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The Effects of Attending High Individual and Collective Teacher Efficacy Schools on Ninth Grade On-Track

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Abstract: Ninth grade on-track is predictive of high school graduation, more than race, socioeconomic status, and prior achievement combined. Although initiatives characterized by an intense focus on the ninth-grade year are being increasingly implemented, research has not fully documented and tested mechanisms linked to improved outcomes. Using survey and transcript-level data and causal mediation analysis, this study tests the effects of students attending high teacher efficacy (self and collective—TSE and CTE) schools on ninth grade on-track in an urban school district in a northeast state in the United States. It further examines the extent to which ambitious instructional practices, defined as culturally relevant and transformative pedagogy, mediate the effects of TSE on ninth grade on-track and how levels of supportive school culture moderate these relationships. The findings indicate that urban ninth-graders attending schools with high TSE and CTE are more likely to be on track at the end of ninth grade. Additionally, the direct effect of students attending a school with high TSE was mediated by the level of ambitious instruction. We discuss implications for teacher education (TE) and professional development.

Keywords: teacher efficacy; teacher self-efficacy; collective teacher efficacy; school culture; freshman on-track; causal mediation analysis; culturally relevant teaching; transformative education; ambitious instruction



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1. Introduction

Our study is concerned with yielding evidence on the levers that can improve secondary student (i.e., high school) outcomes. High school graduation, a critical step toward strong postsecondary options, remains abysmal in many urban schools in the United States and schools serving historically disadvantaged populations, even though nationwide rates have increased dramatically over recent decades. A body of research points to the ninth-grade year as a pivotal moment for ensuring that students are on track to graduate [1–3]. While initiatives characterized by an intense focus on ninth grade are increasingly implemented with success, research has not fully tested the mechanisms linked to improved ninth grade outcomes to aid further development, training, and replication. Teachers' belief in their capacity to improve instruction, support students, and foster engaging educational experiences is hypothesized to be a mechanism of improving ninth grade outcomes. Research has signaled the role of teacher beliefs in improving ninth grade on-track [4–6], but the link between them has not been explicitly studied.

From prior research, we can define teacher self-efficacy as teachers' individual belief in the extent to which they can positively influence student learning and outcomes [7]. The concept of teacher efficacy, as originally conceived by Bandura [8], was built around individual cognition, which was later extended to beliefs about the collective. Collective efficacy is defined as "people's shared beliefs in their collective power to produce desired outcomes" [9], p. 65, and collective teacher efficacy (CTE) is defined as a mutual belief among teachers that they can significantly impact student outcomes [10].

TSE and CTE are strong predictors of positive classroom practices and student-related outcomes, including student self-efficacy [11–13]. Teachers with high self-efficacy tend to be willing to take pedagogical risks to improve instruction and implement innovative approaches in classrooms [14], including incorporating community-based instructional learning [15] and seeking active learning spaces to improve student engagement [16]. Other practices include providing support and helping students feel more confident [17], placing less emphasis on behavior management [18], or reduced reliance on emotional reactions to student misbehaviors [8,19] have been linked to increased teacher efficacy.

Teacher self-efficacy and collective teacher efficacy are typically developed through four main sources. These are as follows: (1) mastery experiences where teachers actively engage in different teaching practices, (2) vicarious experiences in which teachers can observe other teachers, (3) verbal persuasion, and (4) emotional encouragement [20]. These four main sources have been found in the rich descriptions of ninth-grade on-track initiatives, specifically by providing a structure for interacting with colleagues that could serve as mentor teachers as well as providing an organizational structure for teachers to reflect on their craft and consider how to develop their ability to support students [21–23].

Our study examines the effects of teacher self-efficacy and collective teacher efficacy on ninth-grade on-track, and we further argue that the discussion of broader implications for teacher education and professional development programs in fostering and sustaining such efficacy is part of the contribution to the research. The research looks more closely at teacher beliefs and practices, not necessarily at the start of their teaching career, but understanding the complex consequences of sustaining efficacy among the teachers. It seeks to underscore the significance of sustained efficacy among educators and its implications for teacher education programs and professional development. This takes the perspective of teacher education as a continuum—a career-long process [24–26]. Pre-service teachers' sense of efficacy is initially based on academic performance until they begin student teaching [27–29]. School conditions, perceptions of colleagues, and school leadership experienced can further depress levels of efficacy [22,30] and teachers often feel different levels of efficacy in different teaching contexts [31]. Given numerous threats to maintaining high levels of efficacy, a teacher-education-as-continuum framework can create the foundation for sustaining efficacy through carefully planned pre-service experiences and in-service professional development that build on one another. Thinking of it systematically [24] could implicate a scheme of school leadership and teacher feedback aligned with professional development selection in support of teacher efficacy.

Teacher education (TE) and training has undergone a significant transformation over the decades, progressing from a basic pedagogical focus to a comprehensive emphasis on developing professional competencies and fostering reflective practices in teaching across countries [28,32–35]. In the US context, a recent study conducted by the National Academy of Education [36] still considers the need for teacher education to focus on their attitudes and beliefs and not only the practice. As such, during the student-teaching phase of teacher-training programs, there exists an opportunity to cultivate both TSE and CTE [37,38].

In the pre-service stage, the student-teaching experience can help develop skillful teachers by providing a variety of experiences to help them gain confidence in working with a diverse group of students. Yost [23] recommends not only exposing student teachers to students who may have markedly different learning needs, for example, those with a special education classification, but also to students that may vary in other characteristics such as learning style and school settings (urban, suburban, and rural). When students graduate from their teaching program, they typically experience a drop in self-efficacy when faced with the realities of teaching [20,39]. One way to counteract the drop in teacher self-efficacy and collective teacher efficacy has been through incorporating continuous improvement strategies through professional learning opportunities [40]. This has led to an improvement in CTE, especially among in-service teachers [41,42]. These studies were conducted in the Australian and Singaporean education contexts. Additionally, as teachers continue in

their careers, self-efficacy could come from mentor teachers' experiences. Continuing to build on these experiences with the support of their peers creates a sense of collective and self-efficacy within the school environment, which would ideally support all students.

The context of the study is an urban school district in a northeast state in the United States enrolling majority Black and Latinx students (91% of all 9th graders in 2021–2022). Most students are from low-income families (74% of all 9th graders). The district has an ongoing ninth-grade success initiative, adapted from the Chicago To & Through project [43,44]. The aim of this initiative is to improve ninth grade on-track rates with the expectation that high school graduation and college enrollment rates will later improve. School year 2021–2022 was the first full year where four of fourteen schools intentionally participated in the ninth-grade success initiative. Participating schools began to implement a variety of approaches such as ninth grade success teams akin to professional learning communities (PLCs), tracking quarterly performance in all courses via Ds and Fs reports, school leaders beginning the process of shifting teacher expectations of students and themselves, and creating intentional student supports to keep students on-track.

Motivated by these various bodies of research and the research context, the study tests the effects of students attending schools with high self-reported teacher efficacy (individual and collective) during students' ninth grade year on students' on-track rates. Teachers might report high individual or collective efficacy regardless of whether the school is participating in the ninth-grade success initiative. Therefore, though we expect that participating schools will likely report high efficacy, the study is not an evaluation of the freshman success initiative. Teachers in the same school may have different levels of efficacy, but when most of the teachers of ninth grade students report high efficacy, the reasonable conclusion is that high efficacy is normative in those students' learning environments.

In addition to analyzing the direct relationship between teacher efficacy and ninth grade on-track, the analysis further examines the mediating effects of schools having ambitious instruction practices, which are hypothesized to be concurrently affected by TSE and CTE. Finally, we study the role of school culture, which is believed to potentially influence both predictors and outcomes—TSE/CTE, instructional practices, and ninth grade on-track. When positing a causal relationship, it is important to consider the potential for bidirectional impact. However, we posit that school culture is far more likely to influence teacher beliefs and instructional practices and that it is less likely that individual teacher beliefs and practices would have initially accumulated to create school culture [45,46]. Put differently, if the school's culture does not offer an environment where teachers can maintain positive beliefs about their abilities, then it is not likely that positive beliefs would thrive among any majority of teachers, though individual teachers may maintain positive beliefs.

