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Executive Function Skills and Classroom Behaviors of U.S. Prekindergartners With Special Needs

Kimberly T. Nesbitt[1]* *and Dale C. Farran*[2]

[1] Department of Human Development and Family Studies, University of New Hampshire, Durham, NH, United States,
[2] Department of Teaching and Learning, Vanderbilt University, Nashville, TN, United States

This study explores the executive function (EF) skills in a sample of 4-year-old children enrolled in inclusive prekindergarten (pre-k) classrooms. We compare the EF skills and important classroom behaviors of children with and without identified special needs as well as a sample of English language learners (ELL) in the same classrooms. Identification of special needs and ELL status were each examined as these factors have previously been shown to be associated with young children's EF skills. Compared to their classroom peers, children with identified special needs not only began the year with lower EF skills but made fewer gains over the school year, a similar pattern was observed for children identified as ELL. Compared to their peers, children with identified special needs were observed as engaging in lower levels of involvement, sequential behaviors, and social learning interactions and higher levels of unoccupied and disruptive behaviors, a pattern that was also found for children's entering EF skills (e.g., lower entering EF scores associated with lower levels of involvement). Lastly, children's classroom behaviors differed across teacher-directed and children-directed learning with level of involvement and social-learning interactions higher during child-directed learning, and sequential behaviors higher in teacher-directed learning, a pattern that held across all groups of children.

Keywords: executive function, classroom behaviors, special needs, English language learners, prekindergarten

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***Correspondence:**
Kimberly T. Nesbitt
kimberly.nesbitt@unh.edu

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INTRODUCTION

Children with special needs and young children who are English language learners (ELL) in the U.S. are often served in regular prekindergarten (pre-k) settings, with the idea that the classroom environment will aid their development and allow them to participate in naturalistic settings with other children and adults. While children with disabilities could enroll in specialized preschool programs, pre-k classrooms in the public schools and Head Start are often mandated to give at least priority to children with special needs and, in many cases, required to serve a particular percentage of children in each classroom. The types of disabilities included in regular pre-kindergarten classrooms tend to be milder, with the major diagnosis being speech or language delay; developmental delay is the second most common diagnosis (U.S. Department of Education, 2021).

In many states in the U.S., the greatest surge in pre-k enrollment is coming from children of families who are not native English speakers (Hussar et al., 2020). While states in the northwestern U.S. have more experience with children who speak a language other than English and provide appropriate services (such as dual-language speaking teachers), states in the southern part of the country vary widely in such services despite the dramatic increase in enrollment (Horsford and Sampson, 2013).

Pre-kindergarten classrooms under public school auspices are a relatively new development in the U.S. Consequently less is known about how children with special needs or English language learners fare in these classrooms. Transitioning to a formal setting such as a pre-k classroom involves learning to adapt one's individual learning styles to the uniform expectations of the classroom environment—to learn in a large group, to have the learning focus determined by the teacher, to ignore distractions, to be self-directed and involved, to participate with peers, and to comply with the behavioral demands of the classroom. These kinds of skills are related to what is called executive functions or EF. Self-regulation is another comprehensive term for these kinds of skills.

EF skills involve the development of the pre-frontal cortex, an area of the brain that undergoes protracted development, particularly between the ages of 4 and 6 years (Bull et al., 2011). EF skills are comprised of a set of interrelated abilities that include inhibitory control (being able to hold back, not responding immediately and inappropriately), working memory (being able to hold onto something in memory and work with it—such as remembering three things to do before going to lunch and in the right order), and attentional flexibility (being able to redirect attention from one thing to another, particularly if the teacher asks) (Hughes, 2011; Blair, 2016; Zelazo et al., 2016). Because of its lengthy developmental trajectory, EF skills are particularly susceptible to environmental influence (Haft and Hoeft, 2017).

In general, less well-developed EF skills when children enter pre-k or kindergarten are an important predictor of longer-term achievement and behavior (e.g., Fuhs et al., 2014; Schmitt et al., 2017). Nesbitt et al. (2015) found that children's entering EF skills in pre-k were related to levels of involvement, participation in activities requiring sequential steps, participation in social-learning interactions, as well as instances of being unoccupied, disruptive, or in time out. Morgan et al. (2019) found that EF deficits, particularly in working memory, increased the risk for kindergarten children of having repeated academic difficulties. Moreover, studies show that *improvement* in EF skills such as attention and memory are associated with better academic performance in the early elementary school years (Hughes and Ensor, 2010) as well as predicting being more productively engaged in classroom activities (Pagani et al., 2012).

