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Class size and teacher effects on non-cognitive outcomes in grades K-3: a fixed effects analysis of ECLS-K:2011 data

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Abstract

This study examines the association between class size, teacher characteristics and five non-cognitive student outcomes (i.e., self-control, interpersonal skills, approaches to learning, externalizing and internalizing problem behaviors) in grades K-3. Individual fixed-effects, that control for observed and unobserved time-invariant factors, including student and school time-constant variables, are employed to analyze national data from the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011). Results suggest a significant linear association between reducing class size and interpersonal skills. Teacher experience is saliently, positively and significantly related with student self-control, interpersonal skills, and approaches to learning, and negatively associated with externalizing problem behaviors. Teacher education and certification were not associated with any of the five non-cognitive outcomes. Changing schools had a negative effect on student's self-control.

Keywords: Class-size, Teacher characteristics, Non-cognitive skills, Fixed effects estimation, ECLS-K:2011

Helping children attain fundamental cognitive skills (i.e., learn the essentials of reading, writing and arithmetic) in early grades is a paramount objective of schooling. Although obtaining and improving children's basic cognitive skills at the beginning of school is crucial, cultivating children's non-cognitive skills (e.g., social, emotional skills and approaches to learning) is also important. Social skills are learned behaviors that children utilize to facilitate interactions with others to evoke positive responses and deter negative responses (Gresham & Elliott, 1990). Research has suggested that social skills are associated with increased engagement in learning and ultimately with student achievement (Elliott et al., 2001; Gresham & Elliott, 1990; Wentzel, 1993). Similarly, approaches to learning are behaviors and skills that play a significant role in early childhood development and learning and are theorized to have a positive impact on children's thinking processes and behaviors conducive to school readiness and success (Kagan et al., 1995). In fact, empirical research has documented that increases in approaches to learning correspond to improvements in learning skills and behaviors required for school success (Atkins-Burnett, 2007; Ribner, 2020).

Evidence about the significance of non-cognitive skills and behaviors on students' academic readiness and success is mounting (Jones & Doolittle, 2017). Researchers have argued that social and emotional learning is at the core of schooling (Durlak et al., 2015). Empirical research has supported the notion that cognitive and non-cognitive skills are related and students with higher levels of achievement also exhibit higher levels of non-cognitive skills (Gabrieli et al., 2015). Other researchers have found that social, emotional learning skills facilitate academic performance (Wentzel, 1993; Zins et al., 2004). More recent research has also found that specific non-cognitive skills, such as conscientiousness, self-control, grit, and growth mindset are associated with attendance and student test-score gains in middle school (West et al., 2016). Other empirical evidence has pointed out that non-cognitive skills and behaviors have lasting benefits into adulthood and are important correlates of educational attainment, employment and labor market performance, and health in young adults (Chetty et al., 2011; Heckman et al., 2006; Jackson, 2012; Jones et al., 2015; Levin, 2012). Further, approaches to learning have been acknowledged as a notable factor of school readiness and success and specific components of approaches to learning such as self-regulation and sustainable attention have been identified as important factors contributing to school achievement and readiness (Duncan et al., 2007; Eisenberg et al., 2010).

In summary, social and behavioral skills have been identified as important factors associated with academic success in elementary school grades and early childhood in particular has been identified as the most malleable stage for shaping such non-cognitive skills (DiPrete & Jennings, 2012; Ramey & Ramey, 1998). It seems sensible then to postulate that non-cognitive skills are as important as cognitive skills in children's development, learning and success in primary education. From a child-development perspective, a crucial phase for fostering social and emotional ability and skills is during the early school years (Webster-Stratton & Reid, 2004). This is the period where young children begin formal schooling and go through the transition from home to school. During the early grades students become acquainted with school and classroom routines and school expectations, form work habits, acquire knowledge and learn how to socialize in the school environment. It has been theorized that the ways in which children develop their social and emotional competence in dealing with demands and challenges in the schools, predict their future performance in study, work, and life (Entwisle & Alexander, 1993). Hence, assisting young children to manage emotions and behaviors to get along with peers and teachers, make friendships, follow classroom rules and do well in school is a crucial endeavor especially in early grades (Gresham et al., 2001; Webster-Stratton & Reid, 2004). In fact, youth who experience difficulties in social skills and behaviors may be at risk of school failure (Gresham et al., 2011; Webster-Stratton & Reid, 2004).

Researchers have claimed that to increase students' bonding, motivation, and achievement while at the same time decrease disruptive problem behaviors it is imperative to teach and strengthen non-cognitive skills during early grades (Durlak et al., 2011; Levin, 2012). The majority of teaching and learning in schools takes place in classrooms where students acquire knowledge and learn social skills and behaviors through learning activities and interactions with their teachers and their peers (Jones et al., 2017). That is, the classroom environment, including class size and the two main agents in the classroom, the teachers and the students, plays a fundamental role in students' acquisition of

non-cognitive skills particularly in early grades (Jones et al., 2017). Class size reduction in particular, has been proposed as a promising school mechanism for optimizing the learning environment in the classroom and for promoting social and emotional learning (Dee & West, 2011; Finn, 2019; Smith & Glass, 1980). More recent work also has reported class size effects (i.e., up to 15 students in a classroom) on social, emotional outcomes (Bowne et al., 2017).

Small size classes help teachers reduce time spent on disciplinary and class management matters and consequently devote more time on effective instruction, learning activities, and individualized instruction and personalized processes (Anderson, 2000; Burke, 1986; Finn, 2019; Odden, 1990; Rice, 1999; Stasz & Stecher, 2000). Early research about classroom practices in small classes indicated amplified individualized instruction, student participation, and higher levels of effective teaching (Smith & Glass, 1980). More recent research suggested that in a small class environment students may exhibit better behaviors and may engage more in learning than their peers in large classes (Finn, 2019). Smaller classes may also increase the sense of the classroom community and foster a caring classroom climate where students feel appreciated (Finn, 2019). This sense of belonging may establish better relationships among students and between students and teachers and may result in a more cooperative environment. Hence, it is plausible to theorize that small classes may improve social skills and behaviors.

Moreover, research has established that teachers are a crucial agent in the classroom who can contribute considerably to student outcomes (Nye et al., 2004; Wayne & Youngs, 2003). Previous work has indicated that teacher characteristics (e.g., experience) can affect children's learning and development (Dee & West, 2011; Ehrenberg et al., 2001). For instance, experienced teachers may be able to manage classrooms more efficiently and save, as a result, time to create a more collegial and engaging classroom atmosphere, to strengthen effectiveness of instruction, to increase the quality of communication in the classroom, and to have more individualized interactions with students (Blatchford et al., 2011; Brophy, 2000).

