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Systematic Review

A Systematic Review of the Recent Empirical Literature on Math and Science Teacher Recruitment and Retention

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Abstract

The shortage of math and science teachers is a pressing issue in the United States (US) and globally. This review closely follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and synthesizes findings from 43 peer-reviewed empirical studies published between 2005 and 2024 on the recruitment and retention of math and science teachers, offering a new perspective for understanding and mitigating math and science teacher shortages. This review revealed (a) the qualifications and characteristics of math and science teachers who enter and remain in the teaching profession; (b) that financial incentives, experiential learning, mentorship, and professional development are commonly used strategies and mechanisms to recruit and retain math and science teachers; and (c) that psychological, sociocultural, and working conditions are factors that influence math and science teachers' decisions to enter and remain in the teaching field. While this review primarily focuses on the US context, it offers valuable insights for researchers, practitioners, policymakers, and other key stakeholders worldwide by identifying strategies, mechanisms, and factors that shape teacher recruitment and retention in math and science. This review also discusses gaps in the literature, directions for future research, and implications for research, policy, and practice that emerge from the empirical evidence.

Keywords: teacher; math; science; recruitment; retention; STEM

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Academic Editor: Carla C. Johnson

Received: 8 July 2025
Revised: 15 August 2025
Accepted: 15 August 2025
Published: 20 August 2025

Citation: Solis Rodriguez, J. (2025). A Systematic Review of the Recent Empirical Literature on Math and Science Teacher Recruitment and Retention. *Education Sciences*, *15*(8), 1073. https://doi.org/10.3390/educsci15081073

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1. Introduction

The shortage of math and science teachers is a pressing issue in the United States (US) and globally. Recent data collected by the National Center for Education Statistics (2022) found that nearly 50% of public schools in the US have either a full- or part-time teaching vacancy. However, teacher shortages extend beyond the US teacher labor market. Similar shortages are also observed in other parts of the world (Armitage et al., 2020; Blanco et al., 2023). While teacher shortages are a problem, they are not universal and are acute in specific disciplines, such as math and science (Podolsky et al., 2016).

Teacher shortages have far-reaching consequences, especially in math and science. In today's knowledge-based economy, science, technology, engineering, and mathematics (STEM) skills are essential for driving scientific advancements and technological innovations. Math and science teachers are pivotal in cultivating these skills and serve as instrumental actors in preparing students for an evolving STEM workforce. Moreover, vacancies in math and science classrooms often result in classrooms staffed by underprepared teachers who are more likely to leave their positions, exacerbating teacher turnover rates (Carver-Thomas, 2022), which not only negatively impact the test scores on math

standardized tests of students whose teachers have left but also has a broader, harmful influence on student test scores across the school (Ronfeldt et al., 2013).

This literature review offers a new perspective for understanding and mitigating math and science teacher shortages by focusing on two critical junctures in the STEM teacher pipeline, recruitment and retention. Building upon prior reviews on teacher recruitment and retention (Guarino et al., 2006; See et al., 2024), this review extends the literature base by focusing on math and science teachers—two core subject areas in US primary and secondary (K–12) public schools as well as globally. This review synthesizes findings from 43 peer-reviewed empirical studies published between 2005 and 2024 on math and science teacher recruitment and retention in the US and closely follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The following questions guide the review:

(1) What are the characteristics of math and science teachers who enter and remain in the teaching profession?
(2) What strategies and mechanisms are used to recruit and retain math and science teachers?
(3) What factors influence individuals to enter and remain in math and science teaching roles?

While this review primarily focuses on the US context, it offers valuable insights for researchers, practitioners, policymakers, and other key stakeholders worldwide to help mitigate teacher shortages in STEM education by identifying strategies, mechanisms, and factors that shape teacher recruitment and retention in math and science. In what follows, this review applies a supply and demand framework to study the recruitment and retention of math and science teachers. Next, the methods employed for this review are detailed. A synthesis of empirical findings on math and science teacher recruitment and retention follows. Lastly, the review discusses gaps in the literature, directions for future research, and implications for research and practice that emerge from the empirical evidence to help curb teacher shortages in STEM education.

2. Literature Overview

Teacher recruitment and retention are two key aspects of the teacher pipeline. Research has emphasized that pay, working conditions, preparation, mentoring, and ongoing support are key predictors of teacher recruitment and retention (Darling-Hammond, 2010). These factors affect the recruitment and retention of all teachers, including teachers of color and indigenous teachers, who are underrepresented in public schools (Gist & Bristol, 2022).