Most studies of EF skills in children with disabilities focus on older children, especially those with attention deficit hyperactivity disorder (ADHD) (Johnson et al., 2015). ADHD, by definition, implies some difficulties with attention, memory, and control. Johnson (2012) accounts for the later emergence of ADHD as a consequence of poorly developed EF skills in early childhood. Studies of EF in younger children focus on such disorders as prematurity, autism, and phenylketonuria and find slower rates of EF development (Hughes, 2011). Examining young children with disabilities who had problems in executive function, a recent Finnish study of inclusive classrooms found that those children spent less time with peers (Kuutti et al., 2021). These findings underscore the importance of EF and self-regulation skills for children with special needs, who are likely to begin pre-k with a disadvantage. One question is whether the experiences of young children with special needs in inclusive classrooms will differ based on their EF skills.

Children from low-income families who are English language learners are also at risk of having more poorly developed EF skills as they enter the more formal learning environment of a pre-k classroom (Wanless et al., 2011). Moreover, these children made less gain in EF skills across the pre-k year than English speaking children from low-income families. Demonstrating that EF skills at kindergarten entry were associated with poorer achievement in kindergarten and third grade for ELL children, Finders et al. (2021) argued strongly for finding ways to improve EF abilities during the pre-k year.

For various reasons, the demands of the classroom may be difficult to meet for children with special needs as well as those who do not know English. Much research has demonstrated that young children identified as having special needs have difficulty functioning in a classroom setting. Studies from various countries confirm this finding. In Portugal, for example, children with disabilities in inclusive preschool classrooms had lower levels of engagement across the day, especially in whole group activities (Coelho et al., 2019). Though not common in preschools in all countries, whole group instruction is increasingly used in some countries where the focus is more on learning basic skills.

Kemp et al. (2013) describe the types of classroom engagement of children with a variety of disabilities. Children had the most difficulty being engaged in group activities but were also less engaged than children without disabilities in free play. The authors assert that both types of activities have the potential to provide learning opportunities for children with disabilities, but that they require skilled scaffolding from teachers to help the children. Markova (2017) found remarkably similar results for ELL children in classroom settings. Children learning English were dramatically more engaged during free play than during teacher-directed activities.

Multiple studies have emphasized the importance of adult scaffolding and assistance for both children who are ELL (e.g., Markova, 2017) and children with special needs. Mills et al. (2014) found that to enable young children with language disabilities to interact effectively with peers, adults must help structure the play situation. Without such adult scaffolding, children with disabilities can be isolated even while in a group situation. Early isolation can lead to later exclusion if children do not develop these early important skills (Koller et al., 2018).

Current Study

This study explores the EF skills in a sample of 4-year-old children all enrolled in regular pre-k classrooms. We compare the EF skills and classroom behaviors of children with and without identified special needs and also explore the EF skills and classroom behaviors of a sample of English language learners

in the same classrooms for comparison. We examine important classroom behaviors (level of involvement, sequential/goal-oriented interactions, social-learning interactions, and off-task behaviors) and the contribution of EF skills to those interactions. Moreover, we explore if children's classroom behaviors vary as a function of whether a learning experience is under the direction of the teacher or the child.

MATERIALS AND METHODS

Participants

Study data come from a large-scale evaluation of a pre-k curriculum (Nesbitt and Farran, 2021). The original study consisted of 1,145 consented children from 80 pre-k classrooms in 57 schools across six school districts from two states in the southern U.S. This study includes a total of 1,103 children (M_{age} = 54.5 months, SD_{age} = 3.6 months) who completed at least one assessment at the onset and end of pre-k and who were present for at least one of the three in-class observations. The primary reason children were excluded was moving from the school district during the course of the study. Each study classroom on average had 13.8 children (SD = 3.4) participating in the study.

Approximately 46% of the children were female; 41% were identified as Caucasian, 26% as African American; 25% as Hispanic/Latinx, and 9% as multiracial or another ethnicity. Within this group, 34% were identified as English Language Learners, meaning their first language and the language spoken at home was not English. Nearly 13% of the children had an Individualized Education Plan (IEP). In the U.S. children are classified as needing an IEP if they have special needs. For young children in these pre-k classrooms, the vast majority of the IEPs will be for language or speech delays; these classrooms served few children with more serious disabilities. All children attended public pre-k programs that prioritized enrollment based on economic need.

Executive Function Assessments

A battery of EF assessments was included in the study. Children were assessed individually in a quiet space near their classrooms in the fall (September, October) and spring (mid-March to mid-May). Although all EF assessments were administered in English, verbal directions were accompanied by demonstrations and practice trials with feedback. Assessments were administered in a fixed order within each session with EF assessments conducted at the beginning of each session (session 1 order = Peg Tapping, Head Toes Knees Shoulders, Copy Design; session 2 order = Dimensional Change Card Sort, Corsi Blocks); however, the order of the two sessions varied based on assessor availability.