The paper summarizes relevant research followed by an outline of the conceptual framework guiding measurement development and the analytic strategy. We then describe the data, measures, and methods. The analytic strategy gives significant attention to exogeneity and minimizing selection bias. The remainder of this paper presents and discusses the findings in the context of extant research and the conceptual framework and explores implications for school and teacher practices, teacher education and professional development, and future research.

2. Literature Review

2.1. *The Eighth to Ninth Grade Transition*

The ninth-grade year is one of the most critical junctures in students' academic careers and is often a "make or break" experience for graduating [3]. Education research provides myriad evidence of the stressors related to the middle to high school transition, including adapting to different levels of academic rigor and accountability [47] and managing social pressures [48], which can adversely impact students' attendance [49] and levels of school engagement [50,51]. Across school districts in the United States, moving from one school to another is seen as a challenging period for students, marked by a decline in academic

performance. In Chicago, ninth graders who fail a course during their first semester of high school are at greater risk of dropping out of high school [52–54]. In Philadelphia, ref. [55] find that the type of school attended in eighth grade is a strong predictor of students' academic performance in high school. These studies reveal that a poor transition during the ninth-grade year adversely impacts later school performance, regardless of previous academic performance, race, gender, and other student characteristics. Studies have also shown performing well in ninth grade is a good predictor of future student outcomes, including high school graduation and college enrollment [56–58]. It then becomes pertinent to examine the school-based mechanisms that may improve academic and behavioral performance in ninth grade.

Several studies have highlighted the “ninth-grade bulge”, characterized by higher enrollment in ninth grade when students repeating the grade join new ninth-graders [38,59,60]. The bulge grew from a 4% increase in 1982 to a 12% increase in 2012. Researchers have posited that the increasing bulge trend comes from decreased parent supervision, increased peer influences, and students sometimes being inadequately prepared for high school [38]. This is compounded by the administrative and classroom management aspects that teachers must consider in managing ninth graders who are at different levels due to retention and newcomers [38]. However, less is studied about the inter-relationship between teacher efficacy, school and classroom practices, and the ninth-grade transition.

2.2. Conceptualization of TSE and CTE

Teacher efficacy is broadly interpreted as the confidence “teachers hold about their individual and collective capability to influence student learning” [61], p. 21. Nonetheless, over the last three decades, research on teacher efficacy has notably evolved, particularly regarding how the construct is defined. The definitions of TSE and CTE have been heavily influenced by two theoretical frameworks, resulting in differences in their resulting measures [7,62]. The first is Rotter's locus of control theoretical framework, which is concerned with whether individuals perceive that influence to change outcomes is more dependent on their own efforts or on external factors outside of their control. The measures resulting from this theoretical framework of TSE were not widely incorporated into later studies.

The second theoretical framework for TSE and CTE was based on Bandura's concept of self-efficacy and emerged from his social cognitive theory. Bandura defines perceived self-efficacy as “beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments” [63], p. 3. Bandura theorized that a person's level of perceived self-efficacy influences their efforts, thoughts, emotions, actions, and willingness to persist through difficulty. Using the social cognitive model, Bandura [63] refers to personal self-efficacy among teachers as the confidence teachers hold regarding their ability to perform as an individual teacher, while collective efficacy refers to the belief that the teachers at a school can impact the students they work with. Teacher efficacy measures based on Bandura's social cognitive theory have been found to be more predictive of teacher behavior than those based on Rotter's locus of control theory [10].

2.3. Effects of TSE and CTE on Student Outcomes

Research on teacher efficacy and student outcomes regularly cites that higher teacher efficacy is linked to positive approaches to teaching and interacting with students, thus leading to better student outcomes [64–66]. A seminal longitudinal study by Midgley [66] was conducted as part of a two-year, four-wave panel study with 12 school districts in Michigan (The Transitions at Early Adolescence Project). The study found that students transitioning from junior to high school were more impacted by the differences in teacher's sense of efficacy before and after the transition. More recently, studies have looked at the relationship between teacher self-efficacy and student academic and non-academic outcomes [67–69]. Studies have found a positive association between teachers with self-efficacy and student achievement scores in core subjects [70], improving student's sense of belonging [71,72] and enjoyment in class [73,74]. Another strand of research around TSE

is its relationship to academic risk-taking in the classrooms. This occurs when teachers encourage their students to attempt new strategies and engage in “productive failing”, meaning students can fail and learn from such failure [75,76].

Like the research around TSE, extant evidence suggests CTE to be one of the best predictors of student achievement [8,10,77,78]. A study by Donnohoo and his colleagues [79] was based on a synthesis of 1500 meta-analyses that found the effect of CTE (measured based on Cohen’s *d*) to be 1.57 or three times or more predictive of student achievement when compared with socio-economic status (0.52) or student’s prior achievement (0.65). Where CTE is strong, teachers embrace a more challenging curriculum [10], dedicate more time to supporting students having difficulty [80] and engage in “student-centered” learning [81,82], p. 66, leading to a climate of “help seeking, joint problem solving, and instructional experimentation” within the classroom [83], p. 167, [6]. Research on teacher education and practices also points to how self-efficacious teachers tend to be more risk-taking and thus motivated to shift away from traditional forms of instruction to more inquiry-based [84,85], apply a social justice framework to the curriculum [86], or use places and local context to relate better with students [87]. Considering this context, this study holds practical importance by emphasizing the value of having teachers with strong self and collective efficacy in schools.

Similarly, higher levels of CTE influence teachers to engage in proven productive behaviors as they instruct [88]. Looking at the teacher education literature, we see that teachers with high collective efficacy are more likely to set higher expectations for their students [89], are willing to try new teaching strategies, and are more receptive to innovative ideas [90,91]; thus, their teaching is more individualized for each student [14]. Additionally, when students perceive their teachers to be effective, academic outcomes also improve [70]. Teacher’s having higher collective efficacy also results in them feeling confident in managing behaviors and attempting preventative strategies rather than using exclusionary, disciplinary measures [14]. Thus, teacher’s own motivation and preparedness measured using [77] TSE short-form scale by students was an important predictor of student academic outcomes. The short-form scale primarily captures the competence of teachers as a group, including their skills and training experience. The scale also captures how teachers perceive the tasks at hand as a collective [92,93]. Thus, to set the stage for examining the effect of TSE and CTE on student outcomes, we would also need to look at how they affect classroom instructional practices.

2.4. TSE, CTE, and Instructional Practices

Fives [94], citing Pajares’ work [95] on Bandura’s work on teacher efficacy, concluded that “beliefs are the best indicators of the decisions individuals make throughout their lives”, p. 307. One of the key tenets surrounding TSE is teacher’s belief in being motivated to make decisions based on their own unique teaching experiences and student needs. As indicated, teachers’ practices in the classroom can be influenced by their levels of TSE and CTE so that high-efficacy teachers are more willing to take risks and try new approaches in their classrooms [96–98]. Among these approaches, ambitious instruction practices have been identified as pedagogical approaches that foster a deeper understanding of academic content [98–100]. These practices involve shaping academic content to student needs [88,101,102] and improving teacher–student relationships in the classrooms [103].

Among these, inclusive classroom management practices have been identified as an important and ambitious instructional practice related to teacher efficacy in fostering academic achievement [61,80]. Classroom management practices include avoiding negative reactions toward student’s disruptive behavior or utilizing more preventive strategies [104–106] and implementing a goal structure in the classroom that places more emphasis on the organization and planning of lessons. Having a classroom goal structure has been shown to be linked to greater enthusiasm and instructional aspirations [107,108]. Moreover, high-self-efficacy teachers have been linked to utilizing more mastery experiences in instructional methods over a performance structure. This involves creating an academic environment

where students can thrive and prioritize learning over policies solely focused on students' academic performance [108].