For instance, studies on teacher recruitment have reported that increasing wages is associated with hiring new teachers with stronger educational backgrounds (Gjefsen, 2020) and that when districts raised teachers' entry-level salaries, they were able to attract more highly educated candidates (Jacobson, 1990). Research has also found that candidates with backgrounds in hard-to-staff subjects were more likely to be hired as teachers compared to those with backgrounds in other fields (Goldhaber et al., 2022a), and that individuals tend to cite intrinsic, extrinsic, and altruistic motivations for joining the teaching profession (Thomson et al., 2012; Morettini, 2014). Studies have also found that teacher certification pathways are associated with teacher retention (Guthery & Bailes, 2022; Redding & Smith, 2016).

Studies focused on teacher retention, for example, have found that the quality of teacher preparation received (Goldhaber et al., 2022b), the type of certification a teacher obtains (Zhang & Zeller, 2016), and teacher mentorship (Ingersoll & Strong, 2011; Odell & Ferraro, 1992) predict retention. Research has also shown that organizational characteristics and working conditions within schools (Ingersoll, 2001), including the leadership skills of school administrators (Kraft et al., 2016) and job satisfaction (Perrachione et al., 2008),

substantially influence teacher retention rates. In addition, research has found that when teachers of color and White teachers work in similar schools, their turnover rates do not differ significantly from one another (Carver-Thomas & Darling-Hammond, 2019). Others have also found that teachers of color have high retention rates (Edwards, 2024).

Recent research also indicates a strong need to strengthen recruitment and retention efforts, especially in shortage areas. Sutcher et al. (2019) analyzed recent national data, which revealed a limited supply of teachers in hard-to-staff subjects, such as math and science, partly due to a lack of qualified candidates to meet demand. This review contributes to the broader scholarly conversation on teacher recruitment and retention by synthesizing recent empirical evidence focused on the recruitment and retention outcomes for K–12 math and science teachers, two subjects that are consistently hard to staff in K–12 public schools.

3. Supply and Demand Framework

This review applies a supply and demand lens to better understand math and science recruitment and retention, two key sources for understanding and mitigating teacher shortages in STEM education. In the supply and demand framework, supply refers to the number of eligible individuals willing to teach, while demand refers to teaching positions that need to be filled by qualified individuals (Loeb & Myung, 2010). A shortage typically occurs when the demand for qualified teachers outpaces supply (Sutcher et al., 2016). Teacher shortages are especially acute in math and science (Podolsky et al., 2016; Hutchison, 2012). There are several reasons for these shortages. For instance, there is a growing demand for teachers due to projected increases in student enrollment in primary and secondary schools (NCES, 2020). Low teacher retention rates magnify this demand, with teachers frequently leaving due to pre-retirement factors such as poor working conditions (Ingersoll, 2011). Additional challenges include declining enrollment and graduation from teacher preparation programs, which reduce the supply of new teachers (Sutcher et al., 2016).

Major policy reports have consistently emphasized the need to enhance STEM education by recruiting and retaining more highly qualified STEM teachers (National Commission on Excellence in Education, 1983; The National Academies, 2007; President's Council of Advisors on Science and Technology, 2010). There have also been calls to increase the supply of teachers of color (Basile & Murray, 2015), as they are consistently associated with raising achievement and attainment outcomes for all students (Dee, 2004; Gershenson et al., 2022), and remain vastly underrepresented in the teacher workforce (NCES, 2023), in part due to systemic biases (Carter Andrews et al., 2019) and discriminatory hiring practices in the teacher labor market (D'Amico et al., 2017).

Various national initiatives have been launched in the US to address the supply and demand of teachers and curb teacher shortages in math and science. For instance, the Robert Noyce Teacher Scholarship program is a federal initiative that funds higher education institutions to recruit and prepare STEM majors and professionals for teaching careers in high-need urban and rural school districts (American Association for the Advancement of Science, n.d.). Another example is the Teacher Loan Forgiveness Program, which was established to recruit and retain highly qualified teachers, particularly in fields such as math and science, by offering federal student loan forgiveness to teachers who remain in the profession for at least five years (US Department of Education, n.d.). States have also supported the expansion of alternative teacher certification pathways to increase the supply of teachers (Bland et al., 2023). Although such initiatives have helped address the supply and demand of math and science teachers, shortages persist in these areas.

4. Methods

4.1. Search Strategy

Figure 1 illustrates the PRISMA flow chart of the review process, detailing the number of studies identified, screened, and included, as well as the reasons for exclusion. The PRISMA framework is a widely used guideline for reporting systematic review procedures. I systematically searched several databases to ensure a multidisciplinary perspective, including Education Resource Information Center (ERIC), Education Administration Abstracts, Academic Search Complete, EconLit, and SocINDEX. Searches employed single terms and their combinations, separated by Boolean operators. The search strings in the abstract included the following: "math* teach*" or "science teach*". The search strings in the title included the following: "recruit*", "hiring", "retain*", "retention", "persist*", "turnover", or "turn over". These search strings were applied to each database and accessed through EBSCO. The search terms yielded 291 publications. After removing 54 duplicates, 237 studies underwent subsequent screening and analysis.

