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Review

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Teacher Shortages in Developed Countries: A systematic literature review of measures and their effectiveness

Dave H. J. van Breukelen[1,*], Hanneke Theelen[2]

[1]Fontys University of Applied Science for Teacher Education Sittard, Monseigneur Claessensstraat 4, 6131 AJ, Sittard, The Netherlands
[2]Zuyd University of Applied Science, Nieuw Eyckholt 300, 6400 AN, Heerlen, The Netherlands

The two authors contributed equally to this work.

***Correspondence to:** Dave H. J. van Breukelen, Fontys University of Applied Science for Teacher Education Sittard, Monseigneur Claessensstraat 4, 6131 AJ, Sittard, The Netherlands; Email: d.vanbreukelen@fontys.nl

Abstract: This systematic literature review explores measures implemented in developed countries since 2007 to address teacher shortages across all educational levels, and examines their effects. The review identifies five main categories of interventions: workplace support and improvement, financial incentives and rewards, training and development, recruitment strategies, and stakeholder engagement. These measures operate across different phases of the teacher pipeline (recruitment, pre-service, and in-service) and vary in their short- and long-term impact. Findings indicate a strong emphasis on in-service interventions, such as salary increases and workload reductions, which provide immediate relief but often lack sustainability. Long-term strategies that improve working conditions, enhance professional development, and strengthen teacher preparation are essential to shift the focus from short-term fixes to prevention. Furthermore, teacher shortages are unevenly distributed across regions, subjects, and school types, making universal solutions impractical. Rural and high-needs schools face particularly acute challenges, underscoring the need for context-sensitive approaches. Addressing this complexity requires coordinated action among stakeholders and robust policy support to ensure systemic improvements in recruitment, training, and retention. Ultimately, effective solutions require integrated, evidence-based strategies that combine immediate interventions with structural reforms, sustained investment, and collaborative efforts to build a stable and motivated teaching workforce, thereby enhancing the profession's image and attractiveness.

Keywords: Teacher shortage; Systematic literature review; Teacher pipeline; Measures; Effectiveness

1. Introduction

In recent years, many countries have experienced severe teacher shortages across all educational levels. This challenge has reached critical proportions even in developed nations, where factors such as poor working conditions, high attrition rates, and shifting education policies have intensified the problem (OECD, 2023). Shortages are particularly acute in rural areas, special education, and disciplines such as science, technology, engineering, and mathematics (STEM) (Podolsky et al., 2016). Moreover, an aging teacher workforce and rising student–teacher ratios in certain regions further exacerbate the issue (UNESCO & International Task Force on Teachers for Education 2030, 2024; Sutcher et al., 2019). These trends underscore the urgent need to understand the underlying causes and develop effective solutions.

Although teacher shortages are a global phenomenon, each country faces distinct challenges. In the Netherlands, the shortage has been a major concern since the early twenty-first century. Contributing factors include low enrolment in teacher education programs, high dropout rates, and an aging teaching workforce (Rinnooy Kan et al., 2007). High attrition rates - driven by work pressure, demographic shifts, and socioeconomic constraints - further aggravate the situation, while policy responses often fail to meet the profession's needs (UNESCO & International Task Force on Teachers for Education 2030, 2024). Despite increased awareness and targeted interventions, the Netherlands continues to struggle with attracting and retaining teachers, mirroring trends observed in many other countries.

Although extensive research addressed teacher shortages, many studies fail to offer a comprehensive understanding. Existing research frequently concentrates on specific countries, contexts, or educational sectors, such as STEM (e.g., Hutchison, 2012), special education (e.g., Billingsley & Bettini, 2019), rural areas (e.g., Rhinesmith et al., 2023), or particular generations (e.g., Eckert, 2020). While these contributions are valuable, they do not capture the full complexity of the problem. Furthermore, other studies primarily emphasise quantitative dimensions, emphasising the severity of shortages, without exploring root causes or implications (e.g., Garcia & Weiss, 2019). Much of the literature lacks a comprehensive analysis of the complex nature of teacher shortages across the career span, from recruitment to retirement (Garcia & Weiss, 2019; Lindqvist & Gidlund, 2024). To address this gap, a previous study conducted by the authors provided an in-depth examination of causes and consequences of teacher shortages (Theelen & Van Breukelen, 2025). Similar to the present research, that study focused specifically on developed countries, including Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom, Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Iceland, Norway, Switzerland, Australia, Canada, Japan, New Zealand, and the United States (World Population Review, 2024). These nations share several socio-economic characteristics, including (relatively) stable economies, solid educational systems, and structural (public) funding, providing a solid basis for meaningful cross-country comparisons (World Population Review, 2024).