To date, research evidence about the effects of small classes and teacher characteristics has focused mostly on cognitive domains, while research on the association between class size, teacher characteristics and non-cognitive student outcomes has been largely overlooked. Consequently, the objective of the present study is to examine the relationship between class size, teacher characteristics and non-cognitive student outcomes using data from a recent, rich, longitudinal, large-scale study that followed a cohort of kindergarteners through elementary school grades in the early 2010s in the U.S. Class size and three teacher characteristics (i.e., teacher education, teacher certification and teacher experience) are the main independent variables (Nye et al., 2004; Wayne & Youngs, 2003). The dependent variables are five non-cognitive student outcomes: self-control, interpersonal skills, approaches to learning and externalizing and internalizing problem behaviors. Individual fixed effects estimation that eliminates bias ascribable to time-invariant observed and most importantly unobserved or unmeasured variables in longitudinal analyses is employed (see Wooldridge, 2010).

The current study is structured as follows. First, we review the literature about the relationship between class size, teacher characteristics and cognitive and non-cognitive student outcomes. Second, we describe in detail the significance of the present study.

Third, we delineate the methods utilized including data, variables and statistical analyses. Fourth, the results are summarized and discussed. Fifth, a discussion of the main findings is provided accompanied by the limitations of the present study and future directions of research. Finally, concluding remarks are offered.

Review of the literature

Class size

Cognitive outcomes

Cognitive outcomes are regularly represented by student performance in standardized tests. As a result, a vast body of research about class size effects is linked to student achievement. The last 40 years several studies examined the effects of class size on student achievement (e.g., Glass & Smith, 1979; Nye et al, 2000). A noticeable study about class size effects on student achievement was the Tennessee class size experiment also known as Project STAR (Student Teacher Achievement Ratio) which was conducted in the state of Tennessee between 1985 and 1989 (Finn & Achilles, 1990; Krueger, 1999; Mosteller, 1995; Nye et al., 2000). Evidence from analyses of Project STAR data has consistently indicated that students in small classes had on average significantly higher mathematics and reading achievement than students in regular size classes (Krueger, 1999; Mosteller, 1995; Nye et al., 2000).

Several other studies have analyzed non-experimental, observational data to examine class size effects on student achievement. For instance, Akerhielm (1995) found that students in smaller classes had on average higher achievement in science and history than students in larger classes in eighth grade. Pong and Pallas (2001) found that students in smaller classes had on average higher mathematics achievement than their peers in larger classes in eighth grade. Hoxby (2000) reported non-significant class size effects on student outcomes in fourth and sixth grades in Connecticut. Analyses of data from Minnesota however, indicated statistically significant class size effects on student achievement (Cho et al., 2012).

Prior research also evaluated the association between class size and student achievement in European countries (e.g., Pong & Pallas, 2001; Wößmann, 2005). These studies stated non-significant class size effects on mathematics achievement. A more recent study investigated class size effects on mathematics scores in fourth and eighth grades in Cyprus and also reported non-significant findings (Konstantopoulos & Shen, 2016). Other recent research estimated class size effects on mathematics and reading achievement in fourth-grade in various European countries and found by and large that class size reduction was not associated consistently with student achievement (Li & Konstantopoulos, 2016; Shen & Konstantopoulos, 2017).

Additionally, many studies have investigated the effects of class size on student achievement in European countries using econometric methodology. For instance, Angrist and Lavy (1999) examined the effects of small classes on fourth- and fifth grade reading and mathematics scores in Israel and reported significant effects in fifth grade. Krassel and Heinesen (2014) reported significant class size effects on students' 10th-grade grade point average in Denmark. Browning and Heinesen (2007) also found that small class membership in eighth grade in Denmark had a positive impact on students' years of education and high school graduation. In Sweden, Lindahl (2005) reported that

students who were in small classes in sixth grade had on average higher mathematics scores than their peers in larger classes.

The impact of smaller classes on student achievement has also been estimated in Asian and Latin American countries. In Japan, for example, Akabayashi and Nakamura (2014) found a significant and positive impact of small classes on language scores in sixth grade. Research in secondary schools in Bangladesh however discovered that as class size increased, performance on secondary school certificate exam scores also increased (Asadullah, 2005). Lastly, prior work showed significant and considerable class size effects on mathematics and language scores in third grade in Bolivia (Urquiola, 2006). In particular, Urquiola (2006) found that a reducing class size by one standard deviation improves scores by nearly 0.30 standard deviations.

Although findings from Project STAR consistently pointed to positive effects of small classes on student achievement, findings obtained from analyses of observational and quasi-experimental data have been inconsistent. This inconsistency may be attributed to differences in countries (e.g., U.S., European, Asian countries), education level (e.g., primary, secondary), unit of analysis (e.g., student-level, school-level data), subject area (e.g., reading, mathematics), outcome measures (e.g., standardized scores, GPA), and class size measure (e.g., class size, pupil/teacher ratio).

Non-cognitive outcomes

Social skills typically refer to behaviors about controlling temper, following classroom rules and getting along with peers (Gresham et al., 2011). Approaches to learning entail behaviors and skills that students employ as they partake in learning activities (U.S. Department of Health and Human Services, 2019). Generally, non-cognitive skills capture an extensive spectrum of skills that incorporate behaviors, feelings, and thinking processes that evolve during school years and throughout the lifetime (Borghans et al., 2008; DeAngelis, 2021; Garcia, 2016). Some studies have provided more specific definitions of non-cognitive skills that include problem solving, social skills, persistence, self-control, academic confidence, teamwork, creativity, etc. (Garcia, 2016; Rothstein et al., 2008). Other research has identified the importance of certain components of approaches to learning such as self-regulation, persistence to complete a task, and impulsivity management (Costa & Kallick, 2008; McClelland et al., 2014; Mokrova et al., 2013). Our study used five non-cognitive student outcomes, namely self-control, interpersonal skills, approaches to learning, and externalizing and internalizing problem behaviors (see details in the methodology section).

An early meta-analytic review of the class size literature conducted in 1980 synthesized 59 studies that had examined the relationship between class size and non-achievement based outcomes, such as interpersonal attention, engagement, quality of instruction, teacher attitude, and school climate and indicated positive effects of class size reduction on these outcomes (see Smith & Glass, 1980). More recently, Dee and West (2011) reported that being in a smaller class was associated with higher levels of school engagement in eighth grade and subsequent grades. Improvements of non-cognitive skills such as learning motivation and school engagement have also been reported for students who attended smaller size classes (Blatchford et al., 2011). Fredriksson et al. (2013) revealed long-term effects of small class membership in primary school on

students' non-cognitive skills at age 13 and Alivernini et al. (2020) found that attending a small class is associated positively with students' psychological well-being. Another recent study found that small classes had significant and positive effects on enjoyment in learning mathematics in several European countries (Shen & Konstantopoulos, 2021). Although non-cognitive skills have been recognized as essential factors associated with academic and life outcomes (Heckman et al., 2006; Kautz et al., 2014; Lindqvist & Vestman, 2011), by and large the evidence about the effects of class size on non-cognitive student outcomes in early grades is sparse.