Apart from classroom management practices, implementing culturally responsive pedagogy and transformative learning approaches are also considered ambitious instructional practices. Culturally relevant pedagogy focuses on the teacher's positionality and practices, emphasizing social justice through a critical investigation of racial and other systems of oppression in the learning process in the classroom [109–111]. Transformative learning practices encompass various elements, such as teachers reflecting on their own self-awareness about implicit biases [112], adapting to diverse learning needs [113], implementing democratic teaching practices [31], and innovation in teaching methods to better reflect a context-specific curriculum [113]. For example, teachers with high self-efficacy used assessments to gather information about student interests and progress and developed more dynamic instruction to be more flexible yet purposeful [64].

Likewise, cultivating developmental relationships with students is also regarded as an ambitious instructional practice [114]. This involves teachers not only expressing care and elevating student expectations but also offering support and encouragement, sharing authority in the classroom [100,115], and assisting students in recognizing their potential opportunities for the future [116]. Having more positive relationships with teachers as students transition from middle to high school has improved student's sense of belonging and academic outcomes [117]. However, less is discussed about whether and how TSE and CTE influence teacher's motivation to incorporate culturally relevant pedagogy or build developmental relationships with students in classroom management practices. In this study, we address this research gap by testing the relationship between TSE, CTE, and ambitious instructional practices discussed above. In the next sub-section, we also highlight how school culture could play an influential role in the relationship between TSE, CTE, instructional practices, and student outcomes.

2.5. The Role of School Culture

Many factors in a school impact a teacher's attitude and ability to successfully educate and create a positive classroom climate for their students. These factors include leadership support, professional development strategies, and community engagement [5,118]. Leadership styles that are inclusive and supportive for teachers lead to increased feelings of independence and confidence in their work [119]. Among types of leadership, evidence showing the influence of instructional and transformative school leadership on teacher's collective efficacy is prominent [120–122]. Instructional leadership is focused on teaching practices, whereas transformational leadership focuses more on capacity building, engagement, and empowering the staff [67,123]. As such, there is evidence of a direct influence of transformational school leadership on teacher efficacy, motivation, and student outcomes [121,124,125].

There is also a strong inter-relationship between professional development strategies for improving teacher efficacy and student outcomes [65,126,127]. Broadly construed, professional development refers to the opportunity teachers have to learn new teaching strategies based on changing student needs and academic expectations [128–130]. Professional development strategies can be geared toward building open and communicative styles towards students, deeper conceptual learning, and raising student expectations [128,131]. Well-designed and implemented professional development has been shown to improve teachers' confidence in implementing new practices [127,132]. Inter-relatedly, the need for professional development is seen more among novice teachers with 0–4 years of experience [93]. The study findings showed that new teachers tend to have lower self-efficacy, mostly attributed to the lack of new or updated professional development opportunities or professional development being a one-size-fits-all approach.

School administrators fostering activities such as professional learning communities (PLCs) in their efforts to improve teacher efficacy have received increasing attention in education research and practice. In PLCs, teachers are given space to collaborate and learn

from each other [133,134], giving teachers more tools to bring to their classrooms [135], fostering shared and supportive leadership in decision-making [136], and establishing networks of interconnected PLCs [137]. As such, many studies have provided evidence of how PLCs predict greater CTE and, in some cases, TSE [46,134,136,138]. Furthermore, studies have shown how healthy school climate with more access to resources, leadership influence and consideration in decision-making have been conducive to building teacher efficacy [139–141].

While the dimensions defining school culture are still evolving [142], another set of studies contends that when teachers experience a greater sense of empowerment and possess a collective voice within the school, they are better equipped to take on increased responsibilities in fostering a supportive school culture and leadership marked by mutual collaboration and respect [143,144]. However, there is also compelling evidence indicating that leadership practices and professional opportunities significantly enhance teacher efficacy [46].

3. Conceptual Framework

In our literature review, we highlighted some of the strongest evidence on TSE, CTE, instructional practices, school culture, and student outcomes and the possible inter-relationships. Our conceptual framework is driven by the premise that when ninth graders experience teachers with high levels of efficacy (individual and collective), they are more likely to overcome the usual developmental challenges of the eighth to ninth grade transition and thus end ninth grade on-track than similar students who do not experience ninth grade in a high efficacy school. Many students in high-need schools face transition challenges coming into 9th grade. These challenges include but are not limited to stressors and social pressure, feeling inadequately prepared for high school or differing academic expectations, especially for students of color [48,55]. Being exposed to teachers with high self and collective efficacy can lead to improvement in classroom management activities, better relationships with students and parents, and autonomy to address student needs [88,102,103]. Furthermore, a supportive school culture can help to improve teacher engagement by collaborating with each other, providing consistent, well-supported professional development, and supportive leadership linked to teacher–leader trust. Studies also show shifting educator beliefs and practices can result in culture shifts within schools over time that better support vulnerable students toward success [145–149]. That shift is ordinarily generated or at least initiated by school-level conditions.

The hypothesis of this study is that there is a direct effect of TSE and CTE on ninth grade on-track, i.e., a student attending a high TSE/CTE school is more likely to be on-track. An indirect effect is posited as well when schools have instructional practices that are ambitious, defined here as culturally relevant teaching and transformative pedagogy, likely to result from greater TSE and CTE. Furthermore, these relationships are not independent of the school culture. As described, we expect that school culture affects TSE, CTE, ambitious instruction practices, and ninth grade on-track. Figure 1 depicts our conceptual framework.

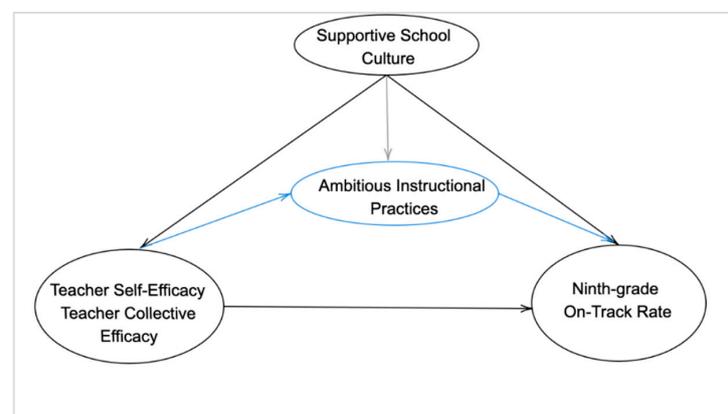


Figure 1. Conceptual framework.

4. Methodology

4.1. Data

Data include student-level demographic, academic, and enrollment information provided by the school district through a data-sharing agreement. We conducted teacher and student surveys in the summer (May/June) of the 2021–2022 school year, the second full year of the pandemic. The district provided a deidentified linkage between surveys and student records.

4.2. Sample

Ninth-grade students enrolled in 2021–2022 in all regular public schools in the urban district are the sample of focus. Of 17 high schools in the district, 14 participated in the survey, and after removing records with most questions unanswered and those where fewer than three teachers participated in the survey, 9 schools were included in the sample. The 9 schools enrolled 1600 ninth graders. Table 1 provides insights into the demographic composition of each school that is in the sample, their socio-economic status (as indicated by the percentage of students eligible for free or reduced lunch), whether they are magnet/specialized or comprehensive schools, and if they have implemented initiatives aimed at supporting ninth-grade success. Table 1 also provides information on whether a participating school was considered a high TSE or high CTE school based on teacher responses on the efficacy scales along with the 2021–2022 ninth grade on-track rates. Eight (8) out of nine schools have at least 92% or more Black or Latinx students enrolled, with six schools showing 98% or greater enrollment of Black or Latinx students, mirroring the overall district demographics. Given the study context, in 2021–2022, 4 schools were also involved in the ninth-grade success initiative. On the teacher self-efficacy scales, 6 out of 9 schools were considered high self-efficacy schools and 5 out of 9 schools were considered high collective efficacy schools based on the teacher responses. Among the participating schools, on-track rates varied from 66% to 99%. Specifically, 3 out of 9 schools achieved on-track rates exceeding 91%, whereas 2 out of 9 schools recorded an on-track rate of 66%. Upon further comparison, we also find that among the 4 out of 9 schools that had freshman success initiatives, 3 of them were considered high TSE schools, and 2 out of 4 schools were considered high CTE schools. Among these 4 schools, we see that school 9 was not considered high TSE or high CTE, based on the teacher responses. Furthermore, the on-track rates for these 4 schools were above 72%, with the on-track rates of 2 schools being higher than 91% in 2021–2022. School 9, which was not considered high TSE or high CTE and had a freshman success initiative, had the lowest on-track rates (73%) compared to the other three schools.