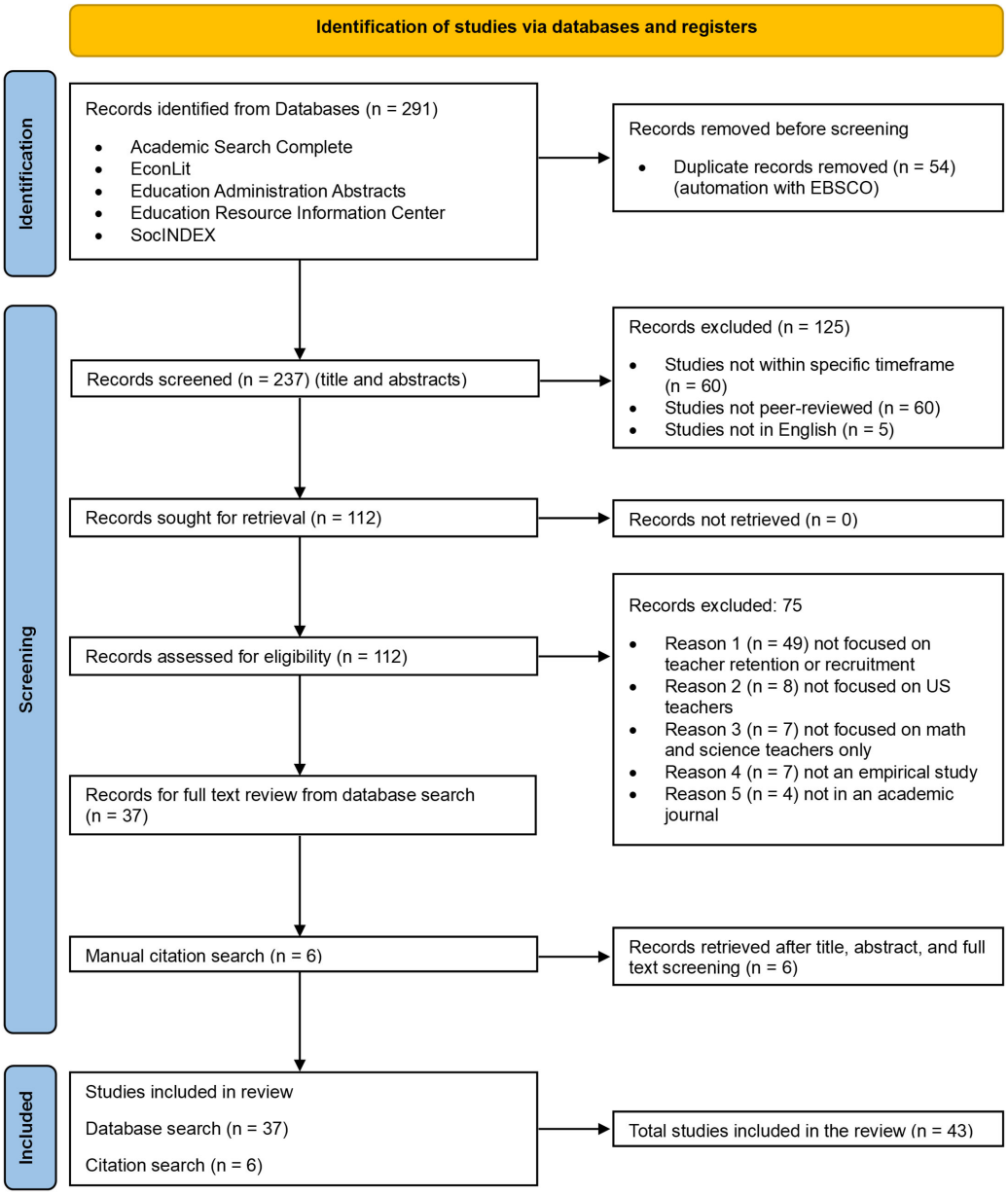

Figure 1. Flow chart of the review process. Note. Adapted from the PRISMA flow diagram (Source: Page et al., 2021).

4.2. Screening and Review Criteria

After the identification phase, studies were first screened based on titles and abstracts. The scope of the present review was limited to peer-reviewed studies published between 2005 and 2024, building upon Guarino et al.'s (2006) systematic literature review on teacher recruitment and retention, which included studies published before 2005. Review articles, dissertations, book reviews, and conference papers were excluded from the analysis. Studies not within the specific time frame (n = 60) and that were not peer-reviewed (n = 60) were excluded. Studies not in English (n = 5) were also excluded. This resulted in 112 out of the 237 studies being sought for retrieval.

In the second screening, studies were excluded if they were not focused on teacher retention or recruitment (n = 49), not focused on US teachers (n = 8), not focused on math and science teachers only (n = 7), not empirical where evidence was gathered through quantitative, qualitative, or mixed methods to analyze and arrive at their findings (n = 7), and not in an academic journal (n = 4). This resulted in 37 out of the 112 studies being sought for full-text review.