Teacher characteristics

It is generally acknowledged that teachers play a fundamental role in promoting student learning (Nye et al., 2004; Rivkin et al., 2005; Wayne & Youngs, 2003). Prior research has documented that teacher instruction or what teachers do in the classroom is directly related with student outcomes (Good & Brophy, 1987; Konstantopoulos & Sun, 2014). However, overall, research evidence about the association between teacher characteristics and student achievement has been mixed. Some reviewers of the literature have reported that teacher characteristics (e.g., education, experience) are not consistently related with student achievement (e.g., Hanushek, 1986). Other reviewers however have suggested that teacher experience and teacher education are important determinants of student achievement (Greenwald et al., 1996). The contradictory results in these review studies stemmed from differences in the samples of studies that were included in the reviews (i.e., differences in the data synthesized) and in the statistical tools used to analyze the data (e.g., meta-analytic methods versus vote counting). Nonetheless, teacher experience, in particular, has been identified as a strong predictor of student achievement. For example, early work on teacher effects found that teacher experience is associated with student achievement (Murnane & Philips, 1981). Other studies have also indicated a positive association between teacher experience and student achievement (Clotfelter et al., 2010; Nye et al., 2004). The teacher's level of education has also been theorized to be correlated with student outcomes both short- and long-term (Lee, 2018). Previous work has also reported a positive association between teacher certification and student achievement (Clotfelter et al., 2010; Goldhaber & Brewer, 2000; Wayne & Youngs, 2003).

With regard to teacher effects on non-cognitive outcomes, research has suggested that the effects teachers have on social, behavioral skills are larger than those on student achievement and that teachers who are skilled in improving student achievement are not necessarily as successful in enhancing social behavioral skills (Jennings & DiPrete, 2010). More recently, a study reported significant and positive teacher effects on students' motivation (Ruzek et al., 2015). Other recent research reported positive teacher effects on students' attitudes such as self-efficacy in mathematics and on students' growth mindset, grit, and effort in the classroom (Blazer & Kraft, 2017; Kraft, 2019).

The present study

Social skills and approaches to learning are considered key facilitators of school performance, readiness and success (Atkins-Burnett, 2007; Li-Grining et al., 2010; Duncan et al., 2007; Ribner, 2020). Research has shown that improvements in non-cognitive

skills are linked to improvements in cognitive outcomes during school years (McClelland, et al., 2017). There is also evidence of long-term effects of non-cognitive skills in adulthood (Gabrieli et al, 2015; Heckman et al., 2006; Kautz et al., 2014; Lindqvist & Vestman, 2011). Thus far, multiple empirical studies have examined extensively teacher and class size effects on cognitive student outcomes (e.g., Angrist & Lavy, 1999; Finn & Achilles, 1990; Krueger, 1999; Nye et al., 2004; Rivkin et al., 2005). Nevertheless, there is a dearth of studies in the literature that examine the impact of teacher and class size effects simultaneously on non-cognitive student outcomes in early grades.

The present study fills in that literature gap and provides empirical evidence about the effects class size and teachers have on non-cognitive student outcomes. The results of this study aspire to enhance understanding of the factors that contribute to the development of social skills and behaviors and ultimately lead to school success. In this study teacher effects are gauged through three observed teacher characteristics: teacher education level, years of teaching experience and certification. All three variables had been found to be correlates of cognitive outcomes in prior work (e.g., Clotfelter et al., 2010; Nye et al., 2004; Wayne & Youngs, 2003). Information about class size was provided by teachers and was reported in the spring of each grade.

To summarize, there are three gaps in the literature. First, the evidence about small class effects on non-cognitive student outcomes especially on the aspect of students' social and emotional skills in education has been minimal, with very few exceptions (e.g., Dee & West, 2011; Shen & Konstantopoulos, 2021). Second, there is a considerable scarcity of empirical evidence about teacher effects on non-cognitive student outcomes, with few exceptions (e.g., Araujo et al., 2016; Kraft, 2019). Third, although teachers and classroom context (e.g., class size) are in principle coupled to shape jointly classroom processes and ultimately student learning, class size effects and teacher effects are typically examined separately in the literature. We argue that class size and teacher effects work in concert, and therefore it seems judicious to investigate class size and teacher effects simultaneously.

The present study addresses these literature gaps and sheds new light on the associations between class size, teacher characteristics (i.e., teacher education level, experience and certification) and non-cognitive student outcomes (i.e., self-control, interpersonal skills, approaches to learning, externalizing and internalizing problem behaviors). Specifically, because the acquisition of non-cognitive abilities relies upon the social context in the classroom, the overarching goal of this study is to examine whether classroom context, captured by class size, and salient teacher characteristics are associated with non-cognitive student outcomes in early grades (K-3). The general hypotheses are that children in classrooms with fewer students who have teachers who are certified and have higher levels of education and experience, should have higher levels of non-cognitive abilities than other students (Dee & West, 2011; Jennings & DiPrete, 2010; Nye et al., 2004).

In summary, the present study contributes to the literature in four ways. First, the effects of class size and teacher characteristics on non-cognitive skills are examined concurrently. Second, with regard to class size, the present study estimates both linear and non-linear associations between class size and non-cognitive student outcomes. To estimate the linear relationships between class size and non-cognitive

student outcomes class size was used as a continuous variable (i.e., the actual number of students in a classroom as reported by the teacher). To capture non-linear relationships between class size and non-cognitive student outcomes we modeled class size via three binary indicators with different thresholds (i.e., a maximum number of 20, 17 or 15 students in the classroom). These class size threshold points had been mentioned in previous research (e.g., Bowne et al., 2017; Krueger, 1999; Nye et al., 2000; Rice, 1999) and had been used in various class size initiatives in states like California and Wisconsin. Third, this study uses a suitable statistical method to analyze longitudinal data with repeated measurements collected each year for a few primary grades. In particular, individual fixed effects estimation are applied to eliminate all time-constant effects (observed and unobserved) and produce high internal validity estimates for class size and teacher characteristics. Fixed effects estimation is especially appropriate for controlling for unobserved time-constant effects in panel data (Wooldridge, 2010) and has been utilized successfully in empirical work in economics (e.g., Clotfelter et al., 2010; Schurer & Yong, 2012). Details on the advantage of applying fixed effects estimation is provided in the statistical analysis section. Fourth, to determine the associations between class size, teacher characteristics and non-cognitive student outcomes in early grades we analyzed data from a recent, longitudinal, large-scale study conducted in the U.S. in the 2010s, namely the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011). As a result, our findings offer timely, updated evidence about class size and teacher effects on non-cognitive outcomes in grades K-3. In addition, because we analyzed ECLS-K:2011 national data our estimates should have high external validity than those obtained from small, convenience samples.

