frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 27 September 2022
DOI 10.3389/feduc.2022.944731

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Special Educational Needs, a section of the journal Frontiers in Education

RECEIVED 15 May 2022
ACCEPTED 16 August 2022
PUBLISHED 27 September 2022

CITATION
Christopher C and Newman K (2022) Exploring classroom practices associated with greater student engagement that may benefit low-income students in the early grades.
Front. Educ. 7:944731.
doi: 10.3389/feduc.2022.944731

Exploring classroom practices associated with greater student engagement that may benefit low-income students in the early grades

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Previous research has identified specific classroom practices that are associated with greater academic and self-regulation gains for students in prekindergarten (PreK) and kindergarten (K) classrooms. These practices include reducing time in transition, more time in sequential activities, more opportunities for associative and cooperative interactions, more math, teachers' using higher levels of instruction, positive classroom climate, and more teacher listening to children. This cross-sectional study aims to determine whether these specific classroom practices are associated with higher student engagement. A secondary goal was to examine whether economically disadvantaged (ED) students in more engaged classrooms scored higher on measures of math, language, and literacy. Researchers collected individual student assessment data in math, language, and literacy for a sample of 407 PreK and K students and conducted day-long observations in their classrooms. In addition to collecting behavioral count data on the focal classroom practices, observers rated students' engagement across the day. Results revealed that students who experienced more of the beneficial classroom practices also showed higher engagement. Covariate-adjusted standardized mean difference effect sizes showed the greatest differences for transition time, sequential activities, associative and cooperative interactions, teachers' listening, the amount of instruction, behavior approvals, and teacher tone, indicating that students experiencing more of these practices were more engaged than students experiencing fewer of these practices. To address our secondary goal of exploring between-group differences on assessments, we created groups based on ED status and engagement (operationalized using a median split for student engagement). While assessment scores were higher for non-ED students than ED students, regardless of their level of engagement, based on the literature researchers expected that ED students who were more engaged would have higher scores on assessments than their less engaged counterparts. Contrary to this hypothesis, there were few differences across groups. The largest positive effect sizes were for math and vocabulary. ED students with higher engagement had *lower,* not higher, scores on measures of literacy and passage comprehension. However,

the magnitude of these effect sizes was small. Results provide preliminary evidence that these specific classroom practices are associated with greater student engagement.

KEYWORDS

student engagement, economic disadvantage, low-income students, high quality instruction, early education

Introduction

A confluence of evidence suggests that lower achievement in early grades predicts lower achievement in subsequent grades (e.g., Duncan et al., 2020). A host of school readiness indicators such as pre-academic and socioemotional skills at age four have predicted later academic outcomes through Grade 5 (Ricciardi et al., 2021). Across six large-scale longitudinal studies, math, reading, and attention skills at school entry were the strongest predictors of later achievement (Duncan et al., 2007). Early math emerged as the most powerful predictor of later academic success. In another study that focused on math specifically, children who exhibited a low-level developmental trajectory of number knowledge in early childhood (i.e., ages 4-7) continued to have low mathematic achievement in second and fourth grades (Garon-Carrier et al., 2018). In fact, children in the low-level group fell about two years behind children in the higher trajectory groups. Thus, existing research consistently emphasizes the importance of early skill attainment for later achievement.

Risk factors for lower achievement in early childhood

Several risk factors for lower achievement emerge in the early childhood years. Early attention difficulties have also been found to significantly increase children's risk for reading difficulties and overall achievement (Rabiner et al., 2016). Similarly, growing evidence emphasizes the importance of socioemotional skills for achievement, independent of cognitive readiness skills (Cerda et al., 2014; Davies et al., 2016). Children with poor socioemotional skills, such as high levels of challenging behavior, face heightened risk of negative academic outcomes (Hamre and Pianta, 2001).

One of the most documented risk factors for lower academic performance in the early years is economic disadvantage (Halle et al., 2009; Pratt et al., 2016). Children from economically disadvantaged backgrounds enter school with lower academic skills compared to their higher-income peers (Lee and Burkham, 2002; Dotterer et al., 2012), and this difference persists through the middle (Liu et al., 2016) and high school years (Duncan et al., 2019). A study of reading achievement found that economically disadvantaged children in the low ability reading group in early elementary had a low probability of transitioning to the higher ability group through grade 8 (Liu et al., 2016). Children from low-income households also face challenges in long-term achievement, such as applying to and enrolling in post-secondary opportunities (Hardy and Marcotte, 2022).

One of the reasons for the strong, negative relationship between economic disadvantage and achievement is that children from low-income backgrounds are disproportionately exposed to adverse conditions such as living in neighborhoods with higher rates of crime and violence (Kasehagen et al., 2018), which has been found to predict chronic absenteeism and poorer achievement (Liu et al., 2013). At the same time, there are contextual factors, such as access to family-centered healthcare, that mitigate the negative effects of economic disadvantage on achievement (e.g., Bethell et al., 2014). Moreover, research has found that robust academic and socioemotional skill development prior to kindergarten can act as a protective factor minimizing the effects of economic disadvantage (Quirk et al., 2013).

Student engagement predicts achievement

Engagement has been identified as a key learning process in early childhood that predicts achievement during PreK (Lindström et al., 2021) and through eighth grade (Hamre and Pianta, 2001). Engagement in early childhood settings has been broadly defined as children's developmentally appropriate interactions across multiple activity types and contexts in the learning environment (McWilliam and Casey, 2008). More specifically, researchers have characterized engagement as orientation to and involvement in instruction and instructional activities, materials, and tasks (Zimmerman et al., 2017, 2020). A helpful theoretical framework to describe the relation between engagement and achievement is the performance-based model of instruction (Greenwood, 1996). This model theorizes that engagement is the path between instruction and child outcomes. Children must engage with high-quality instruction and activities to experience enhanced outcomes. The model

suggests that children's access to learning opportunities through direct instruction, interactions during child-led activities, or observational learning increases as their engagement level increases.

Children's connectedness with teachers also influences their achievement (Hamre and Pianta, 2001). The emotional connection and high-quality interactions between teachers and children is fundamental for young children's adaptation to and engagement with the school environment, which in turn relates to academic performance (Birch and Ladd, 1997). One indicator of high-quality interactions with teachers is prolonged conversations: more frequent complex language exchanges with teachers have been related to children's gains in language skills, a critical competence for school success (Burchinal et al., 2021). Positive teacher-child relationships also play an important role in the formation of social competencies that support positive adjustment to the school environment, such as initiating and sustaining interactions with peers (Hemmeter et al., 2021).