The final screening phase involved full-text reviews, and all 37 articles met the review criteria. I then conducted a manual citation search, screening titles, abstracts, and full texts, adding six studies to the final total of 43. To ensure accuracy, a second coder independently reviewed the coding at all screening and review phases to confirm that all relevant studies were included according to the review's exclusion/inclusion criteria.

4.3. Data Extraction and Analysis

With the final pool of 43 peer-reviewed empirical studies, I applied an analytic review template adapted from Castro et al. (2024) to map information relevant to the questions guiding this review and to describe the components of each research study, including each study's methods and relevant findings concerning recruitment or retention outcomes for math and science teachers (see Table S1). I organized these findings into three sections, each directly addressing one of the review's guiding questions.

4.4. Limitations

This review has some limitations. First, it includes only published studies, which may subject the findings to publication bias. Second, this review is limited to studies related to math and science teachers, rather than the entire STEM teacher spectrum. Third, to present a broad overview of the research on math and science teacher recruitment and retention research, I did not review or exclude empirical studies based on their quality (e.g., the soundness of their research designs).

5. Results

The results are presented in Sections 5.1–5.3. In the first section, I highlight the characteristics of math and science teachers who enter and remain in the teaching profession. In the second section, I examine the strategies and mechanisms used to recruit and retain math and science teachers. In the third section, I consider factors that influence individuals to enter and remain in math and science teaching roles.

5.1. Characteristics of Math and Science Teachers Who Enter and Remain in Teaching

5.1.1. Demographics and Qualifications

One study found that math and science teachers tend to be White, female, and middle-aged. Nguyen and Redding (2018), using a nationally representative sample of 42,010 STEM teachers spanning from 1988 to 2012, found that these teachers are most likely to be White, female, and have a mean age in their early 40s. This study also found that although the

teaching profession has grown more racially diverse, teachers of color still represent less than 20% of the overall STEM teacher workforce. In addition, they found that STEM teachers are more likely to have graduated from selective colleges (e.g., colleges with low acceptance rates), hold advanced degrees, have a first or second college major in a STEM field, or have obtained a state certification in a STEM field. However, they noted that those working in schools with a high percentage of students receiving free and reduced-priced lunch (FRPL) are often less experienced and less likely to hold advanced degrees, have strong STEM backgrounds, or come from selective colleges.

Four studies find that demographics and qualifications were key predictors of retention. Brantlinger and Grant (2024) analyzed data from 378 math teachers. They found that teachers' socioeconomic status (SES) was significantly associated with retention at five years, and that teachers' SES explained their retention independent of teacher race. Tai et al. (2007) analyzed data from 745 math and science teachers. They found that older teachers were more likely to remain in urban and suburban school districts. They also found that rural districts struggle the most in retaining math and science teachers. Grant and Brantlinger (2022) investigated the retention rates of 608 NYCTF secondary math teachers over 9 years. Their research showed that peak turnover occurred between years 3 and 5 rather than the initial 1 to 3 years. Palermo et al. (2022) analyzed data from 2410 science teachers and found that years since receiving certification, students' performance in chemistry, and teaching in isolation significantly predicted science teacher retention.

5.1.2. Certification Pathways

Two studies found that retention rates among math and science teachers entering through standard certification pathways are higher than those of alternative pathways. One study found comparable retention rates between both certification pathways. Using longitudinal data from Texas, Marder et al. (2020) investigated the retention rates of 53,000 math and science teachers prepared through standard and alternative teacher certification pathways. Their study found that math and science teachers who received standard university preparation had higher retention rates than their alternatively certified peers. Boyd et al. (2012) analyzed data from over 600 math teachers. They found that math teachers from the New York City Teaching Fellows (NYCTF) Math Immersion alternative certification program tended to exhibit higher attrition rates than their peers from standard certification programs but lower rates than those from Teach For America. However, Tai et al. (2006) analyzed data from 671 math and science teachers and found that alternatively certified teachers had comparable retention rates to their traditionally certified peers.

One study found that mid-year turnover rates among alternatively certified math teachers were especially high. Brantlinger (2021) surveyed 600 NYCTF math teachers in the alternative certification program and found high mid-year turnover rates among alternatively certified teachers in the program, particularly during their first year of teaching, even though participants in this selective program had committed to repaying some of the program's costs if they left before completing their two-year commitment.

A separate study found that alternative certification programs help recruit math and science teachers. Abell et al. (2006) analyzed data from over 50 participants who enrolled in the Science and Mathematics Academy for the Recruitment and Retention of Teachers alternative certification program. They found that the program helped recruit math and science teachers, but intentional gatekeepers (e.g., entrance criteria) and unintentional gatekeepers (e.g., internet accessibility) constrained or facilitated the program application process.