Methodology

Dataset

ECLS-K:2011 provides the most recent longitudinal information about children's development in early grades in the U.S. A national probability sample of kindergarten students of diverse socio-economic and ethnic backgrounds was followed for several grades in elementary school. Data were collected from several sources namely, students, parents, teachers and schools. ECLS-K:2011 data are appropriate for the purpose of the present study because they include information about class size, teacher characteristics and children's non-cognitive social, emotional and behavioral skills. We utilized four waves (grades) of the longitudinal data that were collected for each grade every spring (i.e., kindergarten through third grade). We focused on grades K-3 because in these four grades only one teacher was assigned in each classroom. Therefore, important information about class size, teacher characteristics and non-cognitive outcomes was provided by one teacher only. Starting in fourth grade however, information on the outcomes and main predictors was provided by different teachers (e.g., reading and mathematics teachers), which complicates data analyses (Tourangeau et al., 2018). The data entailed repeated measurements of the outcome variables across grades, which allowed us to conduct individual fixed effects analysis. The ECLS-K:2011 public use dataset was utilized.

Dependent and independent variables

The dependent variables included five non-cognitive outcomes that were constructed by the ECLS-K:2011 team of experts. Five dependent variables were used: (a) self-control, (b) interpersonal skills, (c) approaches to learning, (d) externalizing and (e) internalizing problem behaviors. All five outcomes were collected from teachers' questionnaires for each student in each grade. For each non-cognitive outcome, a higher value suggests a higher level of a particular skill or behavior. Three of the outcomes (i.e., self-control, interpersonal skills, approaches to learning) indicated positive social, emotional, and behavioral skills. The self-control scale included four items that captured a child's ability to control temper, respect others' property, accept peers' ideas, and handle peer pressure (see Tourangeau et al., 2013). The interpersonal skills scale included five items that rated a child's ability to get along with others, form and maintain friendships, help other children, show sensitivity to others' feelings and express feelings, and present ideas and opinions in positive ways (Tourangeau et al., 2013). The approaches to learning scale included seven items that rated a child's skill in organizing belongings, showing eagerness to learn new things, working independently, easily adapting to changes in routine, persisting in completing tasks, paying attention, and following classroom rules (Tourangeau et al., 2013). The two remaining outcomes (i.e., externalizing and internalizing problem behaviors) indicated negative social and emotional skills. In kindergarten the externalizing problem behaviors scale included five items that measured arguing, fighting, getting angry, acting impulsively, and disturbing ongoing activities (Tourangeau et al., 2013). In the first, second and third grades however, the externalizing problem behaviors scale included six items. The sixth item added measured the child's tendency to talk when the child was not supposed to be talking (Tourangeau et al., 2018). The internalizing behaviors scale included four items about exhibiting anxiety, loneliness, low self-esteem, and sadness (Tourangeau et al., 2013). The ECLS-K:2011 items measuring students' social skills and behaviors (i.e., self-control, interpersonal skills, externalizing and internalizing problem behaviors) are based on items from the Social Skills Rating System (Gresham & Elliott, 1990). The items of the approaches to learning scale were developed for the ECLS-K studies exclusively (Tourangeau et al., 2018).

Each item in these five social and emotional skills and approaches to learning scales followed a Likert-type four-point scale [never (1), sometimes (2), often (3), and very often (4)]. For each of these five non-cognitive measures the mean rating across the items for each student was computed in order for each non-cognitive outcome to be approximately on a continuous scale. The reliability coefficients of these scales (excluding the approaches to learning scale) ranged between 0.76 (internalizing problem behaviors in the spring of first grade) to 0.89 (externalizing problem behaviors in kindergarten) (Tourangeau et al., 2013, 2018). The reliability coefficient for the approaches to learning scale remained constant (i.e., 0.91) across grades (Tourangeau et al., 2018). All five non-cognitive outcomes were available in all four grades (K-3) and were constructed using the same questions. As a result, all non-cognitive outcomes were comparable across grades.

The main independent variables were class size and teacher characteristics. The teacher reported class size variable was continuous, that is, in each grade the teacher reported the actual number of students in his or hers classroom. We also coded class size using binary indicators with upper bounds of 20, 17 or 15 students in the classroom.

The three teacher characteristics were represented by the highest-level of education of the teacher, teacher certification, and years of teacher experience. Teacher gender and race were suppressed in the public use dataset and consequently were not utilized in the analysis as individual predictors. However, assuming these variables are time-invariant their effects should be captured by the fixed effects methodology. The covariates we added in our models controlled for time or grade effects and students' changing schools in the spring of first, second and third grades. In particular, the dummy variables about changing schools indicated whether in the spring of first, second or third grades at least four students who participated in ECLS-K:2011 moved into a destination school (see Tourangeau et al., 2018). According to the ECLS-K:2011 manual, this move occurred by and large when a school provided education only through a specific grade (e.g., first grade) or when a school closed (see Tourangeau et al., 2018).

Statistical analysis

We employed individual fixed-effects estimation because it controls effectively for all observed and most importantly unobserved time-constant variable effects in longitudinal analyses. In particular, the individual fixed-effects methodology addresses adequately potential omitted variable bias due to time-invariant unobserved variables (Wooldridge, 2010). This methodology is an effective statistical tool that can lessen bias due to selection or confounding in longitudinal data (Gunasekara, et al., 2014). The main advantage of the method is that it accounts for a range of time-invariant variables. This is especially important for unobserved variables related with student background, home environment, socioeconomic status, personality traits and learning processes at home that are time-constant. When such effects are not taken into account in statistical analyses of panel data (i.e., when these variables are not included in the linear model), confounding or omitted variable bias is possible and in such case the estimates of class size and teacher effects would be biased. Fixed effects estimation appropriately eliminates bias related to omitted variables that remain constant over time. Specifically, fixed effects estimation allows measured and most importantly unmeasured time-constant variables to be correlated with the variables that are included in the linear model and thus the coefficients of the main predictor variables (e.g., class size, teacher experience) are appropriately adjusted to facilitate unbiased inference.

In our statistical analyses it was important to take into account the complexity of the sample design of ECLS-K:2011. In particular, ECLS-K:2011 adopted a three-stage design where geographic areas throughout the U.S. were sampled at the first stage (cluster sampling), schools within these geographic areas were sampled in the second stage (cluster sampling) and students within the sampled schools were sampled at the third stage. Multi-stage designs such as the one adopted in ECLS-K:2011 encompass two main features. The first important feature is the unequal probability of selection of units that can take place at different stages of the sampling design. Specifically, to assure adequate representation of minority students in the sample, such students (e.g., Latino students) may be selected with a higher probability than other students (e.g., white students). Similarly, to ensure representation of small, rural schools in the sample, such schools may be selected with a higher probability than larger schools in urban or suburban areas. To address this unequal probability of selection issue, we conducted analyses using weights

provided by ECLS-K:2011. These weights also take into account unit nonresponse effects. In particular, we used the student-level sampling weight W12AC0 from the base year (i.e., kindergarten) of ECLS-K:2011 that adjusted for nonresponse of the teacher-level questionnaire in the spring of 2011. This weight was utilized in the fixed effects estimation and in the computation of descriptive statistics of the variables of interest.