Risk factors for lower engagement

Structural factors that affect young children may also contribute to lower classroom engagement. According to the bioecological theory of human development, multiple and overlapping systems (e.g., home, school, and community) in which children interact influence their development (Bronfenbrenner and Morris, 2006). One such microsystem is the family unit. Low cognitive stimulation in the home, such as lack of learning materials and stimulating activities, are risk factors for academic achievement difficulties (Duncan et al., 1994) and decreased self-regulation (Downer and Pianta, 2006). Low cognitive stimulation outside of school may contribute to low classroom engagement because children have fewer opportunities to engage with learning activities that require paying attention and regulating behaviors, both of which support higher engagement in classroom activities. Economically disadvantaged children are significantly more likely to experience low cognitive stimulation in the home as family resources are restricted (Evans, 2004).

Acknowledging that economic disadvantage puts students at risk of being less engaged at school, several studies focus specifically on low-income studies to explore potential practices to help promote greater engagement (e.g., Lee and Bierman, 2015; Archambault et al., 2020). For example, Lee and Bierman (2015) identified classroom climate as being particularly important for students' engagement in a sample of kindergarten students transitioning from Head Start to elementary school. They then suggest future research should test the degree to which aspects of classroom climate are malleable and design interventions to promote improvement in climate.

Beyond the larger structural influences on engagement, such as early experiences of low cognitive stimulation and poor classroom climate, there is evidence that engagement may be a direct result of the quality of instruction children receive and the classroom activity settings they experience at school. For example, when teachers dominate the linguistic environment and leave little room for child talk, children's engagement suffers (Hindman et al., 2019). Moreover, specific parts of the day are more challenging for promoting high levels of engagement. Transitions have been associated with less positive engagement with teachers and tasks (Vitiello et al., 2012). In addition, children's level of engagement is often lowest during teacher-directed activities like whole-group instruction (Coelho et al., 2020).

Classroom practices that promote engagement

In contrast, activity settings that provide children with more choice (e.g., free choice centers) have been associated with more positive engagement with tasks and peers (Vitiello et al., 2012) and higher levels of involvement in learning activities (Coelho et al., 2020). A study of child behaviors and classroom settings across the day found that children who spent less time in whole group activities showed greater gains in language skills (Burchinal et al., 2021), indicating a higher degree of engagement and thus learning when more time was spent in smaller, more flexible groupings. Furthermore, child-managed experiences, such as play and activities in which children are active participants, have been associated with increased interactions and greater engagement (Markova, 2017). Child engagement is also related to teachers' communication-facilitating behaviors, such as listening, waiting for children to initiate, and being at the children's physical level to encourage child talk (Girolametto and Weitzman, 2002; Piasta et al., 2012). Further, when teachers foster a more positive classroom climate through positive student-student and student-teacher interactions, students are more engaged (Williford et al., 2014; Khalfaoui et al., 2021). This cluster of studies emphasizes the importance of specific characteristics of instructional interactions and types of activity settings for fostering high levels of engagement and subsequent learning. While some studies (e.g., Lekwa et al., 2019) have examined the relationship between broad domains of classroom practices and student engagement, no existing studies that we know of have examined which specific classroom factors are related to higher engagement for economically disadvantaged students specifically.

Classroom practices associated with student achievement

Recent research has focused on identifying classroom practices that are most predictive of students' academic and self-regulatory gains across the PreK (Farran et al., 2017) and K (Christopher and Farran, 2020) years. Using a classroom observation tool that focuses on collecting behavioral count data, the first study established a set of specific instructional practices that were predictive of students' gains across measures of math, language, literacy, and self-regulation over the school year. These practices include reducing time in transition, more time in sequential activities (i.e., activities that require planning, and doing things in a particular order), more opportunities for associative and cooperative interactions (i.e., activities that require back-and-forth communication between children toward a shared goal, such as taking turns playing a game), more math, higher levels of instruction (e.g., teachers asking inferential questions), positive classroom climate, more teacher listening to children, and higher student engagement. After the first year of the study, researchers continued to collect data on additional cohorts of students and their teachers in PreK classrooms, replicating the initial findings. Using the same observation protocol and individual student assessments, a subsequent study replicated these findings in a sample of K classrooms (Christopher and Farran, 2020), bolstering support for these practices as being important to promoting high quality instruction for young children. Although there is evidence of the benefits of these practices for children *regardless* of income status, it is likely that these practices may be particularly beneficial for students at high risk of being less engaged and, in turn, lower achieving: low-income students.

Current study

Our guiding framework (see **Figure 1**) is that specific classroom practices are more or less likely to promote student engagement, and that higher engagement is associated with higher achievement. Identifying practices that promote engagement for low-income students is particularly important given the ample evidence that these students are at greater risk of falling behind their peers (e.g., Brooks-Gunn and Duncan, 1997), and previous evidence indicates that student engagement is a strong predictor of achievement across all students, regardless of risk factors (Appleton et al., 2008). The current study aims to determine whether specific classroom practices that have been found to promote academic gains for young children (Farran et al., 2017; Christopher and Farran, 2020) are associated with higher student engagement for low-income students.

Given extant research, we expect to find that student engagement is associated with these key classroom practices, and we expect that ED students in classrooms with higher engagement will experience other beneficial classroom practices. In addition to our primary focus on associations between classroom practices and student engagement, as an exploratory analysis, we will examine students' assessment scores to see if ED students who are in more highly engaged classrooms also have higher scores on measures of math, language, and literacy.

Methods

In fall 2019, researchers collected individual student assessment data for a sample of 407 PreK and K students and conducted day-long observations in their classrooms (49 classrooms in total, 25 PreK and 24 K). Ten students in each classroom were randomly selected for individual assessments, but observation data were collected on all students present on the day of an observation. In total, 795 students were present for observations. Assessment data were not included in analyses if (1) data were incomplete due to the child indicating they did not want to finish any of the assessments or (2) we were unable to acquire students' economic disadvantage status. In addition to collecting behavioral count data on the focal classroom practices, observers rated students' engagement across the day.

Sample

Twenty-five schools were selected across Tennessee that house PreK, kindergarten, 1st, and 2nd grade classrooms as part of a larger study, focused on investigating the quality and alignment of classroom practices across the early grades. For the purposes of this study, we use data from PreK and kindergarten students and classrooms. Some of the schools had multiple classrooms for a given grade, so we randomly selected which classroom to enroll in the study with a few caveats: We wanted to avoid enrolling classrooms with teachers who were (1) new to teaching or (2) had recently switched from teaching one grade to another. In addition to the above eligibility criteria set for classrooms/teachers, we set parameters for schools' eligibility. We chose schools representative of each region of the state (West, Middle, East), representative of urban, suburban, town, and rural areas (based on the CDC 2005-2006 locale classification), and representative in terms of percentage of students who are economically disadvantaged and the percentage of black and Hispanic students. The study sample schools were randomly selected from the list of 437 schools that met eligibility criteria.