5.1.3. Pedagogical and Content Training

One study found that new math and science teachers from alternative certification programs often received less comprehensive training in pedagogy and classroom management than those who received their training from traditional higher education-based teacher certification programs. Boyd et al. (2012) found that NYCTF Math Immersion program teachers had received fewer instructional and classroom management courses than their peers from college-recommended standard programs.

A separate study examined the relationships between content training and teacher retention. Viviani et al. (2023), in their analysis of 307 math teachers, found that both subject-specific (e.g., math sequencing) and subject-general (e.g., classroom management) aspects of perceived initial preparedness predicted teachers' 5- and 8-year retention in their first schools, their 8-year retention in their first district, and their overall 8-year retention in the profession.

5.1.4. Supply and Demand

One study found a balance in the supply and demand of math and science teachers. Ingersoll and Perda (2010) used nationally representative teacher data from 1999 to 2001, which included over 500,000 teachers, and found a sufficient supply of new math and science teachers to meet demand, even after accounting for increases in student enrollment and teacher retirements. However, they noted that the supply–demand balance became considerably tighter when considering pre-retirement factors for teacher attrition (i.e., teachers leaving the teacher workforce altogether), such as working conditions.

5.1.5. Retention Patterns

Two studies found that math and science teachers were not more likely to leave teaching than their non-STEM teacher peers. A separate study pointed out that turnover intention and observed turnover were not related. Nguyen and Redding (2018) observed that STEM teachers were slightly less likely to leave their positions than non-STEM teachers. Ingersoll and May (2012) found that math and science teachers were not more likely to leave teaching for non-education jobs compared to other teachers. Moreover, Grant and Brantlinger (2023) analyzed data from 620 math teachers and found that teacher turnover intention and observed teacher turnover were not strongly associated.

Two studies found higher retention rates of math and science teachers of color, and one found lower retention rates. Brantlinger and Grant (2022) investigated the retention trends among two distinct subgroups of teachers within the NYCTF program: graduates from highly selective colleges and Black and Latinx community insiders (i.e., teachers who have social ties to their local communities where their schools are located). Their study revealed significantly higher retention rates among Black and Latinx community insiders in their first school hired than their counterparts from selective colleges and other NYCTF math teachers. Brantlinger and colleagues (2023) analyzed data from 617 math teachers. They found that community insiders (i.e., graduates of New York City high school graduates) had significantly higher odds of district retention at the 3-, 5-, and 8-year marks compared to community outsiders. They also found that Black community insiders with prior teaching experience had higher odds of retention. In contrast, Larkin et al. (2022) studied the five-year career trajectories of 231 new secondary science teachers in New Jersey. They found that although alternative training programs attracted more individuals who identified as people of color, they had lower 5-year retention rates than their peers from standard certification programs.

Three studies found notable migration patterns of math and science teachers, a key dimension of teacher retention. Ingersoll and May (2012) analyzed national survey data

from over 40,000 math and science teachers. They found that teachers were moving from poor to non-poor schools, from high-minority to low-minority schools, and from urban to suburban schools. Harrell et al. (2019) investigated the transfer and retention rates of 76 new math and science teachers from the UTeach program, a university-based teacher preparation program to increase the number of qualified secondary STEM teachers. They found that approximately 20% of teachers transferred to a different school but generally remained in settings with similar student demographics and achievement levels, while about 11% left the profession entirely. Ingersoll and Perda (2010) found that substantial reshuffling occurs in math and science teaching assignments.

5.2. Strategies and Mechanisms Used to Recruit and Retain Math and Science Teachers

5.2.1. Monetary Incentives

Four studies found that the Noyce scholarship helps recruit math and science teachers to teach in high-need schools. One of these studies highlights that Noyce recipients may already be more likely to teach in high-needs schools even without the scholarship. Marder et al. (2022) analyzed data from 202 Noyce Scholarship recipients across eight universities in Texas to investigate whether they had a higher likelihood of staying in teaching than other math and science teachers who did not receive the Noyce scholarship. They found that Noyce recipients exhibited lower retention rates than other STEM teachers and were also more prone to transfer out of schools serving low-income students. They also noted that Noyce scholars tend to teach marginalized students more frequently than their STEM teaching peers from the same institutions, and that their students achieve higher value-added scores in math compared to students of other teachers at the same schools. Zahner et al. (2019) analyzed data from 158 math teachers. They found that the Noyce scholarship was generally successful in recruiting individuals with STEM majors to become math teachers in high-need schools. They also found that Noyce scholars had lower attrition rates compared to Teach For America corps members who were alternatively certified. Martinie et al. (2023) found that the Noyce scholarship and related program activities effectively recruited math teachers and supported their retention as novice teachers. However, Whitfield et al. (2021) found that the Noyce scholarship had a limited impact on the decisions of Noyce scholars to pursue STEM teaching careers or work in high-need schools, as they were already inclined toward teaching in these schools even before receiving the scholarship.