Table 1. Descriptive statistics of the participating schools (2021–2022).

	Total Ninth-Grade Students Enrolled	Percent Black and Hispanic Students	Percent Free and Reduced Lunch	Magnet or Comprehensive	Started Ninth-Grade Success Initiative	High Teacher Self-Efficacy School	High Collective Efficacy School	Ninth Grade On-Track Rate
School code	N	%	%	Yes/No	Yes/No	Yes/No	Yes/No	%
School 1	83	99.3%	73.9%	Yes	No	Yes	Yes	81%
School 2	82	95.2%	67.7%	Yes	No	Yes	Yes	82%
School 3	235	98.7%	67.0%	No	No	No	No	66%
School 4	629	74.6%	70.9%	No	No	No	No	66%
School 5	88	91.3%	84.8%	No	Yes	Yes	Yes	92%
School 6	76	97.8%	83.1%	No	Yes	Yes	Yes	99%
School 7	130	97.6%	73.6%	No	No	Yes	Yes	96%
School 8	116	98.4%	73.4%	Yes	Yes	Yes	No	78%
School 9	172	98.9%	77.3%	No	Yes	No	No	73%

4.3. Measures

4.3.1. Treatment Condition

There were two treatment conditions. The treatment conditions are binary variables representing whether each student attended a high-TSE or high-CTE school in ninth grade, derived based on teachers' responses about their beliefs. When we consider the initial demographics of teachers who completed the survey ($n = 269$) in comparison to the population of teachers in their schools, we see that across the schools, on average, the sample is somewhat skewed by gender, race/ethnicity, years of experience, and schools. Six schools had a sample in which females were over-represented relative to males. Looking at ethnicity, the sample was comparable to the overall population of included schools. However, at seven schools, Hispanic staff were under-represented. White staff members were over-represented in the sample at six schools, while Black staff members in the sample were under-represented at six. District-wide, the percentage of teachers with four or more years of teaching experience within the district is 70.4%. The range of teachers with this level of experience is 16.7–87.7%. Teachers with four or more years of experience were over-represented at four of the schools. To appropriately weight the sample, we predicted the probability of response across the population of teachers in all schools based on gender, race/ethnicity, gender-by-race/ethnicity interactions, years of experience, and school taught that year. The inverse of the predicted probability was applied as weights [150] in subsequent data reduction procedures.

Data reduction procedures with the weighted sample were applied to construct the treatment conditions. Details on the measurement scales are available in the Supplementary Materials. To measure TSE, we used survey items from the previously validated Teacher's Sense of Efficacy Scale (TSES) by Tschannen-Moran and Hoy [7] and researcher-designed items. TSES covered items from the Tschannen-Moran scale, such as teachers' beliefs in their ability to teachers control disruptive behavior, motivate students, implement diverse assessments, clarify information for students who are confused, and assist families in helping their children in their work. However, ref. [31] cites the limits of current measures of teacher efficacy in that they do not engage democratic education, broadly defined to include constructivist teaching, progressive education, and a range of student-centered approaches. Considering gaps in TSE measurement, we developed additional survey items that expand the measurement of teacher beliefs in several dimensions, including teacher beliefs in their ability to foster supportive, developmental relationships with students, implement a culturally relevant curriculum and approach to teaching, and beliefs about their ability to learn to teach in new ways [31,48,116]. Overall, the TSES scale was measured using 28 survey items, including 9 survey items from the previously validated scale, and 18 researcher-designed items. We used both exploratory and confirmatory factor analysis (EFA and CFA, respectively) to develop the TSE scale. The scale consists of standardized factor scores, which were extracted after CFA. We achieved unidimensionality on the proposed scale. The Cronbach's alpha reliability coefficient of the TSE scale is 0.9597.

The collective teacher efficacy scale was developed by Goddard [77]. The scale measures the extent to which teachers feel confident in the other teachers in the school to effectively support students, both behaviorally and academically. The Cronbach's alpha reliability coefficient of the CTE scale is 0.9504. For all scales, after generating scale distribution-driven categories of the standardized scale (five categories), the top two categories were selected to indicate high-TSE and high-CTE teachers. This represents one to two standard deviations above the mean of the standardized scale. High-TSE and high-CTE schools were defined as schools where at least 90% of weighted survey responses were high-TSE and high-CTE, respectively. We further looked at the correlations between the TSE and CTE scales as they relate to whether a teacher had 4+ years of experience and 10+ years of experience. In our analysis, we found low correlations between years of experience and TSE and CTE. All correlations between these variables were less than 0.12.

The Supplementary Materials also provide additional information on the survey items for each constructed scale.

4.3.2. Ninth Grade On-Track (Dependent Variable)

Developed by the University of Chicago Consortium for School Research, ninth grade on-track is an indicator of whether ninth graders are meeting key milestones toward on-time high school graduation. The indicator typically combines credit attainment and course passing benchmarks aligned with the grade ten promotion policy or credit requirements for a district or school. In partnership with the school district, the research team developed an on-track measure with the criteria that students: (1) failed no more than half of a core course and (2) attained 35 or more credits during the ninth-grade year. Core courses reflect five of the subject areas specified in the minimum requirements for a high school diploma—Mathematics, Language Arts, Science, Social Studies, and Health/Physical Education. The on-track measure for 2021–2022 is ultimately a binary (yes or no) indicator. A student is on-track if they meet both criteria and off-track if one or both criteria are not met.

4.3.3. Ambitious Instruction (Mediator Variable)

A composite scale was developed by adapting measures from the University of Chicago 5Essential survey items [58,151] and researcher-designed survey items to measure the extent to which teachers in the school implement classroom practices that represent ambitious instruction by working with students to do more intellectually rigorous curriculum while also being culturally relevant and transformative teaching in their pedagogical approaches [109,110]. We utilized survey items that captured themes such as community-building, critical engagement in the curricula, and co-constructing behavioral expectations with students. We used both exploratory and confirmatory factor analysis to develop the standardized scale in which higher values represent greater levels of these practices. The resulting scale was based on the unrotated results of a factor analysis, and the Cronbach alpha reliability coefficient is 0.9393. The full list of survey items is also available in the Supplementary Materials.

4.3.4. Supportive School Culture

Since school culture can influence all aspects of the conceptual model—TSE, CTE, ambitious instruction, and ninth grade on-track—a measure of school culture was developed primarily from the University of Chicago 5Essential survey [151] and items adapted using the developmental relationship framework by the Search Institute [152,153]. These items measured key elements such as trust in administration, experiencing coherent professional development with clear vision [127,133], having supportive, inclusive instructional leadership [122,136], and having opportunities to collaborate with other teachers can positively influence TSE and CTE [134,154], as indicated in the literature review. The resulting scale includes 28 items reflecting these elements. We achieved unidimensionality on the scale, with a Cronbach alpha reliability coefficient of 0.9666. The full list of survey items is also available under the Supplementary Materials.

Like the TSE and CTE scales, we used scale distribution-driven categories for the standardized scale (5 categories) for ambitious instruction and supportive school culture. We selected the top two categories, which corresponded to self-reported high ambitious instruction and perception of supportive school culture. This represents one and two standard deviations above the mean of the scale. This resulted in the final variables being binary. High-ambitious-instruction and high-supportive-culture schools were defined as schools where at least 90% of weighted teacher survey responses were high ambitious instruction and high perception of supportive school culture, respectively.