Two classrooms per school are included in the study sample: one from PreK and one from K. One classroom teacher opted out shortly after the study began. Thus, in fall 2019, researchers conducted day-long classroom observations and administered individual student assessments of math, language,

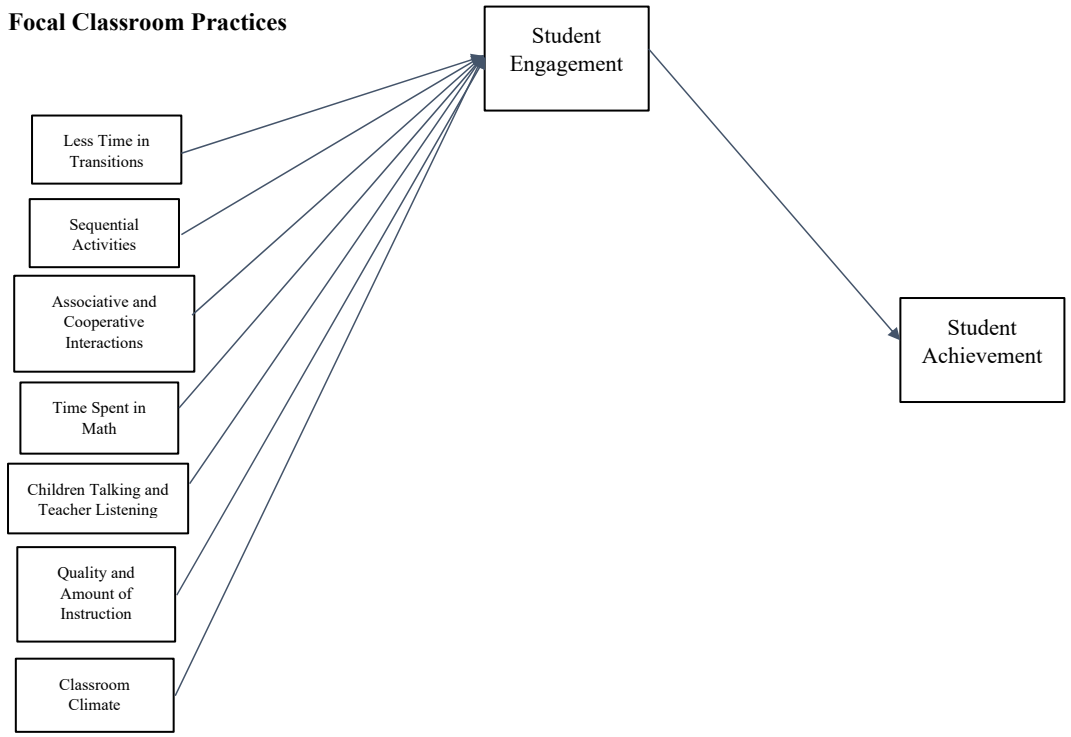

FIGURE 1
Guiding framework.

literacy, and self-regulation for a sample of 407 PreK and K students and conducted day-long observations in their classrooms (49 classrooms in total, 25 PreK and 24 K). In the fall of 2019, we conducted day-long observations and individual student assessments.

Observations

The *Child Observation in Primary Grades* (COPG) (Farran and Anthony, 2014) protocol was used to measure observable aspects of child behaviors in PreK and kindergarten. The COPG was completed in tandem with the *Teacher Observation in Primary Grades* (TOPG) (Bilbrey et al., 2007), which was used to measure observable aspects of PreK and kindergarten teachers' classroom behaviors. COPG/TOPG codes are quantified as either behavioral counts or ratings.

For each of 20-26 rounds of coding ("sweeps"), observers first coded the teacher followed by each individual child in the classroom before returning to the teacher to start another round of the observation and coding process. All children present during the observation day were observed and their behaviors were coded. For each sweep, a classroom member was located and then observed for approximately 3 s, after which the observer immediately coded nine areas of behaviors. Taken together, this collection of snapshots provided a picture of how individuals spent their time in the classrooms. Coding was done continuously throughout the day, with the exception of outdoor recess, indoor gym, and naptime.

COPG variables

The following categories of behavioral count variables were collected in the COPG instrument: verbal/to whom, schedule, interaction state, type of task, and content focus. Verbal and to whom codes were used to capture whether children were talking or listening and to whom they were speaking or listening. The schedule codes were used to document which learning setting the student was in during that specific sweep (e.g., transitions, whole group activities, small groups, centers, etc.). Interaction state captures whether children are alone, parallel (i.e., doing the same activity as another child without interacting), associative, cooperative, or unoccupied. The learning demands of the task and the child's behavior with the activity determine the type of task coded. Examples include fantasy/drama, passive instruction, and sequential activities (i.e., activities that require active participation and planning on the part of the child). Lastly, observers collected information on content focus to see not just what content teachers were presenting, but rather the actual content in which each child was engaged.

Variables from behavior counts were computed as a proportion of sweeps in which the behavior occurred out of the total number of sweeps observed. We used conditional probability looping syntax to create variables that capture the proportion of sweeps in which a particular code was chosen. With this method, a count/sum variable is created as the syntax directs the statistical software to search through a group of variables of the same category (e.g., content focus) and sums the amount of instances in which a certain code was used (e.g., math). After that count variable is created, we calculate a proportion in which the count variable is the numerator while the total number of times any content focus code was recorded is treated as the denominator (e.g., sum of math sweeps/sum of all content focus sweeps).

Student engagement

In addition to collecting behavioral count data on the focal classroom practices, observers rated students' engagement across the day on a 5-point scale from: low, medium-low, medium, medium-high, and highly engaged. For example, if a student is in an activity and looks away from time to time but returns to the activity, they would be rated as medium. If they are intensely focused on an activity and seem oblivious to noises around them, they would be rated high. And if it is clear that a child is off task (e.g., fiddling with another child's hair), they would be rated as low. Each classroom's average engagement was based on approximately 360 ratings, with the observer providing a rating of level of engagement each time they 'swept' a child.