One study found that loan forgiveness programs helped recruit math and science teachers, and another found that tuition-free programs had a similar effect. Smith (2021) conducted a case study involving 10 participants in North Carolina's Teaching Fellows Program, which utilizes loan forgiveness as a recruitment strategy for prospective STEM teachers. Their study found that while these loan-based incentives primarily attracted individuals already interested in becoming STEM teachers, they also had the potential to appeal to those who had not initially considered entering the teaching profession. Moreover, Artzt and Curcio (2008) analyzed data from 81 participants. They found that most participants were recruited into the Teaching Improvements through Mathematics Education program, a four-year tuition-free undergraduate secondary math teacher preparation program, by hearing about it from their teachers who recommended them for the program (32%) or from personal letters sent to them by the program after being accepted to the university (22%). The study also found that most program graduates stayed in teaching.

Two studies highlight that financial incentives are associated with higher retention. Feng and Sass (2017) analyzed state data on over 726,000 Florida teachers to investigate the effects of non-wage compensation strategies on teacher retention in hard-to-staff teaching assignments, such as math and science. They found that the state's loan forgiveness program decreased average attrition rates for middle and high school math and science

educators. Kim et al. (2021) analyzed data for 2,131 math and science teachers and found that late-career salary bonuses were associated with retention.

5.2.2. Experiential Learning

Three studies found that internship opportunities encourage individuals to consider a career in teaching. Worsham et al.'s (2014) study included 34 college students who were given paid internships to explore the possibility of becoming science teachers. Although the internships did not persuade them to commit to a career in teaching, many expressed an openness to the idea of teaching in the future. Factors such as low teacher compensation and classroom management challenges were cited as deterrents to joining the teaching field. Borgerding's (2015) study examined how five early STEM majors, who were not already considering a career in teaching, experienced a summer teaching recruitment internship and found that the experience led some students to consider a teaching career. de la Cruz and Goldman (2023) analyzed data from a sample of nine math teachers and found that an experiential learning program providing early teaching experience inspired participants to consider a career in teaching.

5.2.3. Mentorship and Professional Development

Three studies showed that mentorship and professional development are critical in encouraging STEM teachers to stay in teaching. Nguyen and Redding (2018) showed that increasing the number of content hours in professional development was associated with a 20% reduction in the risk of STEM teachers leaving high-FRPL schools. Fisher and Royster (2016) studied the perspectives of four math teachers to understand their needs better and identify ways to improve support and retention. They found that teachers expressed content-specific and non-content-specific needs and a strong desire for targeted professional development opportunities. Goodpaster et al. (2012) interviewed six rural science teachers. They found that community engagement, professional development opportunities, and the structure of rural schools were critical mediators of teacher retention in rural areas.

5.3. Factors That Influence Individuals to Enter the Teaching Profession and Remain in Math and Science Classrooms

5.3.1. Psychological and Sociocultural

Five studies found that altruistic and intrinsic factors strongly motivated individuals to pursue careers as STEM teachers. Brantlinger (2021) surveyed NYCTF math teachers who were recent graduates, career seekers, and career changers. They found that their primary reasons for entering the STEM teaching field were to seek meaningful work and make a social difference. Newton et al. (2020) analyzed data from 58 math and science teachers. They found that these teachers cited intrinsic motivations, such as a love of math and science, a passion for teaching, and a desire to influence others, as factors that motivated them to join the teaching profession. Personal traits, such as marital status, number of children, advanced degree, and age, also influenced their decisions to enter and stay in teaching. Callahan and Brantlinger (2023) found that math teachers cited altruism and a desire for a meaningful job as reasons for becoming math teachers. Their study also found that job benefits and alternative certification were reasons individuals became math teachers and were entry factors predictive of retention. Fraser-Abder (2010) found that, for five science teachers, understanding and caring for students was crucial to their success in teaching and long-term retention in the profession. Marco-Bujosa et al. (2024) reported that 14 preservice science teachers entered teaching because they were not interested in traditional science careers and valued socially oriented career goals.

One study also showed that prospective STEM teachers of color experienced apprehension when considering a career in teaching as it went against their family's expectations.

Lawrence et al. (2020) analyzed data from four science teachers who participated in a pilot program to recruit biology majors into the teaching profession. They found that STEM majors of color who chose to pursue teaching experienced internal conflicts between choosing a teaching career and their families' expectations to choose a career in the medical profession.

Three studies showed that teacher beliefs and professional identity significantly influence the likelihood of STEM teachers remaining in the teaching field. Olitsky (2020) explored the relationship between school structures, identity development, and the retention of STEM teachers of color. Their study found that a misalignment between a STEM teacher's professional identity and their school practices can influence them to consider leaving the profession. Wong and Luft (2015) conducted a five-year study of 35 new secondary science teachers to investigate the relationship between teachers' beliefs and their commitment to the profession. Their results indicated that teachers with student-centered beliefs were more likely to remain in teaching through at least the end of their third year of service. Olitsky et al. (2019) investigated the teaching commitment of 12 Noyce Scholarship recipients. They found that teachers who prioritized student-centered and pedagogy-centered identities were more likely to remain in teaching if they felt their professional identities were supported through school structures as well as through their collegial and student relationships.