The second important feature of the complex sampling design used in ECLS-K:2011 is clustering and it is a consequence of the sampling of units that introduces between-unit variability at different stages. Our analytic sample involved conceptually two levels, namely students at the top level and repeated measurements linked to students at the bottom level. Hence, it was important in our analysis to incorporate clustering manifested in this case as between-student variability. This variability should be included in the estimation of the standard errors of the regression estimates (i.e., the standard errors of the estimates should be adjusted for clustering). There are multiple ways of adjusting the standard errors for clustering including the use of random effects estimation, design effect estimation, jackknife and Taylor series methods, etc. In STATA (the software package used in this study), analysts can also compute clustered robust standard errors which take the between-student variability and the potential heterogeneity in the residuals (also called heteroscedasticity or non-constant variation in the residuals) into account. We estimated both clustered robust standard errors and jackknife standard errors in STATA and the estimates were identical through the third decimal place. In the Tables we report the jackknife standard errors only, for simplicity.

The individual fixed-effects population equation is expressed as.

$$y_{it} = \delta_1 CS_{it} + \boldsymbol{T_{it}}\boldsymbol{\Delta}_2 + \delta_3 CH_{it} + \boldsymbol{G}_t\boldsymbol{\Delta}_4 + \eta_i + \varepsilon_{it}, \quad (1)$$

where y_{it} represents a dependent variable for student i in time t (i.e., each of the five non-cognitive skill variables: self-control, interpersonal skills, approaches to learning, externalizing and internalizing problem behaviors) that were measured in the spring of each grade; *CS* represents the class size variable as either a continuous or a binary variable (i.e., at thresholds of 20, 17, and 15 students per classroom); the estimate of δ_1 captures the association between class size and an outcome controlling for all other variables' effects; the row vector $\boldsymbol{T}$ represents three teacher variables, including education degree (1 indicates master's or advanced degree and 0 otherwise), certification status (1 indicates regular or standard state certificate or advanced professional certificate and 0 for incomplete certification or no certification), and teacher experience in years (total number of years of teaching experience); the estimates of $\boldsymbol{\Delta}_2$ capture the association between the teacher variables and each outcome controlling for all other variables' effects; *CH* represents changing schools in the spring of the first, second and third grades and the estimate of δ_3 captures the effect of changing schools; and the estimates of $\boldsymbol{\Delta}_4$ capture the time effects that correspond to the elements of the row vector $\boldsymbol{G}$ which represents four time points (grades K-3). In particular, three time dummies were created to represent grades 1–3 with kindergarten serving as the comparison group. These time dummies controlled for potential grade effects (i.e., differences across grades). It was important to control for these effects for a second reason, namely omitting the time dummies from the model can induce serial correlation in the residuals and affect the standard errors of the coefficients (see Wooldridge, 2010). Finally, η_i represents

the individual fixed effects and ε_{it} is the student and time residual of y_{it}. Notice that in fixed effects estimation the coefficients of all predictors included in the linear model are adjusted for fixed effects, the η_i term.

The analysis was conducted separately for each dependent variable and thus, it was repeated five times. First we conducted the analysis where class size was modeled as a continuous variable to gauge linear class size effects. Second, to estimate non-linear class size effects on each of the five non-cognitive outcomes we conducted additional three rounds of analyses and each time a binary class size variable was used. The upper bounds of small classes in these cases were 20, 17 or 15 students per classroom. We analyzed samples of students who had data in all five outcomes across all grades (i.e., each student had data on all five outcome measures across all grades, K-3). Hence, each student contributed equally to the estimation.

The statistical software package STATA was used to analyze the data. We used the "xtset" command first to create the panel data and then we used "xtreg" with "fe" to run the individual fixed effects analysis. Jackknife standard errors were computed to correct the standard errors of the coefficients for clustering. The estimates of the fixed effects analyses show how changes in class size and teacher characteristics are related with changes in the five non-cognitive outcomes over time net of covariates' effects.

Results

Summary statistics

Descriptive statistics of dependent and independent variables used in the analyses across all four grades (K-3) are reported in Table 1. Sample sizes about the total number of students and the total number of observations in grades K-3 are reported separately for each non-cognitive outcome. Overall, more than 6000 students and 24,000 repeated measurements were used in the analyses across outcomes. The means and standard deviations (in parentheses) for self-control, interpersonal skills, approaches to learning and externalizing and internalizing problem behaviors were respectively 3.219 (0.622), 3.151 (0.651), 3.093 (0.694), 1.694 (0.616) and 1.558 (0.513). That is, on average students were often applying positive behaviors with respect to self-control, interpersonal skills and approaches to learning. Across grades and outcome variables the average class size was nearly 21. Approximately 47%, 17% and eight percent of students were in small classes with a maximum number of 20, 17 or 15 students respectively. Nearly 48% of students had teachers with at least a master's or an advanced degree. About 92% of students had teachers with regular or standard state certificate or advanced professional certificate. The average teacher experience was approximately 15 years. Approximately, four percent of students changed schools in the spring of first, second and third grades and moved into a destination school. Students' sample sizes ranged from 6004 (self-control) to 6289 (approaches to learning) and the total number of observations across four grades ranged between 24,016 (self-control) to 25,156 (approaches to learning). In kindergarten 49% of the students were female, 75% were white, 14% were English language learners and five percent were in special education programs. Because these variables are time-constant, their effects were encompassed in the individual fixed effects and therefore it was not possible to estimate their effects discretely.

Table 1 Weighted descriptive statistics of variables included in analyses

	Self-control		Interpersonal skills		Approaches to learning		Externalizing behaviors		Internalizing behaviors	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dependent variables										
Self-control	3.219	0.622								
Interpersonal skills			3.151	0.651						
Approaches to learning					3.093	0.694				
Externalizing problem behaviors							1.694	0.616		
Internalizing problem behaviors									1.558	0.513
Independent variables										
Class size	20.878	4.056	20.852	4.021	20.886	4.043	20.882	4.050	20.863	4.040
Class size ($\leq$ 20 students)	0.468	0.499	0.471	0.499	0.466	0.499	0.467	0.499	0.468	0.499
Class size ($\leq$ 17 students)	0.170	0.376	0.171	0.376	0.169	0.375	0.170	0.376	0.171	0.376
Class size ($\leq$ 15 students)	0.076	0.264	0.075	0.263	0.075	0.263	0.075	0.264	0.076	0.265
Teacher education	0.485	0.500	0.485	0.500	0.483	0.500	0.484	0.500	0.482	0.500
Teacher certification	0.916	0.277	0.917	0.277	0.916	0.277	0.916	0.277	0.916	0.277
Teacher experience	14.643	9.683	14.634	9.706	14.659	9.685	14.638	9.677	14.654	9.693
Student changed school	0.041	0.198	0.042	0.201	0.042	0.200	0.042	0.201	0.042	0.200
Number of students	6004		6052		6289		6232		6149	
Number of total observations	24,016		24,208		25,156		24,928		24,596	

