately 26% of the variance on CBM 2 scores accounted for at that level (see Table 4).

**CBM 3.** Results of the overall model for CBM 3 were also statistically significant ($p = .02$). The weighted grand mean for CBM 3 was 17.44, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from low SES households. Further analysis indicated students with disabilities from marginalized racial/ethnic backgrounds in the CAP-PD group performed, on average, 3.65 points higher than their peers with the same intersectional identities and this difference was statistically significant ($p = .04$). In addition, another increase in teacher-level variance was found for CBM 3 scores, with about 37% of the variance occurring at that level (see Table 4).

## *Students with Disabilities from Low SES Households*

**CBM 1.** Results of the overall random intercept mixed model for CBM 1 were not significant ($p = .05$). The weighted grand mean for this initial vocabulary assessment was 9.06, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from marginalized racial/ethnic backgrounds. Though differences in intersectional student performance between conditions were not significant for CBM 1 ($p = .07$), further analysis indicated students with disabilities from low SES households in the CAP-PD group performed an average of 1.37 points higher than their peers with the same intersectional identities in the comparison condition. Further, approximately 9% of the variance on CBM 1 is accounted for at the teacher level (see Table 5).

**CBM 2.** Results of the overall model for CBM 2 were statistically significant ($p < .001$). The weighted grand mean for CBM 2 was 9.89, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from marginalized racial/ethnic backgrounds. Further analysis indicated students with disabilities from low SES households in the CAP-PD group performed an average of 2.41 points higher than peers with the same intersectional identities in the comparison condition, and this difference was statistically significant ($p = .002$). In addition, teacher-level variance doubled for CBM 2, with approximately 18% accounted for at that level (see Table 5).

**CBM 3.** Results of the overall random intercept mixed model for CBM 3 were statistically significant ($p < .001$). The weighted grand mean for CBM 3 was 9.77, after adjusting for the average MOSART pretest score within teachers' classrooms and the proportion of students from marginalized racial/ethnic backgrounds. Further analysis indicated that students with disabilities from low SES households in the CAP-PD group performed an average of 3.26 points higher than peers with the same intersectional identities in the comparison condition, and this difference was statistically significant ($p < .001$). Additionally, an unexpected decrease in teacher-level variance occurred for CBM 3 scores, with only 5% of the variance occurring at that level in this instance (see Table 5).

## *RQ 2: Performance on General Science Knowledge Posttest (MOSART)*

*Students with disabilities from marginalized racial/ethnic backgrounds.* Results of the overall random intercept mixed model for the MOSART posttest were significant ($p < .001$). The weighted grand mean for this general science knowledge measure was 3.16, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from low SES households. Students with disabilities from marginalized racial/ethnic backgrounds in the CAP-PD group performed, on average, 9.59 points higher than their peer counterparts in the comparison condition and this difference was statistically significant ($p < .001$). Further, approximately 10% of the variance in general science knowledge scores accounted for at the teacher level. These results are shown in Table 4.

**Table 4.** Results Predicting Performance Among Students with Disabilities from Marginalized Racial/Ethnic Backgrounds as a Function of Teacher Participation in CAP-PD.