Building on previous research, this systematic literature review evaluates measures designed to address teacher shortages and its impact on educational systems. Understanding these measures is essential for developing effective policies that alleviate the crisis and strengthen the teaching profession (Garcia & Weiss, 2019; Lindqvist & Gidlund, 2024). By examining the interplay between causes, consequences, and interventions, this review aims to provide a comprehensive framework to inform future research and policy development.

2. Theoretical Background

2.1 Defining teacher shortages and their extent

Teacher shortages involve both quantity and quality dimensions. Quantitatively, a shortage occurs when the available number of teachers is insufficient to meet the demand, as reflected by the number of unfilled positions (Boe, 1996). This concept refers to the gap between teacher demand and supply, determined by the desired number of teachers, pupil enrolment, and established teacher–pupil ratios. According to UNESCO and the International Task Force on Teachers for Education

2030 (2024), as shown in **Table 1**, an additional 44 million teachers will be needed worldwide by 2030 to meet the objectives for primary education (13 million) and secondary education (31 million). These shortages are particularly severe in regions such as sub-Saharan Africa, where rapid population growth and limited teacher training opportunities exacerbate the situation. However, even in Europe and Northern America, which are regions aligned with the context of this study, nearly 5 million additional teachers will be needed by 2030. This demand is driven primarily by high teacher turnover rates and low enrolment. For example, teacher preparation programs in the United States experienced a 32% decline in enrolment between 2012 and 2019, accompanied by a 28% drop in degree completers during this period (Slichko et al., 2023). These statistics, along with an anticipated success rate of only 25-38% in meeting teacher needs by 2030, further highlight the urgent need for effective solutions at all educational levels.

Table 1 Teacher recruitment needs and the expected success rate

Region	Sector[a]	Teachers in 2022(in million)	Additional teachers needed for 2030 (in million)	Countries expected to meet the needs by 2030	Countries not expected to meet the needs by 2030
Europe and Northern America	PRI	4.9	1.7	38%	62%
	SEC	7.8	3.1	25%	75%
Worldwide	PRI	33.7	12.9	40%	60%
	SEC	39.4	31.1	16%	84%

Note. Adapted from Theelen & Van Breukelen, 2025. Data were obtained from the *Global Report on Teachers. Addressing teacher shortages and transforming the profession*, by UNESCO and International Task Force on Teachers for Education 2030, 2024, pp. 36-38. Copyright 2024 by UNESCO.
[a] PRI = primary education, SEC = secondary education.

In addition to quantitative shortages, there is also a qualitative gap, referring to the mismatch between required teaching qualifications and those held by available teachers (Boe, 1996). This occurs when teachers lack the necessary certification, training, or expertise for their roles, even when overall numbers are sufficient but many do not meet assignment standards. In Europe and North America, the share of qualified teachers fell from 97% to 88% in primary education and from 89% to 83% in secondary education between 2012 and 2022 (UNESCO & International Task Force on Teachers for Education 2030, 2024). Both quantity and quality dimensions highlight the need for targeted strategies to recruit and retain adequately qualified teachers across all subjects and levels.

2.2 Teacher shortages and the teacher pipeline

Teacher shortages affect every stage of a teacher's career, from recruitment and training to retention. Based on Barth et al. (2016), these stages are illustrated in the teacher pipeline (**Figure 1**). The pipeline begins with recruitment, attracting and selecting future teachers, followed by preparation through training and certification. Next is hiring and deployment, when teachers are assigned to schools, followed by induction, which supports novice teachers through mentoring and induction programmes. Finally, retention focuses on keeping teachers in the profession through professional development and flexible career pathways. For convenience, these career phases are often grouped into recruitment, pre-service, and in-service stages, though the sequence may vary depending on the certification pathway.

Figure 1 Teacher pipeline

Note. Adapted from Theelen & Van Breukelen, 2025.

The 'leaky pipeline' metaphor illustrates how teachers exit the profession at various stages before completing their career path (Barth et al., 2016). As noted by Lindqvist & Gidlund (2024), shortages stem from multiple challenges throughout the pipeline. Understanding these causes, their consequences, and how they interact with the pipeline is essential before evaluating potential measures and their impact. Effective solutions require an integrated approach that spans all stages of the pipeline, not isolated interventions (Admiraal, 2022).