TOPG variables

The following categories of variables were collected in the TOPG instrument: verbal/to whom, schedule, content focus, teacher task, level of instruction, and teacher tone. The verbal/to whom, schedule, and content focus codes used in TOPG are the same as those from COPG (described above). Teacher task captures the task or activity in which the teacher is engaged and is coded independently of what children are doing. Some examples are instructing, behavior approving, and behavior disapproving. The latter two codes make up part of the classroom climate element of a key quality practice. The level of instruction describes the instruction that is occurring during a specific sweep. It is a rating that ranges from 0 (none) to 4 (high inferential learning). When instruction occurred it was rated on a scale ranging from 1 (interaction with child and activity) to 4 (high inferential instruction). A rating of 2.0 signified basic instruction (e.g., "What color is this? What letter is this?"). Finally, the tone code reflects the positive or negative feel of the classroom. When observers code the teacher tone, they are examining the affect the teacher is displaying in that moment. Variables from ratings were computed as averages across all sweeps observed for each child for COPG variables or each teacher for TOPG variables. The PreK classrooms had one lead teacher and an assistant teacher, and the kindergarten classrooms had only one teacher, no assistants. For continuity across grades, we present TOP data based on the lead teacher in PreK classrooms and the only teacher in K.

For the purposes of this study, not all of the possible codes were used. Rather, we focused on the codes that contribute to the key quality variables identified in PreK (Farran et al., 2017) and kindergarten (Christopher and Farran, 2020): transition time, sequential activities, associative and cooperative interactions, time spent in math, children talking and teacher listening, quality and amount of instruction, and classroom climate.

Observer training and reliability

To achieve certification, observers attend a two-day training followed by classroom observations completed in tandem with an anchor observer to achieve reliability. We defined acceptable reliability as 80% exact agreement on codes within each of the seven areas of behaviors. Observers have up to three attempts to achieve reliability. All observers achieved interrater reliability with an experienced anchor observer. Exact percent agreement and Cohen's κ were computed and presented adequate values. Kappa coefficients for COPG interrater reliability ranged from.83 to.96. TOPG interrater reliability Kappa coefficients ranged from.80 to.91. For the COPG and TOPG variables based on rating scales, we defined interrator reliability as 70% exact agreement. Kappa coefficients for interrator reliability on ratings were as follows:0.74 for student engagement, 0.82 for teacher tone, and.89 for level of instruction.

Assessments

Language and literacy

Peabody Picture Vocabulary Test (PPVT-4; Dunn and Dunn, 2007) The PPVT requires children to point to one of four pictures that represent orally-presented words including nouns, adjectives, verbs, and adverbs.

Additional measures of language and literacy were drawn from the *Woodcock Johnson III Tests of Achievement* (WJIII; Woodcock et al., 2001).

The Letter-Word Identification subtest assesses children's knowledge of upper- and lower-case letters, as well as sight words.

Oral Comprehension assesses children's oral comprehension. During this subtest, the child listens to a short passage read aloud by the assessor and then must supply a word missing from the end of the passage.

Passage Comprehension assesses children's reading comprehension. During this subtest, the child first matches images with symbols then with short phrases. If the child is successful with these tasks, the child then begins reading sentences on their own and filling in missing words as appropriate.

Mathematics

We administered two subtests from WJIII to measure math. *Applied Problems* asks children to solve verbally presented mathematics problems, which are often accompanied by pictures of objects.

Quantitative Concepts assesses children's ability to recognize and name shapes, compare quantities or size of items, and manipulate the number line.

Demographic data

We received demographic data from each school at the beginning of the study including age (date of birth), race/ethnicity, home language, IEP status, gender, and economic disadvantage status (ED), which was defined as qualifying for free or reduced price lunch.

Analytic approach

Using the model presented in **Figure 1** as our guiding framework, we examined associations between specific classroom practices and student engagement. Then, we looked at whether and how student engagement was associated with measures of math, language, and literacy.

Observation data

The goal of our analyses was to provide a detailed description of the instructional practices, academic content, and types of activities and opportunities for student interactions that students experienced during the day-long classroom observations and compare those experiences for for students with higher and lower levels of engagement (operationalized using a median split for student engagement). We chose to use the median split to increase the interpretability of our findings. As DeCoster et al. (2011) note, "When trying to interpret a variable, it is much easier to consider differences between a limited number of groups than it is to consider differences along a continuum. It is often not clear how important specific numeric differences are (p. 199)." We compared students with lower engagement to students with higher engagement in terms of the focal classroom practices.

To further explore between-group differences based on a key risk factor for reduced student achievement, students' level of engagement, participants were split into groups based on ED status and their average level of engagement in learning. Then we compared ED-Low Engagement (i.e., ED students with lower engagement ratings) with ED-High Engagement in terms of the students' assessment scores. Similarly, we compared *non* ED-Low Engagement and *non* ED-High Engagement on assessments.

We conducted multilevel analyses of COPG (student-level data) to account for children nested in classrooms. We first calculated covariate-adjusted means derived from the multilevel models and then calculated Cohen's *d* standardized mean difference effect sizes (MDES) to quantify the magnitude of differences across groups. MDES for TOPG, classroom-level data, were calculated based on classroom-level covariate-adjusted means.

For models focusing on the association of student engagement with the other key classroom practices (described below and presented in **Table 4**), we included proportion of the class that was ED, had an IEP, were ELL, gender (male = 1), average age, and ethnic minority status (minority = 1).

Models examining students' assessment scores in relation to economic disadvantage and engagement used the student-level ED designation, which was linked to their individual scores (described below and presented in **Table 5**). The variable used to create the median split on engagement for the groups was at the classroom level. This is because while we collected observation data on all students in the classroom, we only collected assessments on 10 randomly selected children, and we did not track and link those students with their individual observation data. Thus, the way the data were collected, it was not possible to match a student's individual assessment score to their individual engagement rating.

Assessment data

We calculated age-adjusted standard scores based on students' fall 2019 assessments in math, language, and literacy. We then compared students' assessments across groups, calculating MDES based on covariate-adjusted means.

Results

Observations

Descriptive statistics revealed that students in our 49 classrooms spent, on average, 38% of their school day in transitions, with one student in transitions for 75% of their sweeps. Students were in sequential activities, tasks that require students to plan and follow steps, for 21% of the day on average. Associative and cooperative interactions were rare, with children engaging in these types of interactions 5% of the day. While the average amount of time in math was just 7%, there was one student that spent 35% of time in math. The average level of engagement was 1.95 (medium-low), with a range of 1.00 to 3.38. Children spent an average of 18% of sweeps talking, but 50 students in the sample were never observed talking.

Teachers listened, on average, 9%. However, there was substantial variation, with a range from 0% to the high of

25%, and a large standard deviation (7%) relative to the mean. While the average amount of time in instruction was over 30%, the average level of instruction was 1.85, indicating that teachers were engaging in basic skills instruction, which typically focuses on things like basic recall, letter and number recognition and asking known-answer questions. Classroom climate was fairly positive, with teachers showing a neutral to positive tone, and several classrooms in which very little disapproving was observed. However, there were 13 classrooms in which no behavior approvals were observed, meaning children were not receiving positive feedback from the teacher. Descriptive statistics for observation and assessment data are presented in Tables 1, 2.