Regulation and integration of motor movements (i.e., visual-motor integration) were assessed with the *Copy Design* task (Osborn et al., 1984) in which children are asked to copy eight simple geometric shapes that are increasingly complex. Children had two attempts to draw each design. If an attempt met a defined set of criteria (e.g., should be approximately symmetrical; cannot be rotated) attempts received a score of 1; if it did not, the attempt received a score of 0. Total scores could range from 0 to 16. Interrater reliability for the scoring of the Copy Design was established (κ = 0.79) and the prior test-retest reliability (2-week delay) with pre-k children has been previously demonstrated (r = 0.72; Lipsey et al., 2017).

Working memory was assessed using the backward span from the *Corsi Blocks* task (Corsi, 1972). In this task, children are asked to recall the order in which an examiner points to a series of 3-dimensional blocks fixed to a board in an irregular pattern. Both forward (repeat the pattern exactly as the examiner demonstrated) and backward memory span (reverse the pattern given by the examiner) were assessed. Children had two attempts to complete a pattern. The score was the longest backward pattern a child could correctly repeat. Reliability for a verbal variation of the task (i.e., backward digit span) has been established at r = 0.73 (Lipsey et al., 2017) with children in pre-k.

Children's attention shifting capabilities were assessed using the *Dimensional Change Card Sort* (DCCS; Zelazo, 2006). The task requires children to sort picture cards by features shown on the cards, first by color (red vs. blue color) and then according to shape (star vs. truck). If children were able to make the switch between sorting rules, they were told to sort a set of cards that had either a black border around the card or no border. If the card had a border, children needed to sort cards by color; if the card had no border, they needed to sort by shape. Children received a score of 0 if they did not pass the initial color sort task, a 1 if they passed the color sort but not the shape sort, a 2 if they passed the shape sort, and a 3 if they passed the advanced border version. DCCS test-retest reliability has previously been reported at r = 0.48 (Lipsey et al., 2017) and 0.44 (Müller et al., 2012).

Self-regulation, including the ability to respond in a way that was opposite of an examiner's request, was measured with the *Head-Toes-Knees-Shoulders* task (HTKS; Ponitz et al., 2009). HTKS requires children to respond to two oral prompts, "touch your head" and "touch your toes," then do the opposite in response to those prompts (i.e., touch their heads when the assessor said "touch your toes"). Children were also prompted to touch their knees when instructed to "touch your shoulders" and to touch their shoulders when instructed to "touch your knees." Each trial was scored 0 if the child made an incorrect response, 1 if the child self-corrected an incorrect response, and 2 if the child made a correct response. Task performance was the sum of children's performance on the task's items (range = 0–52). HTKS test-retest and interrater reliability have been established at r = 0.80 (Lipsey et al., 2017) and κ = 0.79 (McClelland et al., 2014), respectively, in pre-k children.

Lastly, children's inhibitory control was measured with the *Peg Tapping* task (Diamond and Taylor, 1996). The task required children to tap a wooden peg once when the examiner taps twice or tap twice when the examiner taps once. Each attempt was scored 0 if incorrect and 1 if correct. A score of −1 was given for the total score if the task was aborted. Final scores ranged from −1 to 16. Peg Tapping test-retest reliability has been children in pre-k at r = 0.80 (Lipsey et al., 2017).

Data are presented for each of these measures separately and also for an equally weighted standardized composite of all five measures (i.e., transforming scores into standardized z-scores and aggregating across the obtained z-scores).

Classroom Behavioral Observations

Daylong observations took place three times during the pre-k year, in the fall, mid-winter, and spring involving the *Child Observation in Preschool* (*COP*; Farran, 2011). All observers achieved interrater reliability with an experienced anchor observer at each time point. The *COP* uses a snapshot behavior-sampling procedure to capture observable child behaviors. Observers progress through a series of 20 rounds of coding, or sweeps, coding each individual child in the classroom before starting another sweep. For each sweep, a classroom member is located, observed, and then, after a count of approximately 3 s, coded across an array of dimensions. When aggregated, the collection of snapshots provides a picture of how members of a classroom spend their time.