| *Dependent Variables* | Coefficient | *SE* | 95% CI | *p* |
|---|---|---|---|---|
| Effect parameters | | | (LL, UL) | |
| *CBM 1* | | | | |
| Intercept | 8.46 | 2.65 | (3.27, 13.65) | .001 |
| Group[a] | 0.57 | 0.91 | (−1.22, 2.36) | .53 |
| cwt_Pretest[b] | 0.17 | 0.06 | (0.05, 0.29) | .004 |
| tmn_SES[c] | 1.84 | 4.13 | (−4.44, 9.08) | .50 |
| Variance components for CBM 1 | | | | |
| Level 1 (within-cluster) | 4.03 | 1.21 | (2.24, 7.26) | |
| Level 2 (between-cluster) | 0.89 | 1.03 | (0.09, 8.61) | |
| ICC | 0.18 | 0.19 | (0.02, 0.74) | |
| *CBM 2* | | | | |
| Intercept | 13.6 | 3.02 | (7.67, 19.52) | <.001 |
| Group[a] | 3.92 | 1.04 | (1.88, 5.95) | <.001 |
| cwt_Pretest[b] | 0.25 | 0.06 | (0.12, 0.37) | <.001 |
| tmn_SES[c] | −8.17 | 4.72 | (−9.89, 4.16) | .08 |
| Variance components for CBM 2 | | | | |
| Level 1 (within-cluster) | 4.22 | 1.25 | (2.35, 7.55) | |
| Level 2 (between-cluster) | 1.46 | 1.19 | (0.29, 7.27) | |
| ICC | 0.26 | 0.18 | (0.07, 0.39) | |
| *CBM 3* | | | | |
| Intercept | 17.44 | 4.99 | (7.66, 27.2) | <.001 |
| Group[a] | 3.65 | 1.75 | (0.22, 7.08) | .04 |
| cwt_Pretest[b] | 0.21 | 0.09 | (0.03, 0.40) | .02 |
| tmn_SES[c] | −12.48 | 7.92 | (−28.0, 3.04) | .11 |
| Variance components for CBM 3 | | | | |
| Level 1 (within-cluster) | 7.83 | 2.76 | (3.92, 15.6) | |
| Level 2 (between-cluster) | 4.69 | 4.37 | (0.75, 29.2) | |
| ICC | 0.37 | 0.27 | (0.06, 0.85) | |
| *MOSART Posttest* | | | | |
| Intercept | 3.16 | 5.37 | (−7.37, 13.7) | .56 |
| Group[a] | 9.59 | 1.89 | (5.89, 13.3) | <.001 |
| cwt_Pretest[b] | 0.63 | 0.13 | (0.37, 0.89) | <.001 |
| tmn_SES[c] | 20.7 | 8.51 | (−11.6, 16.1) | .02 |
| Variance components for MOSART posttest | | | | |
| Level 1 (within-cluster) | 19.92 | 6.31 | (10.7, 37.04) | |
| Level 2 (between-cluster) | 2.21 | 4.86 | (0.03, 163.9) | |
| ICC | 0.10 | 0.21 | (0.001, 0.92) | |

[a]Group represents the two conditions that teachers were randomly assigned to (CAP-S = 0, CAP-PD = 1), with the CAP-PD treatment group as the reference group.
[b]cwt_Pretest = MOSART general science knowledge pretest scores centered within-teacher clusters.
[c]tmn_SES = proportion of students from low SES households grand mean centered around teachers.

### *Students with Disabilities from Low SES Households*

Results of the overall random intercept mixed model for the MOSART posttest were significant ($p < .001$). The weighted grand mean for this general science knowledge measure was 19.57, after adjusting for the average MOSART pretest score within teachers' classrooms, as well as the proportion of students from marginalized racial/ethnic backgrounds. Students with disabilities from low SES households in the CAP-PD group performed an average of 4.97 points higher than their peers in the comparison condition and this difference was statistically significant ($p = .002$). Additionally, approximately 16% of the variance in general science knowledge scores is accounted for at the teacher level. These results are shown in Table 5.

## Discussion

The CAP-PD intervention process was developed to provide teachers with the knowledge and tools needed to deliver

**Table 5.** Results Predicting Performance Among Students with Disabilities from Low SES Households as a Function of Teacher Participation in CAP-PD.

| *Dependent Variables* | Coefficient | *SE* | 95% CI | *p* |
|---|---|---|---|---|
| Effect parameters | | | (LL, UL) | |
| *CBM 1* | | | | |
| Intercept | 9.06 | 0.65 | (7.78, 10.3) | <.001 |
| Group[a] | 1.37 | 0.75 | (−0.10, 2.84) | .07 |
| cwt_Pretest[b] | 0.09 | 0.04 | (0.003, 0.17) | .04 |
| tmn_Minoritized[c] | 2.32 | 3.45 | (−4.44, 9.08) | .50 |
| Variance components for CBM 1 | | | | |
| Level 1 (within-cluster) | 4.03 | 1.21 | (10.3, 16.6) | |
| Level 2 (between-cluster) | 1.26 | 1.09 | (0.23, 6.85) | |
| ICC | 0.09 | 0.07 | (0.02, 0.36) | |
| *CBM 2* | | | | |
| Intercept | 9.89 | 0.67 | (8.58, 11.2) | <.001 |
| Group[a] | 2.41 | 0.78 | (0.88, 3.94) | .002 |
| cwt_Pretest[b] | 0.13 | 0.04 | (0.05, 0.20) | .001 |
| tmn_Minoritized[c] | −2.86 | 3.58 | (−9.89, 4.16) | .43 |
| Variance components for CBM 2 | | | | |
| Level 1 (within-cluster) | 9.46 | 1.15 | (7.45, 12.0) | |
| Level 2 (between-cluster) | 2.08 | 1.08 | (0.75, 5.73) | |
| ICC | 0.18 | 0.08 | (0.07, 0.39) | |
| *CBM 3* | | | | |
| Intercept | 9.77 | 0.58 | (8.63, 10.9) | <.001 |
| Group[a] | 3.26 | 0.66 | (1.96, 4.56) | <.001 |
| cwt_Pretest[b] | 0.12 | 0.04 | (0.03, 0.20) | .006 |
| tmn_Minoritized[c] | 0.29 | 3.05 | (−5.70, 6.27) | .93 |
| Variance components for CBM 3 | | | | |
| Level 1 (within-cluster) | 12.4 | 1.52 | (9.73, 15.8) | |
| Level 2 (between-cluster) | 0.59 | 0.78 | (0.04, 7.79) | |
| ICC | 0.05 | 0.06 | (0.003, 0.41) | |
| *MOSART Posttest* | | | | |
| Intercept | 19.6 | 1.35 | (16.9, 22.2) | <.001 |
| Group[a] | 4.97 | 1.57 | (1.89, 8.05) | .002 |
| cwt_Pretest[b] | 0.40 | 0.08 | (0.24, 0.55) | <.001 |
| tmn_Minoritized[c] | 2.26 | 7.08 | (−11.6, 16.1) | .75 |
| Variance components for MOSART posttest | | | | |
| Level 1 (within-cluster) | 40.5 | 4.87 | (32.0, 51.3) | |
| Level 2 (between-cluster) | 7.71 | 4.24 | (2.62, 22.7) | |
| ICC | 0.16 | 0.08 | (0.06, 0.37) | |