A separate study highlights that critical incidents, specific events, moments, or experiences considered influential by teachers, also shaped their decisions to stay in the field. Hurst and Brantlinger (2022) analyzed data from over 366 math teachers to examine the connection between critical incidents and retention among experienced math teachers with alternative certification. Their study found that critical incidents substantially influence teachers' career choices and retention patterns.

5.3.2. Working Conditions

Two studies reported that collegial interpersonal relationships, especially supportive relationships with administrators, play a substantial role in teacher retention. Nguyen and Redding (2018) found that STEM teachers working in schools with supportive administrators were less likely to leave their positions, regardless of the school's percentage of students eligible for FRLP. Redding et al. (2019) analyzed data from 64 new math teachers. They also found that teachers who received greater support from their administrators were less inclined to quit and that this support played a larger role in reducing new teacher turnover than other forms of support (e.g., mentorship and professional development).

There are mixed findings on whether job satisfaction is associated with math and science teacher retention. One study found a significant relationship, while another did not. Han and Hur (2022), for instance, analyzed a nationally representative sample of over 1,288 STEM teachers. They found that lower satisfaction with career advancement opportunities was correlated with a higher likelihood of leaving teaching, especially among novice STEM teachers. In contrast, Bozeman et al. (2013) studied 385 secondary science teachers using state data and found no significant relationship between teacher satisfaction and retention.

Two studies found that math and science teachers tend to leave under-resourced schools at high rates. Nguyen and Redding (2018) reported that STEM teachers in schools with high percentages of students eligible for FRPL are more likely to leave the profession than their non-STEM counterparts. This trend is particularly pronounced among STEM teachers who hold graduate degrees. Ingersoll and May (2012) also found that turnover for math and science teachers was significantly higher in high-poverty, high-minority, and urban schools.

6. Discussion

This literature review offers a new perspective for understanding and mitigating teacher shortages by focusing on the recruitment and retention of math and science teachers. The review highlights the qualifications and characteristics of math and science teachers who enter and remain in the teaching profession; underscores that financial incentives, experiential learning, mentorship, and professional development are commonly used mechanisms to recruit and retain math and science teachers; and emphasizes that psychological, sociocultural, and working conditions are factors that influence math and science teachers' decisions to enter and remain in the teaching field.

6.1. Characteristics of Math and Science Teachers

The research revealed that the characteristics of math and science teachers, especially their qualifications, are strongly linked to their job retention. Math and science teachers who entered the profession through standard certification pathways tend to exhibit higher retention rates than those from alternative certification pathways (Marder et al., 2020; Boyd et al., 2012), though some research has found comparable retention rates between these two groups (Tai et al., 2006). Higher retention rates for teachers from standard certification pathways are consistent with the broader teacher recruitment and retention literature (Guthery & Bailes, 2022; Redding & Smith, 2016). Given the rising number of alternatively certified teachers to help mitigate labor shortages (Marder et al., 2020) and that alternatively certified math and science teachers tend to have less pedagogical and classroom management training in teaching than their standard certified peers (Boyd et al., 2012), these findings indicate a need for high-quality new teacher supports, such as induction and mentorship programs, to help retain the supply of math and science teachers.

In addition, alternative certification pathways help attract a diverse pool of prospective teachers—including individuals from underrepresented groups, such as people of color—and studies have found that math and science teachers of color exhibit high retention rates (Brantlinger & Grant, 2022; Brantlinger et al., 2023), which is consistent with the broader literature (Edwards, 2024). Importantly, these pathways also play a critical role in recruiting underrepresented math and science teachers, an essential step in diversifying the STEM teacher workforce (Basile & Murray, 2015).

Furthermore, the research found that although the literature suggests a sufficient supply of new math and science teachers to meet demand (Ingersoll & Perda, 2010), more recent data indicate a limited supply and strong demand for teachers, especially in subjects such as math and science (Sutcher et al., 2019). One reason for the shortages may be the notable migration patterns of math and science teachers who frequently move from under-resourced to higher-resourced schools (Nguyen & Redding, 2018; Ingersoll & May, 2012). These patterns illustrate a form of segmentation in the STEM teacher labor market in which the supply of these teachers is not equally distributed and varies by school context. This factor is particularly salient because math and science teachers are no more likely to leave teaching than their non-STEM teacher peers (Nguyen & Redding, 2018; Ingersoll & May, 2012).