Coding was done continuously throughout the entire school day, apart from outdoor recess, meals, and naptime (pre-k classrooms in the U.S. spend the majority of their time indoors and outdoor play sometimes does not occur at all; when it does, it tends to be short). Continuous coding ensures that individuals will be observed across multiple contexts (e.g., large group, centers, transitions). Coding options for each dimension are mutually exclusive. Analytic variables were first computed as the sum of individual scores across the 3 daylong observations (fall, winter, and spring), and then aggregated to the classroom level to provide a picture of classroom practices. Behavioral counts were further computed as proportions of sweeps in which the target behavior occurred out of the total number of sweeps observed, while the variables derived from ratings were computed as averages across all sweeps observed.

The current study focuses on children's behavior. The four behaviors used in this study, children's level of involvement, participation in sequential learning, participation in social learning interactions, and disengagement were all summarized as they co-occurred with learning activities.

Children's level of involvement was coded based on a 5-point scale ranging from 1 (low; off task, not attending to instruction) to 5 (high; intense focus, serious pursuit of an activity, cannot be distracted from task) involvement. Level of involvement was only coded if a child was engaged in a learning activity; thus, for this study, level of involvement was quantified as a child's average level of involvement during learning activities. "Learning activities" were broadly defined as basically any time the child was not unoccupied or disruptive or engaged in waiting for activities to begin. Across the three observations, interrater reliability for involvement in learning was Cohen's $\kappa = 0.69$.

Second, we examined children's participation in sequential learning behaviors, defined as behaviors that involved a sequence of steps or organization. Sequential behaviors could include children examining a book while turning the pages or working on a puzzle or craft project. Across the three observations, interrater reliability for sequential learning behaviors was Cohen's $\kappa = 0.85$.

Third, we characterized children's participation in social learning interactions. Social-learning interactions were defined as instances in which children (with or without the teacher) were working together in the context of a learning activity (which could include playing together during free play). Across the three observations, interrater reliability for social learning interactions was Cohen's $\kappa = 0.86$.

We used three codes from the COP protocol to quantify children's disengagement from these activities. Unoccupied was coded when a child was not attending to a learning-related activity though one was available. Disruptive was coded when children were observed either acting in a manner that drew other classroom members' attention off task, or deliberately misusing or destroying materials. Time out was coded when children were isolated by the teacher from the rest of the class because of behavior. The three codes were compiled to create an unoccupied– disruptive variable. The codes that contributed to the unoccupied–disruptive variable were captured through two categories of type task, which had interrater reliability of Cohen's κ 0.85 and 0.89.

In addition "context" scores were calculated by summing the percent children were observed in teacher-directed activities (whole and small group instruction), child-directed activities (centers or free-play) and the percentage of the observations children were in transitions.

Missing Data

Aggregating across the multiple assessments and observations, complete data were available for 96% of the sample (n = 1,053). The presence of missing data was not significantly associated with any variable included in the study. To avoid bias associated with listwise deletion (Enders, 2010), full information maximum likelihood estimation (i.e., the ML estimator was implemented) was used with the final sample of 1,103 children in Mplus 8.6 (Muthén and Muthén, 1998–2021).

Analytic Approach

All analyses were conducted with group-mean centered variables for classroom behaviors and Spring EF scores (see Raudenbush and Bryk, 2002) and uncentered Fall/entering EF skills. This approach was taken to control for the variation between pre-k classrooms that could affect children's classroom behaviors (e.g., differing pedagogical approaches of teachers) and EF gains, allowing us to compare the classroom behaviors of children with and without identified special needs as well as children identified as ELL within the same classrooms. Approximately 48, 50, 43, and 15% of the variances in the level of involvement, sequential behaviors, social learning interactions, and unoccupied–disruptive were accounted for by between classroom differences, respectively. EF skills were not group-mean centered as they were assessed at the onset of the school year; however, standard errors were adjusted using the complex command in Mplus to further account for the nesting of children within classrooms. Tests of statistical significance controlled for gender and age. Tests of Spring EF also controlled for Fall EF.

To examine group differences based on IEP and ELL status, a dichotomous independent variable for group status was included to predict targeted dependent outcomes (EF scores or classroom behaviors). Children identified by their teachers as ELL or children identified as having an IEP were the reference group for all analyses. Tests of association between the EF skills and classroom behaviors were run separately for each independent

variable of children's entering EF skills and each dependent variable of classroom behaviors.

RESULTS

Presented in **Table 1** are the Fall and Spring EF skill scores for children in two groups. First, those children who were English Language Learners (ELL) scores are compared to those children who were English speakers. The second panel of **Table 1** presents the EF scores for children with a diagnosed special need (an IEP) compared to those children who did not have an IEP.