Sampling weight W12AC0 was used in the analyses

SD standard deviation

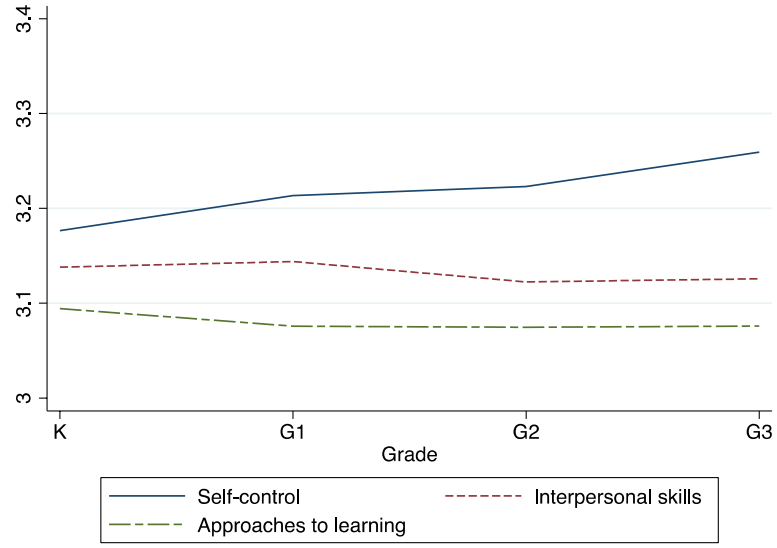

Fig. 1 Average trajectories of self-control, interpersonal skills and approaches to learning in grades K-3. Sampling weight W12AC0 was used in the analyses

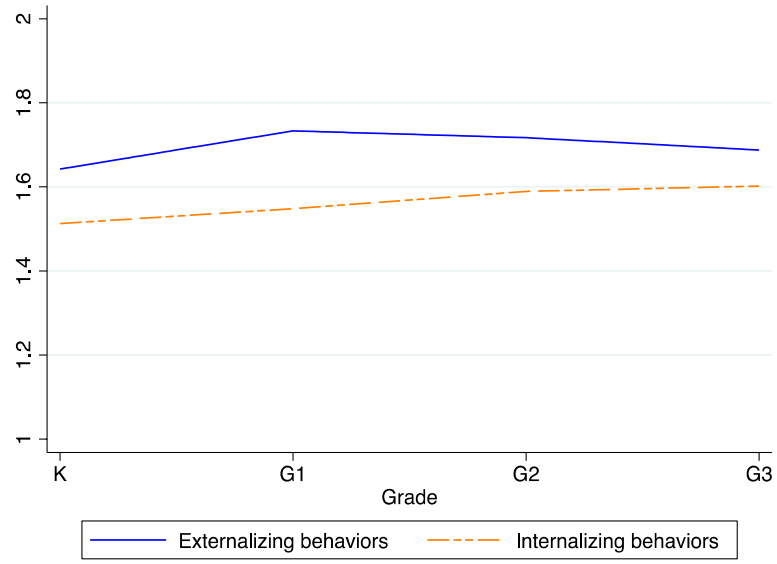

Fig. 2 Average trajectories of externalizing and internalizing problem behaviors in grades K-3. Sampling weight W12AC0 was used in the analyses

To describe how the outcome variables changed across grades K-3 we employed graphs. In particular, Fig. 1 portrays the average trajectories for self-control, interpersonal skills and approaches to learning during the four-year period. For self-control the trajectory was rather flat from kindergarten to second grade, however, some positive growth was detected from second to third grade. For interpersonal skills and approaches to learning the trajectories indicated a small decrease in means between kindergarten and third grade. The average trajectories for externalizing and internalizing problem behaviors are depicted in Fig. 2. The mean of externalizing problem behaviors increased between kindergarten and first grade and then decreased slightly through third grade.

With respect to internalizing problem behaviors Fig. 2 indicated a positive slope from kindergarten through third grade, but by and large the slope was rather horizontal.

Individual fixed effects estimates

Table 2 summarizes regression estimates in standard deviation units produced from the fixed effects analysis for each of the five outcomes. For continuous predictors the estimates are standardized regression coefficients and for binary indicator variables the estimates are standardized mean differences. A Type I error probability of 0.05 was set as the level of significance and a two-tailed test was used. The jackknife standard errors of the estimates are reported in parentheses. The regression coefficients of class size captured the linear association between class size and each of the five outcomes. Class size was significantly and negatively associated with interpersonal skills controlling for all other predictors' effects. The negative coefficient indicated that reducing class size corresponded to significant increases in interpersonal skills. All other class size coefficients were not different than zero. With respect to the teacher characteristics, teacher experience was significantly and positively related with students' self-control, interpersonal skills, and approaches to learning controlling for all other predictors' effects. That is, having a teacher with more years of teaching experience was associated with higher levels of self-control and interpersonal skills and more frequent demonstration of positive behaviors of approaches to learning. Teacher experience was also significantly but negatively related with externalizing problem behaviors net of the effects of the other predictors in the model. That is, having a teacher with more years of teaching experience was

Table 2 Standardized coefficients by outcome in grades K-3: linear class size effects

	Self-control	Interpersonal skills	Approaches to learning	Externalizing behaviors	Internalizing behaviors
Class size	− 0.005	− 0.023*	− 0.009	− 0.007	− 0.005
	(0.009)	(0.009)	(0.008)	(0.008)	(0.011)
Teacher education	− 0.009	− 0.000	0.018	− 0.003	0.028
	(0.014)	(0.015)	(0.013)	(0.013)	(0.017)
Teacher certification	0.030	0.020	− 0.010	− 0.033	− 0.030
	(0.023)	(0.024)	(0.020)	(0.021)	(0.027)
Teacher experience	0.033*	0.022*	0.032*	− 0.031*	0.001
	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Student changed school	− 0.135*	− 0.075	− 0.028	0.044	0.061
	(0.041)	(0.042)	(0.037)	(0.039)	(0.052)
Grade 1	0.015	− 0.049*	− 0.097*	0.180*	0.097*
	(0.015)	(0.015)	(0.013)	(0.013)	(0.017)
Grade 2	0.018	− 0.078*	− 0.089*	0.171*	0.185*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.017)
Grade 3	0.073*	− 0.088*	− 0.099*	0.112*	0.208*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.018)
R-squared	0.004	0.005	0.008	0.018	0.013
Number of students	6004	6052	6289	6232	6149
Total number of observations	24,016	24,208	25,156	24,928	24,596

Sampling weight W12AC0 was used in the analyses. Jackknife standard errors are reported in parentheses

* $p < 0.05$

associated with lower levels of externalizing problem behaviors. In contrast, the association between teacher experience and internalizing behaviors was not different than zero. Overall, teacher experience had a positive influence on four of the five non-cognitive outcomes. Teacher education and teacher certification however were not significantly related with any of the five outcomes.