6.2. Strategies and Mechanisms to Recruit and Retain Math and Science Teachers

Most studies reviewed focused on the monetary strategies and mechanisms to recruit math and science teachers. In particular, four of the six studies highlighting financial incentives in teacher recruitment concentrated on the Noyce scholarship, which is funded by the National Science Foundation. This grant is commonly used to attract STEM undergraduate majors and professionals to teach in under-resourced schools, and studies found it to be effective (Marder et al., 2022; Zahner et al., 2019; Martinie et al., 2023). However, it is less

clear whether the scholarship is influential in retaining teachers it helped recruit, since some individuals already may be inclined to become teachers even without the scholarship (Whitfield et al., 2021). Nevertheless, retaining more Noyce scholarship recipients will not only increase the supply of teachers but also the quality of teachers, given that students of Noyce Scholars score higher on math standardized tests than their peers taught by non-Scholars (Marder et al., 2022). With the increasing federal funding cuts to STEM programs in K–12 and higher education (Schwartz, 2025), such reductions may pose substantial setbacks to math and science teacher recruitment if programs like the Noyce scholarship were to be affected.

The review also found that financial incentives support the retention of math and science teachers (Feng & Sass, 2017; Kim et al., 2021). This aligns with the broader research showing that higher pay strengthens teacher recruitment efforts (Gjefsen, 2020; Jacobson, 1990), while the lack of competitive pay discourages prospective math and science teachers from considering careers in teaching (Worsham et al., 2014). This indicates that the financial opportunity cost of teaching, compared to other higher-paying occupations, remains a significant barrier to both recruiting and retaining teachers (Darling-Hammond, 2010).

6.3. Factors That Influence Individuals to Become Math and Science Teachers and Stay in Teaching

Although altruistic and intrinsic factors strongly motivate individuals to enter math and science teaching and remain in this career (Brantlinger, 2021; Newton et al., 2020; Callahan & Brantlinger, 2023; Fraser-Abder, 2010; Marco-Bujosa et al., 2024), these drivers can be tempered by external pressures. For example, familial expectations or the appeal of higher-paying STEM careers may discourage some prospective teachers from entering education (Lawrence et al., 2020). This suggests that the sole reliance on the nonpecuniary benefits of teaching to increase the supply of teachers is unlikely to offset the pecuniary advantages other professions offer to individuals with STEM backgrounds.

Furthermore, research shows that working conditions are critical to math and science teacher recruitment and retention (Nguyen & Redding, 2018; Redding et al., 2019). In particular, school leader support is consistently identified as a key factor in retaining teachers (Kraft et al., 2016), especially in math and science fields (Redding et al., 2019; Nguyen & Redding, 2018). Mentorship and professional development systems also play an important role, both in supporting math and science teachers (Nguyen & Redding, 2018; Goodpaster et al., 2012) and in predicting teacher retention (Ingersoll & Strong, 2011; Odell & Ferraro, 1992). Such supports are especially critical as growing numbers of teachers enter math and science classrooms with little to no preparation in pedagogy and classroom management, which are core fundamentals of teaching.

6.4. Implications

This review has implications for research and practice. First, most studies reviewed were quantitative and were focused primarily on retention. More longitudinal, qualitative studies are needed to understand how strategies, mechanisms, and factors help shape teacher recruitment patterns. Second, most of the quantitative studies reviewed incorporated correlational research designs. More experimental and quasi-experimental research designs are needed to assess the impact of strategies and mechanisms used to recruit and retain math and science teachers. Third, given that the literature identified mentorship and professional development as key strategies to retaining math and science teachers, school leaders should continue to invest in and improve these forms of support to create a working environment that retains teachers. In addition, schools can recruit new math and science teachers from within by supporting pathways that allow their teacher aides and paraprofessionals to become certified classroom teachers. Lastly, but most importantly, state

leaders and policymakers should prioritize improving teacher compensation by offering salaries and financial benefits that are competitive with private industry. This is crucial to strengthening the recruitment and retention of a highly effective and diverse workforce of math and science teachers.

7. Conclusion

Teacher shortages in math and science have far-reaching consequences for student learning, and it is crucial to increase the recruitment and retention of these instructors. However, addressing teacher shortages is not just about filling vacancies, it is also about ensuring the long-term stability of the teaching profession. Collectively, the empirical evidence in this review indicates that a one-size-fits-all approach will not suffice to alleviate STEM teacher shortages. Instead, comprehensive approaches are needed that include competitive salaries and ongoing high-quality supports. Implementing these strategies will substantially advance efforts to address STEM teacher shortages and build a strong, sustainable, and inclusive STEM teacher pipeline through evidence-informed teacher recruitment and retention efforts.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci15081073/s1, Table S1: Summary of all included studies in this review.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study.

Acknowledgments: Thanks to Carrie Mitchell for research assistance. Thanks to Pedro Reyes and the two anonymous reviewers for their feedback on earlier drafts.

Conflicts of Interest: The author declares no conflict of interest.

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