At the start of pre-k, children classified as ELL had lower EF scores on all measures except *Copy Design*. Interestingly, the *Copy Design* task is the least dependent on language. Children are shown a geometric figure and they are required to copy it exactly. The instructions do not require English in order for children to know what to do. On *Copy Design* children who were ELL actually scored significantly higher than native English speakers. It is hard to disentangle the effects of English instructions from the actual EF skills for this group of children. EF scores for children with an IEP were significantly lower on each EF measure and on the composite.

Examination of residual gains in EF over the pre-k year (spring scores controlling for fall scores) indicated that for Corsi Blocks, DCCS, and HTKS, children not classified as ELL made larger gains compared to their ELL peers while the reverse was observed for Copy Design. In other words, for these measures, the initial differences in EF skills widened over the school year. A similar effect was seen regarding IEP status, with children without an IEP making larger EF gains for every measure except DCCS as well as for the composite.

Table 2 presents a summary of the four classroom behaviors observed across the year for the two contrasting groups of children. Children with an ELL status were significantly rated as more highly involved than English-speaking children, engaged in more sequential type activities, and also significantly more likely to be involved in social interactions. ELL children were significantly less likely to be unoccupied-disruptive.

On the other hand, children who had an IEP had very different classroom behavior patterns than those children without an IEP. They were rated as less involved overall. They were less likely to be doing sequential tasks, less likely to be in social interactions, and more likely to be unoccupied and/or disruptive. The sizes of the effects are large enough to be meaningful and of concern.

Table 3 presents the correlations between entering EF skills and these four classroom behaviors, collapsed across ELL and IEP status. As can be seen, the strongest relations between entering EF skills and classroom behaviors involve children being unoccupied and/or disruptive. Level of involvement is also strongly related to children's entering EF skills, while social interactions were the least predicted by EF.

To further explore if the relations between entering EF skills and children's classroom behaviors varied by ELL and IEP status, moderation analyses were conducted. Specifically, the analysis tested whether the association between the EF standardized composite variable and each of the four classroom behaviors was moderated by ELL or IEP status. Regarding ELL status, there was no significant moderation for any of the four behaviors ($ps > 0.285$) suggesting that the relation between entering EF skills and classroom behaviors was similar for children identified as ELL

TABLE 1 | Prekindergarten fall and spring executive function skills by ELL status, and IEP status.

ELL status						
	ELL		**Not ELL**		**Tests of group differences (Cohen's *D* ES)**	
Variable	**Fall *M* (*SD*)**	**Spring *M* (*SD*)**	**Fall *M* (*SD*)**	**Spring *M* (*SD*)**	**Fall**	**Pre-K gain**
Corsi Blocks, backward	1.06 (1.09)	1.43 (1.31)	1.17 (1.15)	1.62 (1.34)	−0.10	−0.15**
Copy design	1.22 (1.67)	5.70 (2.82)	0.92 (1.44)	4.44 (2.68)	0.20**	0.36**
DCCS	1.11 (0.43)	1.51 (0.55)	1.38 (0.62)	1.73 (0.58)	−0.48**	−0.26**
HTKS	5.91 (10.03)	17.52 (16.62)	11.65 (13.74)	23.94 (16.96)	−0.46**	−0.19**
Peg tapping	2.07 (5.08)	7.86 (6.34)	5.27 (5.83)	10.03 (0.34)	−0.57**	−0.16
Standardized composite	−0.18 (0.54)	−0.11 (0.68)	0.09 (0.66)	0.06 (0.65)	−0.44**	0.02
IEP status						
	IEP		**No IEP**		**Tests of group differences (Cohen's *D* ES)**	
Variable	**Fall *M* (*SD*)**	**Spring *M* (*SD*)**	**Fall *M* (*SD*)**	**Spring *M* (*SD*)**	**Fall**	**Pre-K gain**
Corsi Blocks, backward	0.88 (1.13)	1.22 (1.36)	1.17 (1.13)	1.60 (1.32)	−0.26**	−0.24**
Copy design	0.73 (1.44)	3.95 (2.78)	1.06 (1.54)	5.00 (2.77)	−0.21*	−0.20*
DCCS	1.16 (0.61)	1.56 (0.63)	1.31 (0.57)	1.67 (0.57)	−0.26**	−0.10
HTKS	7.65 (12.32)	17.53 (17.67)	10.04 (12.97)	22.34 (16.95)	−0.19*	−0.22**
Peg tapping	3.06 (5.62)	7.48 (6.23)	4.37 (5.79)	9.54 (5.68)	−0.23**	−0.25**
Standardized composite	−0.20 (0.67)	−0.26 (0.77)	0.03 (0.63)	0.04 (0.66)	−0.36**	−0.49**

Children identified by their teachers as English Language Learners (ELL) or having an active Individualized Education Plan (IEP) are the reference group [negative standardized mean difference effect sizes (ES) indicate lower scores for the reference group]. Estimates of Fall group difference (significance and ES) control for gender and age. Estimates of the PreK Gain are residual gains controlling for Fall scores. DCCS, Dimensional Change Card Sort; HTKS, Head Toes Knees Shoulders.
***$p < 0.01$, *$p < 0.05$.*

TABLE 2 | Children's classroom behaviors by ELL and IEP status.