2.3 Causes of teacher shortages

Based on our previous study, causes of teacher shortages can be classified into four categories (Theelen & Van Breukelen, 2025):

1. *Career conditions*: Excessive administrative tasks, heavy workloads, inadequate resources, insufficient support, low salaries, negative perceptions of the profession, and poor career prospects contribute to teacher dissatisfaction and attrition. Collectively, these factors discourage individuals from entering or remaining in the profession.

2. *Classroom issues*: Large class sizes, insufficient training, and challenging student populations are major stressors, particularly in high-poverty and rural schools. Teachers entering through non-traditional pathways often face additional difficulties due to inadequate preparation, increasing the risk of early attrition.

3. *Demographics*: An ageing workforce and regional disparities in teacher distribution contribute to shortages, particularly in rural and high-needs schools. Declining enrolment in teacher education programmes further widens the supply gap, as fewer candidates replace retiring teachers. In addition, government policies, such as rigid entry requirements and frequent curriculum changes, affect recruitment and retention, yet often fail to align with the underlying causes of teacher shortages.

4. *Well-being: Stress*, burnout, declining job satisfaction, and diminishing professional autonomy further discourage individuals from remaining in the profession. The emotional and physical toll of teaching in challenging environments, combined with a lack of professional respect and support, contributes to high turnover rates.

Although these causes are evident, their interrelated nature creates a vicious cycle that worsens shortages. Low salaries, heavy workloads, and classroom challenges shape negative perceptions of teaching, discouraging candidates and reducing enrolment in teacher education programmes. Excessive administrative demands, poor working conditions, and inadequate support heighten stress and burnout, driving high attrition, especially among early-career teachers. Combined with an ageing workforce, these factors limit solutions such as reducing class sizes and workloads due to insufficient staffing.

The issue of low salaries requires further explanation, as many studies cite it as an important cause. While salaries in education are not necessarily low in absolute terms, they often fail to reflect the demanding working conditions (OECD, 2023). Consequently, careers offering similar pay but better conditions are frequently preferred. Moreover, salary increases do not always yield lasting effects, as other sectors may respond similarly. This underscores the need for cohesive strategies that address the complexity of teacher shortages.

In our previous study, we highlighted the interrelatedness of causes within the teacher pipeline (Theelen & Van Breukelen, 2025). Of the 24 possible interactions, 17 (71%) relate to the in-service phase, 5 (21%) to enrolment, and only 2 (8%) to the pre-service phase. This indicates that many causes of teacher shortages originate within the education system itself, yet the issue is often attributed to formal training institutions (e.g., Eckert, 2020) or addressed through salary increases. This suggests a mismatch between the causes of teacher shortages and the measures taken, which has also been noted in other studies (Billingsley & Bettini, 2019; Admiraal, 2022).

2.4 Consequences of teacher shortages

According to the previous study, the consequences of teacher shortages also include four strongly interacting categories (Theelen & Van Breukelen, 2025):

1. *Impact on students*: Teacher shortages may reduce educational quality, student guidance, performance, and well-being, and can contribute to inequality or instability. Schools often adopt emergency measures such as combining classes, hiring underqualified staff, or cutting lesson time and subject offerings. These measures can limit instructional differentiation and

overall teaching quality. Consequently, students may receive less socioemotional support and individualised instruction, particularly in large classes. Frequent disruptions in student-teacher relationships can negatively affect academic performance. Disadvantaged and rural schools appear most vulnerable, as they often rely on inexperienced or uncertified teachers, which may widen achievement gaps and exacerbate educational inequality.

2. *Impact on teachers*: Teacher shortages may increase workloads for remaining staff, potentially causing classroom challenges, stress, and, in some cases, higher attrition. Teachers might take on extra classes, cover for absent colleagues, and manage additional administrative tasks, leaving less time for preparation and professional development. These pressures, compounded by larger class sizes and unqualified staff, can create a demanding work environment. Consequently, teachers may experience reduced morale, job dissatisfaction, and symptoms of burnout, which could further contribute to attrition.

3. *Impact on schools*: Teacher shortages may lead to employing underqualified teachers, larger class sizes, and increased financial pressures. Schools might hire less qualified or even unqualified staff, which can compromise teaching quality and adherence to standards. To address staffing gaps, classes are often merged, making it harder to provide individualised attention and maintain effective classroom management. Recruiting and training new teachers can also be costly, potentially straining limited budgets and reducing services such as student support and extracurricular activities.