Furthermore, students who changed schools and moved to destination schools in the spring of first, second and third grades had a significantly lower mean of self-control compared to that of other students who did not change schools, accounting for the effects of all other predictors. However, changing schools was not significantly associated with any of the remaining four outcomes. This finding is intuitive to a degree and suggests that changing schools is a disruption that impacts negatively students' self-control. The regression coefficients of time or grade effects were in congruence with the results reported in Figs. 1 and 2. For example, the self-control regression mean was positive and significant in the third grade compared to kindergarten, controlling for other predictors' effects. For interpersonal skills and approaches to learning the grade effects were negative and significant in first, second and third grades compared to kindergarten. That is, the regression means of children's interpersonal skills and approaches to learning decreased in grades 1–3 compared to kindergarten other things being constant. In contrast, the means of children's externalizing and internalizing problem behaviors increased in grades 1–3 compared to kindergarten controlling for the effects of the other predictors in the model. For these two outcomes the coefficients were positive and significant.

Tables 3, 4, 5 summarize estimates of non-linear small class effects coded in three different ways: up to 20, 17, or 15 students in the classroom. All three class-size variables were coded dichotomously and larger class size was the reference group in each case. All other variables in the model remained the same. The small class coefficients represent standardized mean differences. In all three Tables the small class coefficients were close to zero and non-significant. All other results in Tables 3, 4, 5 were similar to those reported in Table 2.

Discussion

This study investigated how class size and teacher characteristics simultaneously influence students' social, emotional skills and approaches to learning in grades K-3. We focused on social, emotional skills and approaches to learning because they are important factors of children's academic and social functioning in early grades and crucial aspects of achieving school readiness and school success (Elliott et al., 2001; Ribner, 2020). Social emotional skills and approaches to learning are also important correlates of cognitive student outcomes (i.e., improve student achievement) during school years and seem to even have lasting benefits into adulthood (e.g., higher educational attainment and wages) (Heckman et al., 2006; Li-Grining et al., 2010; Wentzel, 1993). Individual (student) fixed effects estimation was used to analyze K-3 data from ECLS-K:2011.

With respect to class size the findings suggest that reducing class size corresponds to increasing children's interpersonal skills. That is, it appears that in early grades the small class environment provides a context within which interpersonal skills can be cultivated. Other things being equal, a small size classroom may foster a class atmosphere that is

Table 3 Standardized coefficients by outcome in grades K-3: non-linear class size effects (20 students or less per class)

	Self-control	Interpersonal skills	Approaches to learning	Externalizing behaviors	Internalizing behaviors
Class size	0.001	0.021	− 0.008	0.019	− 0.015
	(0.016)	(0.016)	(0.014)	(0.014)	(0.019)
Teacher education	− 0.009	0.000	0.018	− 0.003	0.028
	(0.014)	(0.015)	(0.013)	(0.013)	(0.017)
Teacher certification	0.029	0.018	− 0.011	− 0.033	− 0.031
	(0.023)	(0.024)	(0.020)	(0.021)	(0.027)
Teacher experience	0.033*	0.023*	0.032*	− 0.031*	0.001
	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Student changed school	− 0.134*	− 0.077	− 0.028	0.043	0.062
	(0.041)	(0.042)	(0.037)	(0.039)	(0.051)
Grade 1	0.015	− 0.050*	− 0.097*	0.180*	0.097*
	(0.015)	(0.015)	(0.013)	(0.013)	(0.017)
Grade 2	0.018	− 0.082*	− 0.091*	0.170*	0.183*
	(0.015)	(0.016)	(0.014)	(0.014)	(0.017)
Grade 3	0.072*	− 0.093*	− 0.103*	0.112*	0.204*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.018)
R-squared	0.004	0.004	0.008	0.018	0.013
Number of students	6004	6052	6289	6232	6149
Total number of observations	24,016	24,208	25,156	24,928	24,596

Sampling weight W12AC0 was used in the analyses. Jackknife standard errors are reported in parentheses

* $p < 0.05$

more accepting and caring compared to a larger classroom. Along these lines, in smaller size classes it may be more likely to form a cohesive group of students than in larger classes. Within a cohesive group that is accepting and caring children may be more likely to share common values, create stronger bonds with peers, maintain friendships, help their peers, and express their feelings and opinions (Finn, 2019). Besides interpersonal skills however, class size was not associated with any of the other non-cognitive outcomes. The non-linear class size effects were also non-significant and close to zero in magnitude. That is, overall, there is weak evidence of class size effects on non-cognitive outcomes with the exception of interpersonal skills. Our findings about class size effects on non-cognitive skills are somewhat congruent with findings from prior work. For example, one recent study found that students in smaller classrooms exhibit higher levels of psychological well-being at school (Alivernini et al., 2020). Another recent study reported that students in smaller classes had higher levels of enjoyment in learning mathematics, biology and chemistry than their peers in larger classes (Shen & Konstantopoulos, 2021).

In terms of teacher characteristics, our findings indicate that teacher experience has a salient effect on children's non-cognitive outcomes. In particular, teacher experience is a significant, positive predictor of students' self-control, interpersonal skills, and approaches to learning and a negative correlate of externalizing problem behaviors. The effect of teacher experience is sizable. For example, a 10-year increase in teacher experience would nearly correspond to a third of a standard deviation increase in students'

Table 4 Standardized coefficients by outcome in grades K-3: non-linear class size effects (17 students or less per class)

	Self-control	Interpersonal skills	Approaches to learning	Externalizing behaviors	Internalizing behaviors
Class size	0.025	0.040	0.031	− 0.029	− 0.026
	(0.020)	(0.020)	(0.018)	(0.018)	(0.023)
Teacher education	− 0.009	0.001	0.018	− 0.003	0.028
	(0.014)	(0.015)	(0.013)	(0.013)	(0.017)
Teacher certification	0.031	0.019	− 0.009	− 0.035	− 0.032
	(0.023)	(0.024)	(0.020)	(0.021)	(0.027)
Teacher experience	0.033*	0.022*	0.033*	− 0.031*	0.001
	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Student changed school	− 0.134*	− 0.074	− 0.028	0.044	0.060
	(0.041)	(0.042)	(0.037)	(0.039)	(0.051)
Grade 1	0.016	− 0.049*	− 0.097*	0.179*	0.096*
	(0.015)	(0.015)	(0.013)	(0.013)	(0.017)
Grade 2	0.019	− 0.080*	− 0.089*	0.167*	0.182*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.018)
Grade 3	0.074*	− 0.092*	− 0.099*	0.108*	0.204*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.018)
R-squared	0.005	0.004	0.008	0.018	0.013
Number of students	6004	6052	6289	6232	6149
Total number of observations	24,016	24,208	25,156	24,928	24,596