Table 3 shows correlations among the indicators of the key classroom practices. The amount of time spent in transitions was negatively correlated with all other key practices, with the highest correlation between transitions and sequential activities (r = -0.60***) and student engagement (r = -0.73***). Sequential activities were significantly correlated with six of the 11 classroom practices Exceptions included associative and cooperative interactions, teacher listening, behavior disapproving, and teacher tone. The strongest associations were with a greater focus on math (r = 0.75***) and greater student engagement (r = 0.63***). In addition to the correlations among math and sequential activities, the amount of sweeps in which children were focusing on math was highly correlated with the amount and level of instruction (r = 0.44**,0.47***), student engagement (r = 0.37***), and tone (r = 0.34*). Interestingly, while engagement was significantly correlated with children talking, teaching listening, and the amount of instruction, it was not significantly correlated with the level of instruction (r = 0.16, n.s.) or any indicators of classroom climate. This may be reflective of the fact that there was relatively little variation in the level of instruction.

Other noteworthy correlations were among teacher listening and teacher tone (r = 0.49***), amount of instruction and teacher tone (r = 0.38***), and associative and cooperative interactions with teacher tone (r = 0.40**). Surprisingly, there were no significant correlations among the indicators of classroom climate. Moreover, teacher listening and child talking were not significantly correlated.

Comparing classroom practices occurring in classrooms with lower versus higher student engagement ratings

Next, we designated students as having lower versus higher average engagement by creating a median-split variable derived from all students' engagement ratings. Using covariate-adjusted means, we calculated effect sizes to quantify differences across groups. Results of these analyses, presented in Table 4, revealed substantial differences in the amount of time students in each group spent in transitions, the amount and level of instruction, sequential activities, math content, and the amount of teacher listening to children. Being more engaged was associated with less time in transitions (d = -0.52), more time in instruction (d = 0.64), more behavior approving (d = 0.49), more positive teacher tone (d = 0.75), more teacher listening and child talking (d = 0.43, 0.42), more time in sequential activities (d = 0.77), more associative and cooperative interactions (d = 0.43), and more time spent in math (d = 0.33). The effect size difference across groups on level of instruction approached zero (d = 0.03). And while the magnitude of the effect was minimal, those in the high engagement group experienced less behavior disapproving (d = −0.07).

Assessments

Students in our sample scored at the national average (100) for PPVT, and just under the average for WJ-III Applied Problems (99.75), but they scored lower on average than the national average on the other math, language, and literacy measures (see Table 2). Scores on WJ-III Quantitative Concepts, which measures students' quantitative reasoning and math knowledge, were lower than for other assessments, with age-adjusted standard scores of ED students averaging under 90.

Exploratory analysis comparing assessment scores of students who were in more versus less engaged classrooms

While the timing of data collection (i.e., a single timepoint during which observations and assessments were conducted) prohibits us from conducting prediction models to examine whether engagement *leads* to higher achievement, as an exploratory analysis, we examined assessment scores of students who were more versus less engaged. MDES were modest between high and lower engaged students, regardless of ED status, on all measures with the exception of Passage Comprehension. While assessment scores were higher for non-ED students than ED students, regardless of their classroom's average level of engagement, the scores for ED students with higher engagement were higher on Quantitative Concepts (d = 0.15) and on PPVT (d = 0.09). Interestingly, ED-High Engagement students had lower scores on Letter-Word Identification (d = −0.12), Oral Comprehension (d = −0.09), and on Passage Comprehension (d = −0.26). These results are presented in Table 5.

Non-ED students with higher engagement scored higher on all measures except Applied Problems (d = −0.12). Effect sizes were positive but very small on Letter-Word Identification (d = 0.06), Oral Comprehension (d = 0.04), and Quantitative Concepts (d = 0.07). There was a slightly larger positive effect on PPVT (d = 0.14). Non-ED students with higher engagement scored higher on Passage Comprehension (d = 0.35). This was the largest effect across all groups. It should be noted, however, that the Passage Comprehension measure is not administered in

TABLE 1 Descriptive information on key classroom practices observed.

		N classrooms = 49, *N* students = 795			
COPG variables	***N*[3]**	***M*[4]**	***SD***	**Min**	**Max**
Practice 1: Transitions					
Transitions[1]	793	38%	12%	14%	75%
Practice 2: Sequential Activities					
Sequential[1]	760	21%	12%	3%	70%
Practice 3: Peer Social Interactions					
Associative and Cooperative[1]	452	5%	6%	3%	35%
Practice 4: Time spent in Math					
Math Focus[1]	538	7%	8%	3%	35%
Practice 5: Children's Engagement					
Average Engagement (1-5 rating)[1]	795	1.95	0.34	1.00	3.38
Children Talking[1,5]	745	18%	10%	3%	54%
TOPG Variables	*N*[3]	*M*[4]	*SD*	Min	Max
Practice 6: Teachers Listening to Children					
Listening to Children[2]	40	9%	7%	2%	25%
Practice 7: Quality and Amount of Instruction					
Teacher – Amount of Instruction[2]	49	31%	12%	8%	66%
Teacher - Level of Instruction (1-4)[2]	49	1.85	0.21	1.00	2.11
Practice 8: Classroom Emotional Climate					
Teacher - Behavior Disapproving[2]	37	5%	5%	2%	19%
Teacher - Behavior Approving[2]	36	4%	4%	2%	18%
Teacher – Tone (1-5 rating)[2]	49	3.27	0.25	2.95	3.83

Variables created with COPG are based on all children present in the classroom on observation days; not just the students who were assessed. [1]All variables represent the proportion of sweeps a given variable was observed except for Level of Instruction, Teacher's Tone, and Children's Level of Involvement which are Likert-type scores. [2]Variable from Child Observation Protocol, df adjusted for nesting of children within the classroom. [3]Variable from the Teacher Observation Protocol. [4]For COPG variables, the N is based on the number of children who were observed doing a given behavior. For TOPG variables, the N is based on the number of teachers observed doing a given variable. The means *do* take into account the fact that a participant might have been observed in a given behavior 0% of their sweeps. [5]Practice 6, Teachers Listening to Children, is operationalized using one variable from TOPG (teacher listening) and one variable from COPG (children listening).

TABLE 2 Means and standard deviations for student assessment standard scores.