4. *Impact on society*: Teacher shortages may harm the profession's public image or contribute to a less educated workforce and citizenry. Teachers face classroom challenges, heavy workloads, and low morale, while schools experience significant difficulties. Such conditions may reinforce negative perceptions of teaching, discouraging potential candidates from entering the field. A shortage of qualified teachers, particularly in key areas such as STEM, can hinder student achievement and skill development, with possible long-term implications for economic growth and social cohesion.

As with the causes, the consequences are closely interconnected and may reinforce one another. This relationship even extends to the link between causes and consequences, suggesting a potential vicious cycle. For instance, teacher shortages may lead to larger class sizes (a consequence), while larger classes can, in turn, exacerbate shortages (a cause). An examination of the teacher pipeline indicates a strong effect on the in-service phase: of the 19 interactions identified in our previous study, 12 (63%) relate to in-service, 5 (26%) to enrolment, and only 2 (11%) to pre-service. In short, measures should strongly impact teachers' daily work and be carefully coordinated to function as a smoothly operating network of interconnected gears across the teacher pipeline.

2.5 This study

While research on teacher shortages is extensive, many studies remain limited by narrow regional focus, specific pipeline stages, particular sectors, generational cohorts, or predominantly quantitative approaches. As a result, they rarely capture the global scale of shortages across the entire pipeline, from recruitment to retirement, and often lack an integrated analysis. Building on our previous study of the causes and consequences of teacher shortages in developed countries, this review examines measures implemented since 2007 to address these shortages. By situating these measures within the broader context of causes, consequences, and the teacher pipeline, the study aims to identify which measures work, which do not, and to what extent they are effective. The guiding question is: *What are the measures taken to address teacher shortages since 2007 in developed countries across all educational levels, and what are their effects?*

3. Methods

A systematic review was conducted to examine teacher shortages in developed countries and their effects across all educational levels (primary, secondary, higher, vocational, and special education). This section outlines the search strategy, inclusion criteria, data extraction, and coding procedures.

3.1 Search strategy and inclusion criteria

Articles were retrieved from Scopus, Web of Science, and ERIC. The initial search combined multiple key terms and synonyms related to teacher shortage (e.g., teacher deficit, lack of teachers), educational levels (e.g., primary education, higher education), developed economies, measure, and effect. However, this detailed

approach missed relevant studies because shortages were described inconsistently; some articles omitted educational level or country references. The strategy was therefore simplified to focus on teacher shortage and its synonyms (e.g., teacher deficit, lack of teachers, educator shortage, educator deficit, lack of educators), ensuring broader coverage. Removed terms were applied as inclusion criteria during abstract screening.

Studies were included if they empirically examined measures addressing teacher shortages, were conducted in developed countries listed in the introduction, and covered primary, secondary, higher, vocational, or special education. The search was limited to peer-reviewed articles in English or Dutch published between 2007 and 2024. This timeframe reflects Rinnooy Kan et al. (2007), who identified 2007 as the onset of an urgent and growing shortage of qualified teachers.

3.2 Screening and selection

Figure 2 shows the selection process. The initial search yielded 1,608 unique hits from ERIC, Scopus, and Web of Science. Screening was done using ASReview software, following the SAFE procedure (Boetje et al., 2024). ASReview was configured with TF-IDF for feature extraction, a naïve Bayes classifier for prediction, a maximum query strategy to prioritise informative samples, and dynamic double resampling for dataset balance. Two researchers first manually screened 1% of records to identify relevant abstracts and reach consensus, training the model for active learning-based screening. Screening continued until 404 abstracts (25%) were reviewed, stopping after 60 consecutive irrelevant abstracts, in accordance with SAFE heuristics. Finally, 102 abstracts (6.3%) were considered relevant for full-text screening.

Full-text screening was conducted collaboratively using a structured coding scheme to ensure consistent data extraction. Data collected included country, educational sector (primary, secondary, vocational, higher, special), focus within the educational pipeline (enrolment, pre-service, in-service), and measures taken with their effects. All 102 full-text articles were jointly reviewed; 38 were excluded for lack of relevance (e.g., non-developed countries or non-educational settings). This initial phase established consensus on inclusion criteria and assessment methods. After alignment, the remaining 64 articles were individually reviewed, resulting in 51 meeting the criteria. The 13 excluded articles lacked research-based support for the measures described. Risk of bias was assessed by examining potential reporting biases and inconsistencies in outcomes. To enhance reliability and minimise subjectivity, screening and coding were conducted collaboratively, ensuring interrater agreement.