4.3.5. Covariates

A set of control variables were selected to account for student characteristics and experiences prior to entering high school, which could influence the high schools in which they enrolled and ninth grade on-track. These included binary variables for gender and race/ethnicity, English language learner status (EL), student with disability (SWD) status, prior performance in core subjects based on grade points, prior attendance rate, and fixed

effects for the neighborhood of the eighth-grade school where each student attended. Students' neighborhood of residence was not available in the data. Consequently, the neighborhood of eighth-grade school was used as a proxy of neighborhood of residence. In this urban district, even though the district has a choice system, students in the elementary and middle grades are more likely to have attended a school in their neighborhood. Cases not having an 8th grade school on record (likely if they transferred into the district for 9th grade) were assigned a missing data category. Eighth-grade course performance data also had missing information. These continuous variables went through multiple imputations based on student demographics and 8th-grade school.

5. Analytic Strategy

The analytic strategy is a quasi-experimental approach testing the effect of attending a self-reported high-TSE or high-CTE school on students being on track in their ninth grade. While students being on track is our outcome of interest, we do not have any baseline measure for comparison. It is likely that students attending high-efficacy schools have some differences with students who did not, such as differences generated by enrollment selection processes and neighborhood. Thus, it is necessary to adjust for selection bias to correctly estimate the effect of attending high-efficacy schools. As such, we matched students based on their 8th-grade performance data to compare academically similar student groups. We utilize propensity score matching (PSM) to identify a balanced treatment and control group of students [155]. Since the dataset is observational, PSM balances the sample based on students' probabilities of attending high-efficacy schools. Inverse probability weighting based on the propensity score [155] would be similarly useful for removing selection bias, but upon testing, balance could not be achieved with propensity score weighting methodology.

A correctly specified propensity score identifies students with a similar probability of attending high-efficacy schools regardless of where they attended school. We hypothesize that a student is more likely to be on track in their ninth grade if they attended a high TSE/CTE school. A logistic regression model was used to estimate the probability of assignment to a high-efficacy school, accounting for pre-ninth-grade covariates. Propensity score models for attending high-TSE and high-CTE schools were conducted separately, and over five imputed datasets were used for each. Student factors include prior performance in core courses and demographic characteristics, which could likely affect treatment assignment. The neighborhood with which the student was associated in eighth grade also likely affects treatment assignments such as middle school to high school feeder patterns. Equation (1) shows the conditional probability, Q_i , of assigning student i to the treatment condition, $D_i = 1$, as independent of observed student-level pretreatment covariates, W_i .

$$\hat{Q}_i = \Pr(D_i = 1) \| W_i \quad (1)$$

The average propensity score across the five imputed datasets was used for the PSM procedure. In the PSM procedure, we performed the match based on the propensity scores using single nearest-neighbor matching with the Mahalanobis distance set by a caliper of one-fifth of the standard deviation of the propensity score distribution [156]. A tight caliper helps to reduce bias and identify closer match between treatment and comparison cases [157]. The matching procedure generated weights for control group cases that were successfully matched to treatment cases. When treatment and control groups are balanced (comparable, as in an experimental study), it is expected that the only difference between the students is the receipt of the treatment. Thus, one can infer that the difference in outcome is a direct effect of the treatment.

We further conduct a causal mediation analysis using the weighted sample from the PSM procedure. The aim is to investigate the effects of attending high TSE and CTE schools on ninth grade on-track and whether any effect is a result of the school having high ambitious instruction. Causal mediation analysis needs to account for the fact that the treatment can change the mediator–outcome relationship [155,158]. The mediator effect on

the outcome can suffer from selection bias not accounted for in the balancing procedures described for treatment assignment. To test whether the ambitious instruction environment has a mediating effect between treatment and outcomes, we draw on the potential outcomes framework [58,155,159] implemented using STATA's *MEDIATE* procedure. The causal mediation procedure decomposes the total effect into (1) direct effect, (2) indirect effect, and (3) treatment-by-mediator interaction effect.

Assignment to a mediator potential outcome (0 or 1) is not likely random and needs to be accounted for in a causal estimation framework. As such, a propensity score model was estimated to identify the probability of assignment to a school with high ambitious instruction classrooms. Pretreatment covariates included student demographic characteristics, prior academic performance, interactions between gender and prior performance, prior attendance, and fixed effects for the neighborhood of eighth-grade school. This captures the premise that higher-performing students are likely to have greater access to schools with ambitious instruction [160,161]. *MEDIATE* fits logit models for both the outcome and mediator, given the binary outcome and binary mediator. We are interested in three treatment-effect estimates—the total effect—which is the average treatment effect, the natural indirect effect through the mediator, and the natural direct effect through the treatment but not the mediator [58,155,159].

$$Y = \beta_0 + \beta_1 Z + \beta_2 M + \beta_3 ZM + \beta_4 X + e \quad (2)$$

Equation (2), drawn from Hong [155], shows the outcome model where β_1 is the direct treatment effect, $\beta_2 + \beta_3$ is the indirect effect—the mediator effect on the outcome under the control condition and the treatment-by-mediator interaction effect—and β_4 is the supportive school culture indicator believed to potentially have influence on ninth grade on-track. Finally, sensitivity analyses using the work of Frank and their colleagues [162] was conducted to determine the robustness of inference to replacement of cases.

Limitations

Several measures—TSE, CTE, ambitious instruction, and supportive school culture—are based on self-reported data from teacher surveys. While the high reliability of the scales constructed leaves us confident in the measures, absent qualitative data collection to directly observe the schools, we cannot be sure about the extent to which our data reflect the realities in the schools. For example, teacher efficacy measures suffer from being inconclusive about the extent to which reported efficacy is inflated [31]. The thresholds for high-TSE, CTE, ambitious instruction, and supportive culture schools were set to 90% of weighted responses to minimize the limitations of self-reported data.

6. Results

Table 2 shows the distribution of ninth graders in the district. Of the 1600 ninth graders in the initial sample, 78% ended the 2021–2022 schoolyear on-track. With respect to the distribution across treatment conditions, the mediator, and moderator, 36% of the sample were in high TSE schools, 29% in high CTE schools, 29% in high ambitious instruction schools, and 19% in schools with supportive culture. The initial sample prior to matching was 52% female and 48% male; furthermore, 48% were Hispanic, 41% were Black, and 11% were from other races. The mean age of 14 is typical for ninth graders, but the wide range suggests that there are overaged students in the grade. More than two-thirds of the sample (74%) is eligible for free and reduced-price lunch. The sample consists of 13% classified with disabilities and 24% in an English learner program. The mean eighth-grade GPA in the core courses ranges from 2.0 to 3.0, but across the five subjects, the GPA for young men tends to be slightly higher than the GPA for young women.

Table 2. Descriptive statistics.

Variable	Mean	SD	Min	Max
Ontrack	0.78	0.41	0	1
Attend High TSE School	0.36	0.48	0	1
Attend High CTE School	0.29	0.45	0	1
Attend High Ambitious Instruction School	0.29	0.45	0	1
Attend Supportive Culture School	0.19	0.39	0	1
Age	14.1	0.675	12	21
Age (log-transformed)	2.65	0.05	2.48	3.04
Student with Disability	0.13	0.33	0	1
Free and Reduced-priced Lunch	0.74	0.44	0	1
English Learner	0.24	0.43	0	1
Attendance Rate 2021	93.26	10.41	17.22	126.11
GPA				
Health/PE	3.04	1.03	−0.21	5.68
ELA	1.99	1.16	−0.99	5.28
Math	1.99	1.16	−2.07	7.41
Science	2.13	1.16	−2.48	6.15
Social Studies	2.12	1.19	−0.81	6.21
Gender				
Female	0.52	0.50	0	1
Male	0.48	0.50	0	1
Race/Ethnicity				
Other	0.11	0.21	0	1
Black	0.41	0.49	0	1
Hispanic	0.48	0.50	0	1
Female × Race/Ethnicity				
Other	0.06	0.24	0	1
Black	0.21	0.41	0	1
Hispanic	0.25	0.43	0	1
Male × Race/Ethnicity				
Other	0.05	0.21	0	1
Black	0.21	0.40	0	1
Hispanic	0.23	0.42	0	1
Ward				
Ward 1	0.09	0.28	0	1
Ward 2	0.26	0.44	0	1
Ward 3	0.15	0.36	0	1
Ward 4	0.04	0.19	0	1
Ward 5	0.17	0.37	0	1
Missing Ward	0.29	0.46	0	1
Health/PE GPA × Gender				
Female	2.96	1.03	−0.21	5.39
Male	3.12	1.03	0.00	5.68
ELA GPA × Gender				
Female	1.86	1.13	−0.99	5.28
Male	2.12	1.19	−0.72	4.57
Math GPA × Gender				
Female	1.87	1.18	−2.07	7.41
Male	2.08	1.23	−0.70	5.63
Science GPA × Gender				
Female	2.02	1.14	−2.48	5.07
Male	2.26	1.16	−0.61	6.15
Social Studies GPA × Gender				
Female	2.00	1.16	−0.81	6.21
Male	2.25	1.22	−0.59	5.65