ELL status			
Variable	**ELL*M* (*SD*)**	**Not ELL*M* (*SD*)**	**Cohen's D ES**
Level of involvement (Rating)	2.46 (0.24)	2.36 (0.27)	0.40**
Sequential behaviors	0.27 (0.09)	0.24 (0.09)	0.30**
Social learning interactions	0.11 (0.07)	0.10 (0.06)	0.04
Unoccupied/ Disruptive	0.03 (0.04)	0.05 (0.05)	−0.34**
IEP status			
Variable	**IEP*M* (*SD*)**	**No IEP*M* (*SD*)**	**Cohen's D ES**
Level of involvement (Rating)	2.30 (0.29)	2.41 (0.26)	−0.40**
Sequential behaviors	0.22 (0.08)	0.26 (0.09)	−0.47**
Social learning interactions	0.09 (0.06)	0.11 (0.06)	−0.33**
Unoccupied/ Disruptive	0.06 (0.07)	0.04 (0.04)	0.42**

Children identified by their teachers as English Language Learners (ELL) or having an active Individualized Education Plan (IEP) are the reference group [negative standardized mean difference effect sizes (ES) indicate lower scores for the reference group]. Level of Involvement Likert ratings range from 1 (low involvement) to 5 (high involvement). Descriptives for other learning-related behaviors are the proportion of observed sweeps characterized by the given behavior. Estimates of group differences (significance and ES) control for gender and age.
***$p < 0.01$.*

TABLE 3 | Associations between entering executive function skills and children's classroom behaviors.

Variable	**Level of involvement**	**Sequential behaviors**	**Social learning interactions**	**Unoccupied/ Disruptive**
Corsi Blocks, backward	0.13**	0.08**	0.12**	−0.14**
Copy design	0.11**	0.11**	−0.01	−0.14**
DCCS	0.10**	0.07**	0.08**	−0.13**
HTKS	0.12**	0.09**	0.10**	−0.09**
Peg tapping	0.12**	0.12**	0.07**	−0.11**
Standardized composite	0.18**	0.14**	0.11**	−0.19**

DCCS, Dimensional Change Card Sort; HTKS, Head Toes Knees Shoulders. Tests of significance controlled for gender and age.
***$p < 0.01$, *$p < 0.05$.*

and their non-ELL peers ($\beta_{involve} = 0.02$, $SE_{involve} = 0.03$; $\beta_{sequ} = -0.02$, $SE_{sequ} = 0.04$; $\beta_{social} = -0.03$, $SE_{social} = 0.03$; $\beta_{unocc} < 0.01$, $SE_{unocc} = 0.03$). Similarly, tests of moderation by IEP status were not significant ($ps > 0.175$) suggesting that the relation between entering EF and classroom behaviors was similar for children with an IEP and their classroom peers ($\beta_{involve} = 0.03$, $SE_{involve} = 0.04$; $\beta_{sequ} = 0.02$, $SE_{sequ} = 0.03$; $\beta_{social} < -0.01$, $SE_{social} = 0.02$; $\beta_{unocc} = -0.05$, $SE_{unocc} = 0.03$). The implication of these findings is that EF skills operate similarly in children irrespective of their designation as English language learners or as having special needs.

We also examined contextual effects on behavior and whether those effects differed for different groups of children. Overall, children were observed engaging in teacher-directed settings (whole group and small group) for 43% (*SD* = 15%) of sweeps and child-directed settings (centers and small group centers) for 31% (*SD* = 16%) of sweeps. Children were observed in non-instructional transitions for 18% (*SD* = 10%) of sweeps.

Table 4 reports the findings from examining whether children's classroom behaviors differed across learning settings (teacher-directed compared to children-directed learning), including if the pattern was moderated by ELL and IEP status. Significant main effects (collapsed across ELL and IEP status) were observed for level of involvement, sequential behaviors, and social-learning interactions, but not for unoccupied/disruptive behaviors. Children's involvement and their social learning interactions were greater in child-directed learning contexts compared to teacher-directed activities, while sequential behaviors mean were higher for teacher-directed instruction.