[a]Group represents the two conditions that teachers were randomly assigned to (CAP-S = 0, CAP-PD = 1), with the CAP-PD treatment group as the reference group.
[b]cwt_Pretest = MOSART general science knowledge pretest scores centered within-teacher clusters.
[c]tmn_Minoritized = proportion of students from minoritized racial/ethnic backgrounds grand mean centered around teachers.

evidence-based vocabulary instruction to students with and without disabilities participating in inclusive science classrooms (Kennedy et al., 2018). However, several of the practices that were purposefully integrated in the student instructional materials (i.e., CAP-S) to support increased performance among individuals with disabilities (Archer & Hughes, 2011; Mayer, 2020) coincide with recommendations for culturally and linguistically diverse students, as well as students from low-income households (Gay, 2002; Kieffer, 2008; Lesaux et al., 2010). Thus, moving beyond the usual focus on overall within-group outcomes common in intervention research, the impact of teacher participation in CAP-PD on science vocabulary and general knowledge growth was analyzed for two groups of students with intersectional identities.

Teacher-level variance and student CBM performance in the CAP-PD group increased throughout the study, indicating students with disabilities from marginalized racial/ethnic backgrounds experienced greater gains in vocabulary knowledge when they received instruction supported by CAP-

PD. Similarly, teacher-level variance and student performance in the CAP-PD group also increased between CBM 1 and CBM 2 for students with disabilities from low SES households, suggesting greater gains in vocabulary knowledge when they received instruction facilitated by CAP-PD, as well. However, although this group still demonstrated significant increases in performance on CBM 3 when participating in CAP-PD classrooms, the diminishing teacher-level variance suggests that other factors aside from changes to teacher practice may have contributed to these gains.

Additionally, students with intersectional identities who participated in CAP-PD classrooms also demonstrated greater gains on the MOSART general science knowledge measures. Although there was greater variance at the student level on this assessment among students with disabilities from marginalized racial/ethnic backgrounds, this group demonstrated large gains overall, scoring an average of 10 points higher than their peers with the same intersectional identities in the comparison condition. Further, students with disabilities from low SES households who received instruction from teachers who participated in CAP-PD significantly outperformed their peer counterparts in the comparison condition, scoring an average of five points higher than their peers with the same intersectional identities, with higher rates of variance at the teacher level in this case.

These results provide a measure of confidence that the CAP-PD intervention process can support increased performance among students with intersectional identities when implemented with science teachers in inclusive classrooms. Moreover, by accounting for students' intersecting identities, the results become more applicable to particular student populations. As various professionals in the field consider questions about what and for whom interventions work, the present study suggests that a more nuanced focus—one which considers the multiple marginalized identities of students—might support more informed decisions regarding instructional practice.

### Limitations and Future Directions

As with all research, this study is limited in several ways. We would be remiss if we failed to first mention the lack of student voice in the present study. As the purpose behind the intersectionality theoretical framework is to call attention to the experiences of individuals who have been placed at the margins due to multiple oppressed sociocultural group identification, their perceptions of implemented interventions should be accounted for. Future studies should incorporate a measure of social validity (e.g., interviews or survey) to prioritize the voices of marginalized individuals with whom CAP-PD is implemented.

Additionally, though there is overlap in the current structure of CAP-S and culturally responsive practices, this was unintentional as CAP-S were designed with a focus on supporting students with disabilities. Thus, more deliberate incorporation of culturally responsive instructional practices (e.g., team-based application activities to support collectivist cultural traditions; Hammond, 2015) should be considered in future developments of CAP-S.