Tables 3 and 4 show the distribution of the unmatched and propensity score-matched sample of ninth graders. Before matching, 1024 (64%) students were in the control group, and 575 (34%) students were in the treatment group for the TSE model and, for the CTE

model, 1140 (71%) students were in the control group and 459 (29%) students were in the treatment group. Cases were matched with replacement within the specified caliper to maximize the number of matched treatment cases. After matching, 258 (31%) students were in the control group, and 575 (69%) students were in the treatment group for the TSE model, and 269 (37%) students were in the control group, and 459 (63%) students were in the treatment group for the CTE model. In most instances, comparison cases had a weight of one or two, but about 25% of the weighted control group had a weight between 3 and 14 in the TSE model, and 18% had a weight between 3 and 8 in the weighted control group from the CTE model. The post-match comparison showed an 87% reduction in median bias (32.1 to 4.1) in the TSE PSM and an 81% reduction in median bias (22.3 to 4.2) in the CTE PSM. The PSM procedure achieved balance across all except three pretreatment covariates in the TSE model.

Table 3. Pre- and post-propensity score matching descriptive statistics for the TSE model.

Variable		Mean				
		Treated	Control	% Bias	% Reduction in Bias	
Student with Disability	Unmatched	0.073	0.159	−27.1		***
	Matched	0.073	0.061	3.8	85.9	
Free and reduced-priced lunch	Unmatched	0.812	0.699	26.5		***
	Matched	0.812	0.814	−0.4	98.5	
English Learner	Unmatched	0.050	0.344	−79.3		***
	Matched	0.050	0.047	0.9	98.8	
Age (log-transformed)	Unmatched	2.639	2.650	−26.5		***
	Matched	2.639	2.641	−3.2	87.9	
Attendance rate 2021	Unmatched	94.211	92.511	16.1		**
	Matched	94.211	93.095	10.6	34.3	
Male	Unmatched	0.586	0.425	32.7		***
	Matched	0.586	0.582	0.7	97.8	
Health/PE GPA	Unmatched	3.125	3.012	10.9		
	Matched	3.125	3.082	4.1	62.2	
Male × Health/PE GPA	Unmatched	1.907	1.305	34.9		***
	Matched	1.907	1.850	3.3	90.5	
ELA GPA	Unmatched	2.183	1.908	24.2		***
	Matched	2.183	2.025	13.9	42.5	*
Male × ELA GPA	Unmatched	1.345	0.878	35.0		***
	Matched	1.345	1.258	7.0	79.9	
Math GPA	Unmatched	2.211	1.869	28.8		***
	Matched	2.211	2.113	8.3	71.3	
Male × Math GPA	Unmatched	1.338	0.852	35.6		***
	Matched	1.338	1.267	5.2	85.4	
Science GPA	Unmatched	2.330	2.053	24.5		***
	Matched	2.330	2.237	8.2	66.5	
Male × Science GPA	Unmatched	1.431	0.927	36.1		***
	Matched	1.431	1.345	6.1	83.0	
Social Studies GPA	Unmatched	2.311	2.047	22.8		***
	Matched	2.311	2.142	14.5	36.2	**
Male × Social Studies GPA	Unmatched	1.400	0.947	32.1		***
	Matched	1.400	1.293	7.6	76.3	
Black	Unmatched	0.583	0.318	55.1		***
	Matched	0.583	0.647	−13.4	75.6	*
Hispanic	Unmatched	0.379	0.537	−32.1		***
	Matched	0.379	0.320	12.0	62.6	*
Ward 2	Unmatched	0.096	0.356	−65.6		***
	Matched	0.096	0.096	0.0	100.0	
Ward 3	Unmatched	0.290	0.069	60.1		***
	Matched	0.290	0.297	−1.9	96.9	

Table 3. Cont.

Variable		Mean		% Bias	% Reduction in Bias	
		Treated	Control			
Ward 4	Unmatched	0.063	0.024	18.8		***
	Matched	0.063	0.056	3.4	81.8	
Ward 5	Unmatched	0.228	0.135	24.3		***
	Matched	0.228	0.235	-1.8	92.5	
Missing Ward	Unmatched	0.188	0.353	-37.7		***
	Matched	0.188	0.191	-0.8	97.9	

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 4. Pre- and post-propensity score matching descriptive statistics for the CTE model.

Variable	Matched	Mean		% Bias	% Reduction in Bias	
		Treated	Control			
Student with Disability	Unmatched	0.081	0.147	-21.1		*
	Matched	0.081	0.094	-4.1	80.4	
English Learner	Unmatched	0.061	0.310	-67.5		**
	Matched	0.061	0.044	4.7	93.0	
Attendance rate 2021	Unmatched	94.705	92.678	20.1		**
	Matched	94.705	94.690	10.0	50.0	
Health/PE GPA	Unmatched	3.094	3.018	7.5		
	Matched	3.094	3.086	0.8	89.5	
ELA GPA	Unmatched	2.170	1.916	22.3		***
	Matched	2.170	2.072	8.6	61.3	
Math GPA	Unmatched	2.202	1.879	27.2		***
	Matched	2.202	2.102	8.5	658.9	
Science GPA	Unmatched	2.338	2.050	25.3		***
	Matched	2.338	2.278	5.3	79.1	
Social Studies GPA	Unmatched	2.265	2.065	17.1		**
	Matched	2.265	2.216	4.2	75.5	
Ward 2	Unmatched	0.111	0.324	-53.3		***
	Matched	0.111	0.102	2.2	95.9	
Ward 3	Unmatched	0.338	0.073	69.4		***
	Matched	0.338	0.344	-1.7	97.5	
Ward 4	Unmatched	0.052	0.032	9.8		
	Matched	0.052	0.039	6.5	34.1	
Ward 5	Unmatched	0.207	0.153	14.2		
	Matched	0.207	0.222	-4.0	71.9	
Missing Ward	Unmatched	0.196	0.332	-31.3		*
	Matched	0.196	0.181	3.5	88.8	

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

The research question investigated whether students attending high-TSE schools or high-CTE schools affect their on-track rates and the hypothesized mediation mechanism of attending a school with high ambitious instruction practices. Causal mediation analyses allow for the decomposition of the mediation effect into direct and indirect effects [58,159]. The total effect is the difference expected in the outcome if all cases received the treatment compared to when no one received the treatment. The total effect is akin to the average treatment effect and can be decomposed into direct and indirect effects. Estimating the natural direct and indirect effects is suitable when a direct effect is assumed, and the research question is examining whether an indirect effect through a mediator is present [58]. The natural direct effect quantifies the treatment effect on students' on-track status when not experiencing the mediator compared to similar students who experienced neither treatment nor mediator. The natural indirect effect is the treatment effect through the mediator if

students experience both the treatment and mediator compared to similar students who experienced neither treatment nor mediator.

Table 5 and Figure 2 present the results from the causal mediation analysis performed using STATA’s `MEDIATE` command. For each treatment, we estimate an outcome model without controlling for supportive culture and with a control for supportive culture. The TSE models reveal a significant and positive effect of attending a high TSE school on the likelihood of student’s ninth-grade year being on track. In the TSE model, where a supportive culture is not accounted for, the natural direct effect is 0.132 (robust SE = 0.040; $z = 3.30$), and the total effect is 0.150 (robust SE = 0.039; $z = 3.84$). The natural indirect effect is also significant, but the coefficient of 0.018 is relatively small (robust SE = 0.006; $z = 2.75$). After controlling for supportive school culture, the natural direct, indirect effect, and the total effect are roughly the same and remain positive and significant. Examination of auxiliary regression results shows that the supportive culture indicator, as measured, does not have a significant impact on the likelihood of being on track at the end of ninth grade. The natural direct effect of attending a high TSE school means that students attending these schools are more than twice as likely to be on track by the end of ninth grade (Odds Ratio: 2.33; Robust SE: 0.64; $z = 3.09$).