Tests of moderation indicated that differences in classroom behaviors by classroom learning setting were similar regardless of ELL or IEP status for level of involvement ($\beta_{ELL} < -0.01$, $SE_{ELL} = 0.03$; $\beta_{IEP} = 0.04$, $SE_{IEP} = 0.04$), sequential behaviors ($\beta_{ELL} = 0.01$, $SE_{ELL} = 0.01$; $\beta_{IEP} < -0.01$, $SE_{IEP} = 0.02$), and unoccupied/disruptive behaviors ($\beta_{ELL} < -0.01$, $SE_{ELL} < 0.01$; $\beta_{IEP} = -0.01$, $SE_{IEP} = 0.01$). However, there were significant interactions ($ps < 0.01$) for social-learning behaviors ($\beta_{IEP} = -0.03$, $SE_{IEP} = 0.01$; $\beta_{IEP} = -0.06$, $SE_{IEP} = 0.02$). While across ELL and IEP status, children were more likely to engage in social-learning in child-directed experiences compared to teacher-directed, the magnitude of the differences was larger for children not identified as ELL compared to their ELL-peers and for children without an active IEP compared to their peers with an IEP. Typically developing children were more likely to engage with their peers during child-directed experiences than both of the other designated groups of children.

DISCUSSION

In this paper, we have presented data on the entering EF skills of children who are English language learners and children who have a diagnosed special need or disability and thus an Individualized Education Plan. All children were members of a full-school-day pre-k program serving children from low-income families and housed in elementary schools. All the classrooms were taught by a licensed teacher and an aide; the focus was supposed to be on learning skills to be better prepared for entering and being successful in kindergarten.

We found, as others have, that both ELL children and children with an IEP enter the formal pre-k learning environment with significantly lower EF skills than their typically developing, English-speaking peers. For children who are classified as ELL, poor English language skills likely contributed to their lower EF performance. The children scored highest and most similar to their English-speaking peers on the one EF measure that

TABLE 4 | Children's classroom behaviors by learning setting and ELL and IEP status.

Variable	Teacher-directed	Child-directed	Cohen's D ES
Full sample			
Level of involvement (Rating)	2.63 (0.17)	2.89 (0.35)	−0.91**
Sequential behaviors	0.36 (0.15)	0.20 (0.15)	1.10**
Social learning interactions	0.08 (0.08)	0.18 (0.17)	−0.78**
Unoccupied/Disruptive	0.06 (0.07)	0.06 (0.08)	−0.04
ELL			
Level of involvement (Rating)	2.66 (0.32)	2.9 (0.31)	−0.79**
Sequential behaviors	0.36 (0.15)	0.20 (0.15)	1.09**
Social learning interactions	0.08 (0.09)	0.17 (0.15)	−0.73**
Unoccupied/Disruptive	0.05 (0.07)	0.06 (0.07)	−0.02
Non-ELL			
Level of involvement (Rating)	2.61 (0.34)	2.87 (0.37)	−0.71**
Sequential behaviors	0.36 (0.15)	0.19 (0.16)	1.12**
Social learning interactions	0.08 (0.08)	0.20 (0.18)	−0.85**
Unoccupied/Disruptive	0.06 (0.08)	0.06 (0.08)	−0.03
Active IEP			
Level of involvement (Rating)	2.58 (0.34)	2.85 (0.4)	−0.73**
Sequential behaviors	0.35 (0.15)	0.18 (0.13)	1.18**
Social learning interactions	0.07 (0.17)	0.15 (0.15)	−0.47**
Unoccupied/Disruptive	0.07 (0.08)	0.07 (0.09)	0.02
No IEP			
Level of involvement (Rating)	2.68 (0.33)	2.92 (0.38)	−0.66**
Sequential behaviors	0.38 (0.15)	0.21 (0.14)	1.13**
Social learning interactions	0.08 (0.08)	0.21 (0.08)	−1.64**
Unoccupied/Disruptive	0.05 (0.07)	0.06 (0.1)	−0.05

The teacher-directed setting is the reference group (negative standardized mean difference effect sizes (ES) indicate lower scores for the reference group). Level of Involvement Likert ratings range from 1 (low involvement) to 5 (high involvement). Descriptives for other variables are the proportion of observed sweeps characterized by that code. Estimates of group differences (significance and ES) control for gender and age.
$^{**}p < 0.01$.

was not language-dependent (*Copy Design*). However, being immersed in an English-speaking classroom for the pre-k year was not associated with strong gains on the other EF measures; the gains of ELL children were significantly less than those of other children. Similarly, children with an IEP scored lower than other children initially and again at the end of pre-k, making significantly less gain on these measures.