Outcome	**Full sample** ***N* = 407**	**Not economically disadvantaged** ***N* = 177**	**Economically disadvantaged** ***N* = 230**
	M (SD)	***M (SD)***	***M (SD)***
WJ-III Letter-Word Identification			
Standard Score	95.95 (12.71)	98.06 (12.60)	94.33 (12.58)
WJ-III Oral Comprehension			
Standard Score	95.12 (14.49)	97.22 (15.31)	93.50 (13.65)
WJ-III Applied Problems			
Standard Score	99.75 (14.05)	102.10 (13.71)	97.94 (14.07)
WJ-III Quantitative Concepts			
Standard Score	91.41 (12.40)	94.13 (12.06)	89.34 (12.28)
Peabody Picture Vocabulary			
Standard Score	100.21 (15.89)	103.27 (16.22)	97.87 (15.27)
WJ-III Passage Comprehension[a]			
Standard Score	95.31 (11.46)	96.28 (11.23)	94.04 (11.71)

[a]WJ-III Passage Comprehension is only administered to students K and up (N = 197) as opposed to the full sample including PreK students (N = 407). Standard scores are normed and age-adjusted. Intraclass correlations (ICCs) for each assessment are as follows: Letter-Word 0.14, Oral Comprehension 0.09, Applied Problems 0.10, Quantitative Concepts 0.14, PPVT 0.06, Passage Comprehension 0.07.

PreK and, thus, the effect size is calculated from a sample size that is half that of the other assessments (ED Low Engagement N = 51, ED High Engagement N = 34; Non-ED Low Engagement N = 38, and non-ED High Engagement N = 74).

Discussion

By using day-long classroom observations, the present study identified specific, measurable factors that are associated with

TABLE 3 Correlations among indicators of the key classroom practices.

COPG variables	1	2	3	4	5	6	7	8	9	10
Transitions										
Sequential Activities	−0.60***									
Associative/Cooperative Interactions	−0.30*	−0.14								
Math Focus	−0.35*	0.75***	−0.24†							
Average Engagement	−0.73***	0.63***	0.36*	0.37**						
Children Talking	−0.23	0.29*	0.26†	0.21	0.37**					
TOPG Variables										
Teacher Listening	−0.25†	0.08	0.15	0.01	0.32*	−0.04				
Amount of Instruction	−0.31*	0.43**	0.25†	0.44**	0.37**	0.21	0.16			
Level of Instruction	−0.10	0.35*	−0.19	0.47***	0.16	0.01	0.14	0.32*		
Behavior Disapproving	−0.10	0.12	−0.07	−0.01	−0.01	−0.09	−0.07	−0.17	0.02	
Behavior Approving	−0.09	0.29*	−0.26†	0.16	0.16	−0.24	−0.30*	0.09	0.21	0.05

†$p < 0.10$. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$. Correlations are based on observation data from 49 classrooms.

TABLE 4 Effect size differences, comparing classroom practices occurring in classrooms with lower engagement versus higher ratings of student engagement.

		Low engagement			High engagement			
	Measures	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	MDES
COPG Classroom Practices								
Transitions	Time in Transitions[2]	395	39%	10%	400	34%	12%	−0.52
Sequential Activities	Sequential[2]	395	17%	9%	400	25%	12%	0.77
Peer Interactions	Associative/Cooperative Interactions[2]	395	4%	5%	400	7%	6%	0.43
Time spent in Math	Math Focus[2]	395	6%	6%	400	8%	8%	0.33
Children Talking	Children Talking[2]	395	15%	10%	400	20%	11%	0.42
TOPG Classroom Practices								
Teachers Listening to Children	Teacher Listening[3]	25	7%	6%	24	10%	8%	0.43
Quality and Amount of Instruction	Amount of Instruction[3]	25	28%	10%	24	35%	13%	0.64
	Level of Instruction[3]	25	1.84	0.24	24	1.85	0.18	0.03
Classroom Emotional Climate	Behavior Disapproving[3]	25	6%	5%	24	5%	5%	−0.07
	Behavior Approving[3]	25	3%	2%	24	4%	4%	0.49
	Teacher Tone[3]	25	3.18	0.21	24	3.36	0.26	0.75

All Cohen's D standardized mean difference effect sizes (MDES) from COPG are estimated from the covariate-adjusted means derived from multi-level models to account for clustering of students within classrooms. MDES based on TOPG variables estimated from covariate-adjusted means from single-level models. Covariates include: percentage of children within a classroom identified as an ethnic minority, classified as experiencing economic disadvantage, percentage of male students, English Language Learners, percentage with an independent education plan, and for average age. [1]All variables represent the proportion of sweeps a given variable was observed except for Level of Instruction, Teacher's Tone, and Children's Level of Involvement which are Likert-type scores. [2]Variable from Child Observation Protocol. [3]Variable from the Teacher Observation Protocol.

greater student engagement, which is critical to student learning. We chose to focus on classroom practices that previous studies have found to be predictive of student achievement in PreK and K. Some of the practices are composed of more than one variable, with the majority quantified using behavioral count data. Three variables–level of instruction, teacher tone, and level of engagement– are based on ratings with behavioral anchors where interrator reliability was achieved. We operationalized classroom climate as a combination of factors including behavior approving, disapproving and teacher tone. Quality of instruction was defined as a combination of the level and amount of instruction. Finally, the amount of teacher listening and children talking were used to capture teachers' providing students with opportunities to talk during interactions. For one of these practices based on a combination of variables, more child talking, both components were significantly related to higher student engagement. None of the components of classroom climate were related to student engagement. While only one component of quality of instruction (amount of instruction, not level of instruction) was associated with student engagement.

The majority of the focal classroom practices are related to student engagement

In examining the associations between our focal classroom practices and student engagement, we found several significant relationships. First, and not surprisingly, students spending

TABLE 5 Means and standard deviations for ED student assessments with lower versus higher engagement.

	Economically disadvantaged students		
	Low engagement[1] (*N* = 121)	High engagement (*N* = 109)	
	M (SD)	*M (SD)*	MDES
Outcome			
WJ Letter-Word Identification	94.13 (13.22)	92.62 (11.85)	−0.12
WJ Oral Comprehension	94.06 (13.94)	92.88 (13.37)	−0.09
WJ Applied Problems	97.08 (13.52)	99.08 (14.75)	−0.01
WJ Quantitative Concepts	87.95 (11.89)	91.18 (12.60)	0.15
PPVT	96.72 (14.97)	99.37 (15.60)	0.09
WJ Passage Comprehension[2]	94.98 (11.17)	92.62 (12.51)	−0.26
	Non-economically disadvantaged students		
	Low engagement (*N* = 68)	**High engagement (*N* = 109)**	
	M (SD)	*M (SD)*	MDES
Outcome			
WJ Letter-Word Identification	97.89 (10.91)	98.67 (13.59)	0.06
WJ Oral Comprehension	97.32 (16.06)	97.87 (14.83)	0.04
WJ Applied Problems	103.67 (13.88)	101.98 (13.65)	−0.12
WJ Quantitative Concepts	93.96 (12.65)	94.85 (11.71)	0.07
PPVT	102.01 (18.47)	104.23 (14.51)	0.14
WJ Passage Comprehension[2]	93.80 (8.09)	97.73 (12.55)	0.35