Table 5. TSE and CTE treatment effects.

	Outcome Model 1 Excluding Supportive Culture					Outcome Model 2 Including Supportive Culture						
	Coef.	Robust SE	z	95% Conf. Interval		Coef.	Robust SE	z	95% Conf. Interval			
Attending High TSE School (n = 833)												
Natural Indirect Effect	0.018	0.006	2.75	**	0.005	0.030	0.016	0.007	2.33	*	−0.003	0.030
Natural Direct Effect	0.132	0.040	3.30	**	0.054	0.210	0.119	0.043	2.77	**	0.035	0.203
Total Effect	0.150	0.039	3.84	***	0.073	0.226	0.135	0.043	3.11	**	0.050	0.220
Attending High CTE School (n = 728)												
Natural Indirect Effect	0.013	0.012	1.09		−0.010	0.036	0.014	0.012	1.16		−0.009	−0.036
Natural Direct Effect	0.145	0.034	4.21	***	0.077	0.212	0.165	0.046	3.57	***	0.075	0.256
Total Effect	0.158	0.032	4.97	***	0.096	0.220	0.179	0.050	3.59	***	0.081	0.277

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

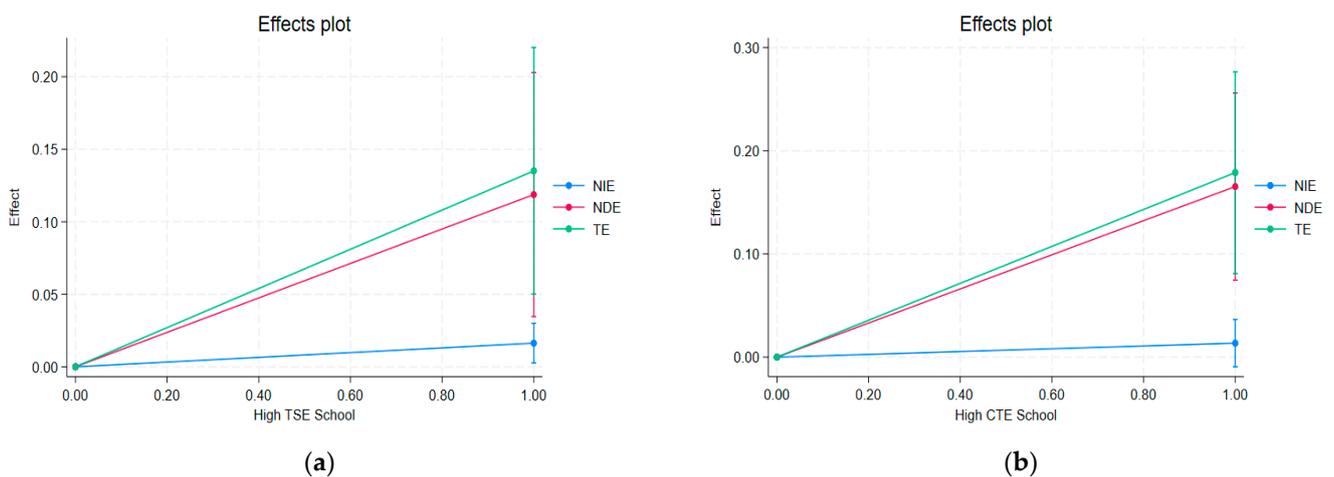


Figure 2. TSE (a) and CTE (b) effects plot. NIE is the natural indirect effect; NDE is the natural direct effect, and TE is the total effect.

Looking at the potential outcome means, we could expect that if no student experienced the TSE treatment or the ambitious instruction mediator (Y0M0), then the on-track rate would be 76% (Table 6). If everyone experiences treatment and mediator (Y1M1), then the on-track rate, by contrast, would be 90%. The on-track rate would be 88% if everyone experienced the treatment but no one experienced the mediator (Y1M0); con-

versely, it would be 79% if no one experienced the treatment but everyone experienced the mediator (Y0M1).

Table 6. Potential outcome means in ninth grade on-track.

	Coef.	Robust SE	z		95% Conf. Interval	
Teacher Self-Efficacy						
No treatment, no mediator (Y0M0)	0.764	0.039	19.77	***	0.689	0.840
Yes treatment, no mediator (Y1M0)	0.883	0.016	56.01	***	0.852	0.914
No treatment, yes mediator (Y0M1)	0.790	0.042	18.61	***	0.707	0.873
Yes treatment, yes mediator (Y1M1)	0.899	0.014	63.17	***	0.872	0.927
Collective Teacher Efficacy						
No treatment, no mediator (Y0M0)	0.757	0.043	17.79	***	0.673	0.840
Yes treatment, no mediator (Y1M0)	0.922	0.016	56.94	***	0.890	0.954
No treatment, yes mediator (Y0M1)	0.827	0.038	21.61	***	0.752	0.902
Yes treatment, yes mediator (Y1M1)	0.936	0.014	67.68	***	0.908	0.963

Note: *** $p < 0.01$.

Like the TSE model, attending a high CTE school (Coef. = 0.145; robust SE = 0.034; $z = 4.21$) leads to a positive natural direct effect on the likelihood of being on track at the end of ninth grade and at a similar level in the first TE model not accounting for the level of a supportive culture (Table 5). However, the natural indirect effect (0.013; robust SE = 0.012; $z = 1.09$), though positive, is not significant. That is, when students attend a high CTE and high ambitious instruction school as measured, they are no more or less likely to be on track compared to students who attend a high CTE school but not a high ambitious instruction school as measured. In the discussion, we return to looking at the measures to understand what this might mean in practice.

The inclusion of the supportive culture indicator does not do much to alter the natural direct effect (0.165) of attending a high CTE school (Robust SE = 0.046; $z = 3.57$), and the effect remains significant. The positive but insignificant natural indirect effect remains, and the total effect is again significant. Examination of the auxiliary CTE model shows that, like the TSE model, the supportive culture indicator does not play a positive significant role (Coef. = -0.267 ; Robust SE = 0.458; $z = -0.58$) in the relationship between attending a high CTE school and ninth grade on-track. After controlling for the supportive school indicator, the natural direct effect of attending a high CTE school means that those students are nearly four times as likely to be on track (odds Ratio: 3.800; robust SE = 1.257; $z = 4.04$).

The potential outcome means for the CTE analysis are again informative (Table 6). With respect to high-CTE school as treatment, the ninth grade on-track rate would be highest (94%) if everyone received the treatment and the mediator and lowest if no one received the treatment or the mediator (76%). The on-track rate would be 83% if no one received the treatment and everyone received the mediator and 92% if everyone received the treatment and no one received the mediator.

Sensitivity Analysis

The effect estimates are robust to replacement of cases. Based on the robustness of inference to replacement (RIR) analyses [162,163], to invalidate the inference for the natural direct effect for the TSE model, 41% of the estimate would have to be due to bias; 345 cases would have to be replaced with cases for which there is an effect of zero. To invalidate the inference for the natural direct effect for the CTE model, 53% of the estimate would have to be due to bias; 389 cases would have to be replaced with cases for which there is an effect of zero.