The continued poor performance of both groups of children (ELL and those with disabilities) should be of concern. It appears that the EF skills of inhibitory control, working memory, and attention shifting may be critical for children to engage and meaningfully gain from formal learning environments. Pagani et al. (2012), Morgan et al. (2019), and Finders et al. (2021) similarly demonstrate the importance of entering EF skills for kindergarten achievement as well as learning beyond kindergarten. Of importance is the issue of whether these skills can be improved through intervention or enhanced pre-k classroom environments before kindergarten.

We observed all children three times across the year, examining the important classroom interactive behaviors of the level of involvement, engagement in sequential/goal-oriented activities, and participation in social learning interactions (associative and cooperative interactions) as well as off-task behaviors. For these behaviors children who were English language learners distinguished themselves from children with disabilities. ELL children participated in the classroom significantly more than children who were English speaking. They were rated as more involved, participated in the more demanding sequential learning tasks, and were more often interacting with peers but were seldom observed unoccupied. In great contrast, children with a diagnosed disability were rated as the least involved of all the children. They did not engage in demanding learning tasks or with their peers as often. Moreover, they were the most likely to be observed unoccupied or disruptive.

It is important to remember that despite these group differences, our data suggest that the EF skills children have already developed when they enter the pre-k classroom will predict each of the four classroom behaviors, regardless of IEP and ELL status.

It seems to be especially difficult for children with lower EF skills to occupy themselves productively in the classroom. Similarly, when these children are engaged with learning opportunities lower EF skills are associated with lower levels of involvement. This could be because of the children's being more distractible or it could be because of a less well-developed attention span. These findings are particularly important for children with special needs because they are coming into the classroom with poorer skills in all the executive function skills we measured. Children's specific diagnoses, in this case primarily language delay, may not convey the other developmental difficulties they have that could prevent them from benefitting from the classroom experience. Poorer skills in attention, working memory, and inhibitory control appear to be associated

with children being less participatory with peers and teachers in social interactions. These children did not engage with the kinds of sequential materials that could help expand their attention and working memory skills, and they seem to have difficulty becoming highly involved in classroom activities. Consequently, the lack of these quality interactions does not bode well for the children's future development.

While the present study extends our current understanding of how EF skills impact the experiences of children in early care and education settings by examining relations across children who are English language learners and children who have been diagnosed with special needs, there are important study limitations. First, as all measures of EF skills were administered in English, it is hard to disentangle the effects of providing directions in English from the EF skills. To better understand the EF skills of ELLs future research must consider the delivery of assessments in a child's home language. The study is also limited by an inability to examine if findings vary across the category of a child's diagnosed special need. Unfortunately, study schools only indicated the presence of an IEP, not the reason for the plan. Future research is needed to better understand the development and classroom experiences of children based on their unique neurodevelopmental needs.

Notwithstanding these limitations, it seems clear that teachers may not be prepared for children who need this much help in finding involving things to do in the classroom or know how to create activities that will stimulate and hold children's attention. In a relevant study of family interactions and the longitudinal development of EF skills, Hughes and Ensor (2009) found that the most facilitative adult behaviors for the development of EF involved scaffolding, meaning asking open-ended questions, and providing praise, encouragement, and elaborations during structured activities. These would appear to be the kinds of behaviors teachers could employ during child-directed activities when they have more opportunities to interact individually with children. However, an Australian study concluded that while there were many opportunities for children to learn, particularly during free-play and center routines, opportunities will not result in changed developmental trajectories unless the childcare and education workforce are able to implement instructional strategies that have been proven to be successful for this population (Kemp et al., 2013; Watson et al., 2016). In their Portuguese study, Coelho et al. (2019) concluded that teachers were not taking advantage of the full potential of free play and centers as opportunities for children with disabilities to interact and learn.

How teachers are to learn these skills, however, is an important question that has a significant impact on the design of teacher training programs and in-service professional learning. Teachers may not receive the necessary preparation for providing the kind of individualized attention children with disabilities need in the classroom setting, particularly as they are coming into the classroom with less well-developed EF and self-regulatory skills. The same holds true for those classified as ELL, particularly in states where this population is relatively new. It is necessary to evaluate the certification requirements of early education teachers to confirm that pre-k teachers are trained in developmentally appropriate practices to support the individual and social-cultural needs of their students. Moreover, ongoing professional learning must be provided to teachers that aligns with expanding knowledge of the science of how children learn. As the U.S. increases funding for pre-k classrooms and these settings become common for children who are learning English and those with mild disabilities, much more attention is needed on how to make these settings facilitative of the development of skills like those related to EF. There is good evidence these skills are critical for long-term school success.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Protections Program, Vanderbilt University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

Both authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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