All Cohen's D standardized mean difference effect sizes (MDES) from student data are estimated from the covariate-adjusted means derived from multi-level models to account for clustering of students within classrooms. [1]Engagement median split was based on classroom-level average engagement as students' observation data were not linked to their assessment data. [2]The WJ-III Passage Comprehension is administered beginning in kindergarten, so the sample size is half that of the other measures (N = 85 in the ED group and N = 112 in the Non-ED group).

more time in transitions had lower student engagement. Transitions are necessary throughout the school day – students must move from one activity to the next. When classrooms have transitions that last longer, however, it may be due to disorganization and a lack of students' internalizing the flow of the day. For example, in our observations, we noted that transitions were often due to students waiting while teachers gathered materials, waiting in line to wash hands, or stopping an activity while the teacher pauses to manage student behavior. During these transitions, students miss out on learning opportunities that are associated with higher engagement. This point is underscored by the fact that we found a strong positive relationship between the amount of time in instruction and engagement.

We also saw significant relationships between the amount of teacher listening and child talking with engagement. When teachers asked questions and provided space for children to respond, children tended to be more engaged. This mirrors research indicating that students benefit from extended wait-time during teacher-student interactions (McKay, 1988), and that teacher listening promotes greater student involvement (Cadima et al., 2015).

Similarly, we found that classrooms where there were more frequent associative and cooperative interactions had higher average student engagement. This is consistent with previous research indicating that children that have more opportunities to interact with one another, they exhibit higher engagement in learning (Coolahan et al., 2000; Morales-Murillo et al., 2020).

Moreover, students that spent more time in sequential tasks had higher student engagement. This is not surprising given that sequential tasks, by definition, require planning. Thus, to carry out a sequential activity, a student would need to have some level of engagement. Similarly, children in classrooms with more math content showed higher average engagement. In our sample, sequential activities and math were highly correlated. This is likely because many early math skills are sequential in nature, requiring planning (e.g., patterns, measurement). This planning, in turn, requires that a student be engaged. For example, a child creating a pattern with interlocking cubes would need to engage their working memory skills as they hold

the alternating colors in their mind and search for the correct color to extend the pattern.

Contrary to what we expected, none of the components of classroom climate were significantly correlated with students' engagement. However, when we examined the experiences of higher and lower engaged students, we found strong effects of behavior approving and tone, suggesting students who experienced a more positive climate tended to be more engaged. Several studies suggest that classroom climate contributes to student engagement (e.g., Khalfaoui et al., 2021). It is possible the non-significant correlations are at least in part due to there being little variation in teachers' use of behavior approving and disapproving, with data skewed toward zero. And, similarly, little variation in teachers' tone. More research on the contributions of the components of classroom climate is needed to gauge the relative importance for student engagement.

Lower engagement is related to poorer instructional practices

Using a median split on our indicator of child-level engagement, we compared two groups of students– those with higher engagement and lower engagement– in terms of the other focal practices they experienced. This allowed us to determine whether students in each group differed in terms of how their day is organized, the quality of instruction they received, the types of interactions they had, and the climate they experienced. Our findings suggest that being less engaged comes with a host of other issues including: having more transitions, less time in instruction, a more negative classroom climate, fewer opportunities for children to talk, fewer sequential activities, fewer associative and cooperative interactions, and less time in math content. Although each practice may uniquely contribute to lower engagement, it is likely that a combination of these problems makes it particularly difficult to be engaged.

At odds with previous research (Bundick et al., 2014; Spivak and Farran, 2016), we found that classrooms with higher engagement did not differ in their level of instruction. It may be that teachers in classrooms with lower student engagement are aware that their students are less engaged, and they are choosing to use, open-ended questioning, for example, in an effort to engage their students. Indeed, there is evidence that teachers are accurate at estimating the level of engagement of their students (Lee and Reeve, 2012), which informs their instruction.

There are also questions about the direction of effects for the associations born out in our results. Just as students react to teachers' behaviors, teachers react to students. One of our findings was that teacher tone was higher with more highly engaged students. When teachers' perceive their students are highly engaged, they may have fewer issues with behavior management and experience less stress. In this scenario, it seems plausible that teachers' tone is influenced by students' engagement. In support of this, previous research has found that teachers' emotions are highly influenced by their interactions with students and student behaviors, including student engagement (e.g., Hagenauer et al., 2015). Teachers often report that positive interactions with students ("seeing a breakthrough in learning") elicit feelings of joy and satisfaction (Hargreaves, 2000). Conversely, teachers report experiences of anger and frustration – which would affect a tone rating– in response to higher rates of student misbehavior (Chang, 2013).

Similarly, we found that teachers of highly engaged students spend more time instructing and listen more. But that may be due to the influence of student engagement on teachers' behaviors, rather than the reverse. For example, if students are less engaged in learning activities (e.g., book reading), they may be less likely to engage in discussion or answer questions, which, in turn, means teachers do not have the opportunity to listen to them. If students are less engaged, teachers also may spend less time in instruction due to the need to focus on behavior management.

Economically disadvantaged students in highly engaged classrooms show little difference in assessment scores

As an exploratory analysis, we also compared the assessment scores of low-income and higher income students from classrooms characterized as more highly engaged versus those with lower engagement. Contrary to what we expected given the previous literature, we found that low-income students in highly engaged classrooms only scored higher on one of the math measures and one on vocabulary; however, our concurrent data collection prohibits us from making causal attributions. If we had post-test assessments, it is possible that we might find that there are no associations between pre-test assessments and engagement, but that students in more highly engaged classrooms have higher scores by post-test (or more growth, controlling for pre-test scores) as compared to students in less engaged classrooms.

We found no meaningful differences in terms of low-income students' knowledge of letters and sight words and on oral comprehension. Moreover, we found that low-income students in classrooms with lower engagement actually scored higher on the measure of reading comprehension than those in more engaged classrooms. One explanation for this finding may be that more time spent in contexts associated with lower engagement, such as whole group activities, is not necessarily detrimental to all types of learning. In early childhood classrooms, one of the most common activities that occurs during whole group time is book reading. In our sample, students spent almost a quarter of the day in whole group activities, with students in classrooms with a higher proportion of ED students experiencing more time in whole group than

students in classrooms with a lower proportion of ED students. However, again, because we cannot investigate causality, we are merely speculating as to why we might see higher scores on reading comprehension for low-income students exhibiting lower engagement.