Further, the CAP-PD intervention process focuses on improving teachers' knowledge and implementation of evidence-based instructional practices which should, theoretically, result in greater variation between teachers. This anticipated teacher-level variance was certainly true for the majority of findings; however, this was not the case for the group of students with disabilities from low SES households across all science vocabulary CBMs administered. From CBM 1 to CBM 2, teacher-level variance doubled, from 9% to 18%; but, from CBM 2 to CBM 3, this level 2 variance decreased to 5%. This unexpected decrease in teacher-level variance may be related to spillover effects resulting from comparison teachers' use of CAP-S. For example, the CAP-S provided to both groups embed evidence-based vocabulary instructional practices (e.g., prior knowledge review, student-friendly definition). Thus, if comparison teachers used CAP-S as created, they implemented some evidence-based vocabulary instruction, despite the lack of instruction and coaching in practice use. To better control for concerns with spillover effects in future studies of CAP-PD, researchers should consider randomizing at the school level so that a true control group can be utilized.

Lastly, accounting for students' intersecting identities resulted in dramatic decreases to sample size, primarily when accounting for marginalized race/ethnicity. These decreases in sample size unfortunately led to multicollinearity across the preferred multilevel random coefficient models. It is important to note that sample decreases were likely more significant when accounting for marginalized race/ethnicity because the schools involved in the present study comprised majority White students. However, this is not to say that quantitative intersectional analysis should be avoided if conducting research in predominately White schools. Rather, the purpose and importance of intersectional analysis is to understand the confluence of a variety of individuals' marginalized identity attributes, which may or may not include race/ethnicity. For instance, students with disabilities from low SES households constituted the largest intersectional group ($n$ = 167) and, while this group was not accounting for race/ethnicity, the intersection of disability and low SES still constitutes a form of intersectionality. Therefore, while this limitation may have impacted the type of statistical model that could be used, it does not detract from the purpose and importance of intersectional analysis.

## Conclusion

In conclusion, when inclusive middle school science teachers participated in the CAP-PD intervention process, changes to their instructional practice (i.e., as demonstrated by increases in teacher-level variance) resulted in significant growth in students' knowledge of science vocabulary, as well as general science knowledge. Further, quantitative intersectional analysis through use of multilevel random intercept models in the present study provided a more nuanced perspective on exactly whom the CAP-PD intervention process can best support at the student level. While there are important considerations for future developments and research related to this intervention, as well as for quantitative analysis through an intersectionality lens, it is encouraging to find that the CAP-PD process provides the in situ learning experiences that inclusive science teachers need to enhance performance and achievement among students who face multiple forms of marginalization.

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## ORCID iDs

Lindsay M. Griendling https://orcid.org/0000-0002-5243-990X
John Elwood Romig https://orcid.org/0000-0002-7490-3400

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## Author Biographies

**Lindsay M. Griendling, MS** is a doctoral candidate in the School of Education and Human Development at the University of Virginia. Her research interests are centered around the importance of supporting effective communication across special education policy and practice to improve schooling experiences and outcomes for students with dis/abilities from minoritized racial/ethnic backgrounds.

**Victoria J. VanUitert, PhD** recently completed her doctoral degree at the University of Virginia's School of Education and Human Development. Her research focuses on enhancing science learning, literacy, critical thinking, and participation of students with disabilities and supporting teachers in providing evidence-based instruction to facilitate student success.

**Michael J. Kennedy, PhD** is an Associate Professor of Special Education in the School of Education and Human Development at the University of Virginia. His research focuses on the intersection of teacher quality, multimedia, professional development, and implementation of evidence-based and high-leverage practices.

**Wendy J. Rodgers, Ph.D.** is an Assistant Professor of Special Education at Virginia Commonwealth University. Her research centers on effective instruction in inclusive co-taught classrooms and on classroom observation of special education teachers.

**John Elwood Romig, PhD** is an Assistant Professor at the University of Texas at Arlington. His research focuses on effective literacy instruction and assessment practices for students with mild to moderate disabilities.

**Hannah Morris Mathews, PhD** is an Assistant Professor of Special Education at the University of Florida. Her research considers the individual and institutional experiences that are a part of special educators' professional socialization, and how these experiences shape instructional quality and students' access to equitable educational opportunities.

**Katherine N. Peeples, PhD** is an Assistant Professor of Special Education Literacy at Illinois State University. Her teaching and research focus on training and coaching special education teachers to deliver highquality reading interventions and other literacy-related evidence-based practices.