Sampling weight W12AC0 was used in the analyses. Jackknife standard errors are reported in parentheses

* $p < 0.05$

self-control and approaches to learning and nearly a quarter of a standard deviation increase in interpersonal skills. Moreover, a 10-year increase in teacher experience would correspond to a decrease of about 0.30 standard deviations in externalizing problem behaviors. This finding indicates that more experienced teachers play an important role in improving children's non-cognitive skills in early grades. This finding seems intuitive, because one would expect experienced teachers to be effective in classroom management and instructional practices. It is reasonable to theorize that experienced teachers are more likely to manage their classroom competently, employ instructional practices that stimulate thorough, active learning, and improve student attention, engagement and participation in learning activities (Good & Brophy, 1987; Kyriakides, 2008). Also, experienced teachers may be able to establish friendly, collegial, collaborative classroom environments where they show to their students that they care about them and make students feel valuable (Finn, 2019). Thus, experienced teachers should be better equipped to increase students' levels of positive social skills and behaviors in self-control, interpersonal skills and approaches to learning and decrease students' levels of negative social skills and behaviors in externalizing problem behaviors. This finding is consistent with results reported in a previous study where experienced teachers were more effective at teaching social and behavioral skills (Jennings & DiPrete, 2010).

Students who changed schools and moved into a destination school in the spring of the first, second and third grades had significantly lower levels of self-control compared to levels of self-control of students who did not change schools. This result seems

Table 5 Standardized coefficients by outcome in grades K-3: non-linear class size effects (15 students or less per class)

	Self-control	Interpersonal skills	Approaches to learning	Externalizing behaviors	Internalizing behaviors
Class size	− 0.009	0.045	0.001	− 0.014	− 0.002
	(0.028)	(0.028)	(0.026)	(0.026)	(0.031)
Teacher education	− 0.009	0.000	0.018	− 0.002	0.028
	(0.014)	(0.015)	(0.013)	(0.013)	(0.017)
Teacher certification	0.029	0.018	− 0.011	− 0.034	− 0.031
	(0.023)	(0.024)	(0.020)	(0.021)	(0.027)
Teacher experience	0.033*	0.022*	0.032*	− 0.031*	0.001
	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Student changed school	− 0.134*	− 0.075	− 0.028	0.045	0.061
	(0.041)	(0.042)	(0.037)	(0.039)	(0.052)
Grade 1	0.015	− 0.048*	− 0.098*	0.179*	0.097*
	(0.015)	(0.015)	(0.013)	(0.013)	(0.017)
Grade 2	0.017	− 0.081*	− 0.091*	0.169*	0.184*
	(0.015)	(0.016)	(0.014)	(0.014)	(0.017)
Grade 3	0.071*	− 0.094*	− 0.102*	0.109*	0.206*
	(0.016)	(0.016)	(0.014)	(0.014)	(0.018)
R-squared	0.004	0.004	0.008	0.018	0.013
Number of students	6004	6052	6289	6232	6149
Total number of observations	24,016	24,208	25,156	24,928	24,596

Sampling weight W12AC0 was used in the analyses. Jackknife standard errors are reported in parentheses

* $p < 0.05$

intuitive, because students who change schools may have fewer opportunities to create strong connections with their peers and develop a feeling of belongingness to their classroom and school. Thus, students who change schools may be less likely to accept their peers' ideas, handle peer pressure, and respect others' property. This finding suggests that changing schools disrupts children's chances to get along with their peers and teachers and create cohesive bonds with other children.

Limitations and future research

This study analyzed data from ECLS-K:2011, which is the most recent cycle of the longitudinal study. Results reported here provide evidence about the recent (2011 through 2014) education system in kindergarten and early elementary grades in the U.S. Nonetheless, the data were collected pre-pandemic and therefore our results may not apply precisely to schooling experiences during and post-pandemic because children's school routine was strongly disrupted for nearly two years.

Although the fixed effects methodology controls adequately for observed and unobserved time-constant variables in the model and adjusts appropriately all regression estimates, especially of the main predictors, the coefficients of observed variables (e.g., ethnicity, gender) cannot be estimated since all fixed effects, observed and unobserved, are controlled for altogether in the linear model. Moreover, while fixed effects estimation eliminates bias attributed to time-invariant variables, observed and unobserved, it does not address potential bias due to time-varying variables, especially unobserved

variables. It is unclear that we were able to control sufficiently for all relevant time-varying effects in our model. If for instance, there are time-varying effects of unobserved variables that were not included in our estimation and could change the coefficients of the main predictors in our model dramatically (e.g., alter statistical significance), our results may potentially suffer from bias.

The analytic sample used in the fixed effects estimation was restricted to student data that included information on all four grades (K-3) with respect to outcomes and predictors. Hence, it is unclear that our sample is similar of the original national sample of kindergarten students in 2010–2011 or representative of the target population (i.e., 5-year old kindergarten students in the U.S.). Although we used weights in our analyses (descriptive statistics and fixed effects estimation) to account for unequal probability of selection of units and for nonresponse, it is not obvious that we can effectively project our findings to the original target population.

Another potential limitation is that while the non-cognitive scales measured in ECLS-K:2011 incorporated several parts of social skills and approaches to learning, they did not incorporate all possible elements of social skills and approaches to learning. For example, components such as self-regulation, asking for help and cooperating well with other students and the teachers were not measured. Consequently, the non-cognitive measures used in our study do not necessarily capture the whole span of the social skills and approaches to learning constructs; instead they focus on certain aspects of the constructs as measured in ECLS-K:2011.

Future work could investigate the associations between class size and teacher characteristics and non-cognitive outcomes in middle school and high school. Further, future research could probe the associations between class size and teacher characteristics and individual elements of social skills and approaches to learning to determine whether these elements are affected similarly by class size and teacher characteristics or differently. By conducting such research projects researchers may gain a more detailed understanding about the differential impact of class size and teacher characteristics on specific components of non-cognitive outcomes.

Conclusion

Our findings suggest that class size and teacher characteristics such as experience and certification may be contributing factors to enhancing children's non-cognitive skills in early grades. Reducing class size in particular, can potentially have a twofold benefit on students in cognitive and non-cognitive domains. However, the results of this study do not show a consistent association between class size and non-cognitive outcomes. Still, it would be prudent for policy makers, when making decisions about adopting class size reduction programs, to take into consideration evidence about class size effects on both non-cognitive and cognitive student outcomes. Lastly, because changing schools seems to have a detrimental effect on student self-control, offering support mechanisms to students who change schools and assigning such students to smaller classes with experienced teachers in early grades will likely reduce the adverse effects.

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Author contributions
Both authors contributed equally to this manuscript. The order is alphabetical.

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Availability of data and materials
The ECLS-L:2011 public use data utilized in the study are available at: https://nces.ed.gov/ecls/dataproducts.asp

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
There are no competing interests.

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