We do know from the literature that low-income students especially benefit from expository comments that give or explain information during book readings (Gerde and Powell, 2009; Barnes et al., 2017), whereas children with higher initial language skills, who tend to be from higher income backgrounds, benefit more from abstract discussion during book readings (Reese and Cox, 1999). In terms of measuring engagement, book readings that feature more teacher comments and fewer interactive discussions may lead to lower classroom engagement, on average. However, given evidence that knowledge-building comments are especially helpful for developing low-income students' narrative understanding, it's plausible that low-income students in low-engagement classrooms may score higher on reading comprehension due to more time spent in whole-group book readings that tend to be less engaging.

Non ED students in more highly engaged classrooms, however, scored higher on all measures except Applied Problems. While it is possible that student engagement, and the other beneficial classroom practices that are associated with higher engagement, are associated with higher scores, we found little evidence of this in the present study. It is important to acknowledge that the majority of the effect sizes describing group differences on assessment scores were small in magnitude. Moreover, as we have cautioned above, is possible that the timing of the data collection explains the lack of association. For example, if we had collected observation data early in the year and assessment data both at the beginning and end of the year, we might have seen that engagement had a positive effect on assessment scores. With cross-sectional data, we are limited to looking at associations from a single timepoint.

Though we cannot test this with our data, it is possible that the direction of some of the relationships between practices and assessments is the reverse of our framework (i.e., key classroom practices lead to higher engagement, which leads to higher achievement). For example, teachers' practices may be influenced by student characteristics such as the teachers' perception of their students' entering skill level and students' own behaviors. Indeed, research suggests that teachers' perceptions of students' ability within a class differ (Timmermans and Rubie-Davies, 2018), and that different expectations influence both teachers' instruction (Rubie-Davies et al., 2015) and students' subsequent achievement (Timmermans and Rubie-Davies, 2018).

It is also possible that many of these relationships are bi-directional. For example, it may be that teachers with students that have higher entering skills give them more opportunities to talk because students are more advanced in their vocabulary and are better able to answer open-ended questions. This, in turn, could lead to greater engagement.

Implications

Findings from the present study, particularly associations between student engagement and teacher practices, point to important topics for teacher training and professional development that are often overlooked. In early childhood classrooms, activity settings that provide more choice, like play and open centers, increase children's engagement (Vitiello et al., 2012; Coelho et al., 2020). Our finding on the relation between more frequent associative and cooperative interactions and higher student engagement offers a potential explanation for why activity settings like centers support engagement. During centers, children exercise greater choice over the types of materials they play with, how they play, and the peers with whom they interact. Associative and cooperative interactions occur when children are talking, working with shared materials, and co-constructing ideas together. Thus, one of the pathways between higher engagement and activity setting may be the presence of social learning interactions like the ones identified in this study. It takes considerable teacher skills to foster successful associative and cooperative interactions during centers. Some of these include previewing engaging materials and how to use them, modeling and pre-teaching cooperative games, and supporting social emotional skills like initiating play with peers and problem-solving. Yet PreK and early grades professional development efforts often focus on specific, content-based practices (e.g., how to teach discrete literacy skills), especially when PreK classrooms reside in elementary schools. Professional development and coaching efforts designed for early childhood classrooms that help teachers organize centers with interesting materials and facilitate peer interactions around shared topics will be necessary to increase occurrences of associative and cooperative interactions and thus bolster engagement.

A second focal area for professional development based on these findings is teacher-child discourse. Despite evidence that teacher language patterns are difficult to change (Dickinson, 2011; Mendive et al., 2016), targeted interventions with coaching demonstrate more success than comprehensive literacy and language professional development programs (Wasik and Hindman, 2011). The current finding on the importance of elevating teacher listening and child talk for increasing engagement supports prior research (e.g., Girolametto and Weitzman, 2002; Piasta et al., 2012) and provides a targeted area for coaching and teacher growth. In this study, the prevalence of teacher listening and child talk was linked to engagement, as opposed to the content or subject-matter of discussions, for example. Therefore, coaching efforts that support growth in teachers' listening behaviors, such as how often they position

their body at eye-level with children and look at children with a positive or interested expression to encourage child talk, could have a considerable impact on engagement.

Many practices identified in this study that were associated with engagement may be especially beneficial for students at risk for lower engagement and achievement, though our findings were inconclusive. Childhood poverty has been consistently linked to lower engagement and achievement due to multiple factors that tend to coincide in low-income households, such as low cognitive stimulation in the home and elevated parental harshness (Evans, 2004; Karreman et al., 2006; Pratt et al., 2016) that influence children's developing self-regulation (Blair and Raver, 2012). Self-regulation, in turn, affects children's ability to adapt to the school environment and engage in learning tasks at school in ways that support achievement (Blair and Razza, 2007).

Limitations and future directions

It is important to note the limitations of the cross-sectional design for the current study. The study was initially designed as longitudinal, with researchers planning to collect additional classroom observations in Spring 2020 and end-of-year student assessments. This would have allowed us to explore causal relationships. Unfortunately, with the onset of COVID-19, we had to suspend data collection and explore descriptive analyses and associations of classroom practices and students' assessment scores rather than testing causal relationships. While the cross-sectional nature of the data does not allow us to make causal attributions or examine student engagement as a mediator (**Figure 1**) of the relationship of key classroom practices and student achievement (i.e., due to the temporal order of data collection required), this study provides evidence that these specific classroom practices are associated with greater student engagement. We found only minimal evidence that engagement was associated with higher scores on measures of math, language, and literacy, regardless of economic disadvantage. Future research using a longitudinal design involving the collection of multiple time points of observation and assessment data is needed to determine whether these practices are the cause of increased engagement for ED students, and whether implementing these specific practices leads to greater pre-post gains.

Data availability statement

The datasets presented in this article are not readily available because the dataset produced from this study is kept by the Principal Investigator for internal use. The PI will review data requests on a case-by-case basis prior to making the data available. Requests to access the datasets should be directed to CC, caroline.h.christopher@vanderbilt.edu.

Ethics statement

The studies involving human participants were reviewed and approved by Vanderbilt University Institutional Review Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

CC and KN contributed to the writing of this manuscript, with KN primarily focusing on the introduction and discussion. CC directed the data collection, conducted the data analysis, and created the tables presented as part of this manuscript. Both authors contributed to the article and approved the submitted version.

Funding

This research was funded by grants from the Bill & Melinda Gates Foundation (grants UWSC10509 and OPP1195942), awarded to the CC.

Acknowledgments

The authors gratefully acknowledge the support of the Bill & Melinda Gates Foundation, as well as the schools, teachers, and students who participated in this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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