7. Discussion

The research questions posed in this study examined the relationship between teacher self-efficacy and collective teacher efficacy to student's on-track rates in the ninth-grade year. The findings revealed that in schools where teachers reported high levels of TSE and CTE, students were more likely to stay on track in their ninth-grade year. However, the mediating effect of students attending a high ambitious instruction school with a high CTE school was not significant. On the other hand, the mediation analysis in the TSE model indicates that attending a high ambitious instruction school positively affects ninth grade on-track. This is an important finding. The ambitious instruction scale was primarily centered around transformative teaching approaches and culturally relevant teaching. The positive mediating effect of ambitious instruction on the TSE and ninth-grade on-track relationship, though small, supports the hypothesis that TSE can impact ninth-grade on-track when teacher beliefs lead them to be more confident in taking instructional risks and implement innovative approaches in the classroom [81,88]. This is a promising finding. To influence ninth grade on-track, the teaching approaches would need to be strong enough to keep students from failing core courses and help them attain sufficient credits. The findings supports this premise, though, thinking of the potential outcomes means (Y1M0), students would largely still be on track (88%) if they experienced a high-TSE school but not a school that has high ambitious instruction.

Still, the insignificant indirect effect through ambitious instruction indicates lingering uncertainties about how traditionally measured CTE interacts with a progressively measured ambitious instruction scale. CTE represents teachers' beliefs in their colleagues' abilities as a collective and not necessarily their own abilities. Therefore, the conceptual link between CTE and their own instructional practices may be weaker than the link between TSE and instruction. The insignificant effect of the mediator suggests that in schools where most teachers report these ambitious practices, CTE did not influence ambitious instruction enough to make it more likely for students to be on track at the end of ninth grade. Thus, the relationship between TSE, CTE, and ambitious instruction in terms of culturally relevant pedagogy warrants further qualitative study as extant research has pointed to the positive influence of culturally relevant teaching and transformative approaches on student experiences and outcomes [69,92]. It would be important to understand the consistency of implementation across schools, how ambitious instruction is embodied in each school building, and why TSE or CTE might have a strong or weak relationship with ambitious instruction.

Interestingly, attending a supportive school culture, as measured, did not affect the relationship between TSE/CTE and ninth grade on-track. This study examined school culture in terms of leadership support, quality and coherent professional development, teacher-principal trust, and collaborative teachers, which also reflects key components of school culture in the literature [65,120,132]. This finding underscores a broader need to better understand how our current conceptualizations of supportive school culture may fall short in terms of the relationship between TSE/CTE and 9th grade. This implicates future qualitative study.

The findings of this study validate the need for future research on facilitating shifts in teacher mindsets. They lead us to explore how a focus on mindsets can be incorporated into teacher education. First, the identified effect of TSE on ninth grade on-track is significant to the literature, given the expanded measurement of TSE. Prior measurement of TSE focused on domains such as managing student behavior and assessment, in addition to motivating students. We employed a measure of TSE that encompassed the previously validated TSES and included measures on teacher beliefs about their ability to build developmental relationships with students and implement culturally relevant pedagogy, transformative learning, and inclusive discipline practices. Much of the recent work carried out concerning teacher education discusses the need for more reflective practices as part of the training program [154]. The expanded measurement of TSE and its significance to ninth grade on-track provides a foundation to not only incorporate these practices with the district and

school leadership but also offers insights into the adaptation of training and professional development initiatives to embrace transformative mindsets. For example, this goal can be accomplished by integrating reflective practices, offering staff dedicated time and space to analyze school data for informed decision-making, and involving staff in shaping the school's goals, fostering a sense of ownership and commitment to the work.

Second, while a supportive culture geared toward teacher collaboration, development, and engagement has shown to be insignificant in affecting the relationship between TSE/CTE and ninth grade on-track in our models, it was proven to be an important mechanism to improving ninth grade on-track in the extant literature [46,134,136]. As such, additional research is needed to build a consensus around how schools can build stronger cohesive cultures that will meaningfully impact student outcomes. While the school culture scale in our study captured the perceived quality of professional development, it did not capture the specifics of professional development delivery to help differentiate the types of professional development. Future research can interrogate whether and how professional development sessions were included as part of a school's organizational routine. These could be in a variety of formats, including professional learning communities (PLCs), collaboration between teachers and universities, or sessions focused on improving instruction. While the school culture scale captured the perceived quality of professional development, it did not capture the specifics of professional development delivery to help differentiate the types of professional development. In our study, FSI has been an ongoing PLC in the school district, focusing on adapting collaborative and inquiry-based learning sessions. In these sessions, school leaders are afforded the opportunity to review their school's data as they relate to key metrics of the progress of their ninth-grade students and reflect with their peers. School leaders are expected to turnkey the learnings from these sessions to school staff. Future research should study differential experiences and perceptions of these types of professional development activities so that, where substantiated with evidence, the findings can help practitioners create opportunities to design teacher education programs focused on diverse professional development strategies.

Freshmen success initiatives help in-service teachers build on the four major tenets of developing self-efficacy by providing a structure for interacting with colleagues that could serve as mentor teachers as well as providing an organizational structure for teachers to reflect on their craft and consider how to develop their ability to support students [20]. According to Emily-Krone Phillips [3], who wrote a book about the freshmen year experience called *The "Make or Break" Year*, one of the key factors in a teacher's ability to support students through their freshmen year is the belief that all students can learn. When teachers develop self-efficacy, this fuels the belief that all students can learn because teachers have the confidence and problem-solving skills to work with a diverse array of learners.

However, research also notes that novice teachers do not always get the opportunity to self-reflect [23]. With FSIs, colleagues are encouraged to create systems and structures so that all young people can succeed [3]. By studying TSE and CTE in the FSI context of our study, we can begin to make conceptual links between teacher education and PLCs. FSIs create an opportunity for teachers to come together to reflect on course-level and grade-level trends and identify ways to improve student performance. These meetings can help facilitate collective self-efficacy since they provide the opportunity for teachers to learn from each other, problem-solve, and center on a common goal. More importantly, FSIs can be a distinctive platform for pre-service teachers to gain valuable experiences to better understand student's learning needs and be part of a supportive school culture environment. This would also directly influence their levels of self and collective efficacy over time.

Finally, although not directly studied, the findings from this research suggest potential leverage points during crises such as the recent COVID-19 pandemic [164], when the study took place. Conducted during the 2021–22 school year, our survey coincided with intermittent remote learning, possibly influencing some schools' sense of coherent culture and teacher efficacy. While this study does not directly analyze the effects of individual's

school's change in strategies to continue teaching online, based on the discussions with the school district, we outline recommendations that have been pursued to some extent during the COVID-19 pandemic. These include increasing weekly collaboration time to a minimum of 90 min, expanding teacher-leadership roles, improving pre-service experiences, diversifying teacher pipelines, and encouraging self-care and collaborative support [165].

Now more than ever, there is a compelling argument to prioritize equity-focused teaching [166]. Teachers need enhanced readiness to address students' socio-emotional needs. Crises like COVID-19 also brought back the importance of school culture, where teachers need to be empowered to collaborate and share decision-making [167]. Research has pointed to supportive school culture conditions cultivating teacher resilience and perseverance, especially through fostering inter-personal relationships and building a community of practice through professional development activities [168]. The urgency for robust teacher educator preparation has never been clearer [166]. This would require reimagining teacher educator curriculum and practicum [169] and incorporating trauma-informed practices that are innovative [154,166] and build on each other's professional learning journeys.

8. Conclusions

Based on the study findings and prior literature reviews, we believe there is a next phase of high school change, centered around nurturing teacher's self and collective efficacy that will play a significant role in keeping ninth grade students on-track to graduate.

To build those conditions, teacher education, both in-service and pre-service, can serve as a key lever to develop both collective and self-efficacy. The current study's results mark a step towards testing the effects of an expanded measure of teacher self-efficacy on student outcomes. Further exploration is needed to understand how pre-service teacher education programs and in-service professional development strategies are geared towards influencing teacher efficacy and whether distinctions exist between novice and experienced teachers. In future studies, we would also like to directly study or evaluate the success of the Freshman Success Initiative, how it is intertwined with teachers having high self and collective efficacy, and the impact of teacher education and professional learning communities centered around the work of FSI. This work is intended to inspire future practitioner-centered research strands focused on the development of teacher education programs and development within school systems.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/educsci14050546/s1>, Table S1: Teacher Self-Efficacy Scale, Table S2: Collective Teacher Efficacy Scale, Table S3: Ambitious Instruction Scale, Table S4: Supportive School Culture Scale.

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