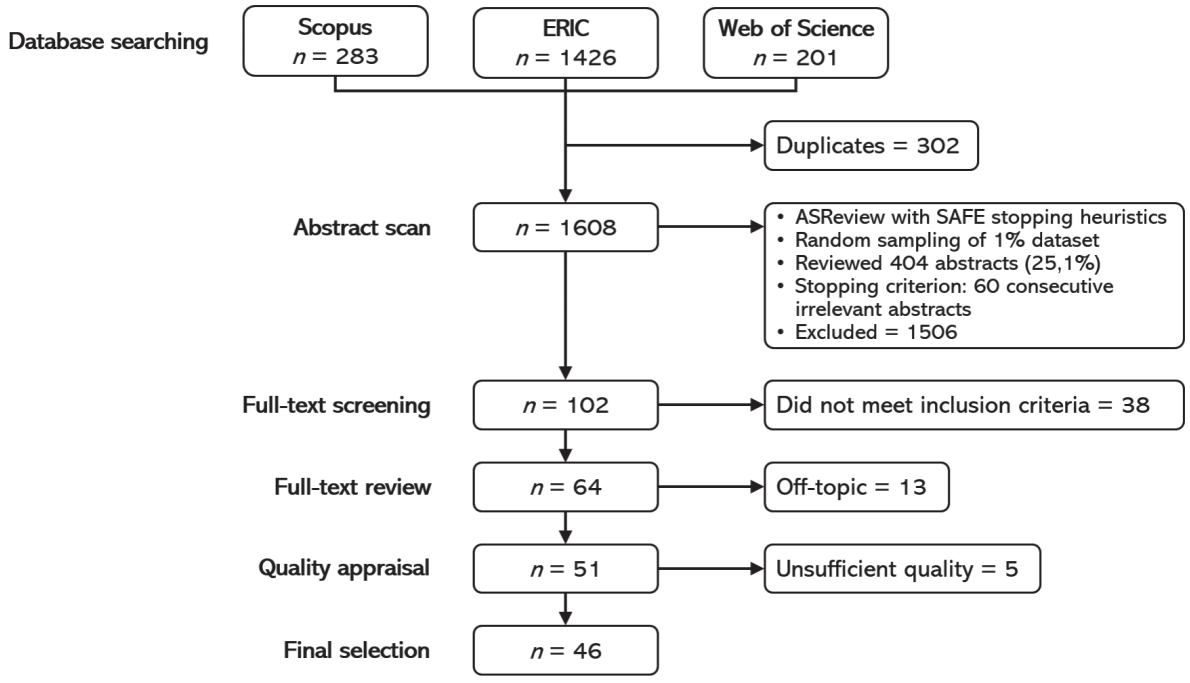

Figure 2 Flowchart selection process

3.3 Quality appraisal

To ensure reliability and validity, a quality assessment was conducted using the Joanna Briggs Institute (2017) critical appraisal tool for literature reviews and the criteria proposed by Symonds and Tang (2024) for quantitative, qualitative, and mixed-methods studies. Studies failing to meet the required methodological standards were excluded. Of the 51 articles reviewed, 46 remained.

3.4 Data analysis

Data were analysed using open and axial coding to identify central themes and connections across studies. This enabled systematic categorisation of measures addressing teacher shortages and insights into potential interventions and their effects. Atlas.ti was used to organise and structure emerging themes. To enhance reliability, codes were collaboratively developed, ensuring consensus and minimising individual bias.

4. Results

4.1 Included studies and identified measures

The aim of this review was to examine measures addressing teacher shortages and their effects. **Table 2** lists the 46 included studies alphabetically by author and provides details on country, educational sector (primary, secondary, vocational, special, higher), research methodology (mixed methods, quantitative, qualitative, literature review), and position within the teacher pipeline (recruitment, pre-service, in-service).

Table 2 Overview of the included studies

No.	Authors (year)	Country	Sector[a]	Method	Teacher pipeline[b]
1	Admiraal (2022)	Belgium, Netherlands	PRI, SEC	Quantitative	3
2	Admiraal (2023)	Belgium, Netherlands	PRI, SEC	Quantitative	3
3	Bates et al. (2024)	Australia	HIG	Mixed methods	2
4	Billingsley and Bettini (2019)	United States	SPE	Literature review	3
5	Birch et al. (2021)	European countries	SEC, HIG	Quantitative	1,2,3
6	Boström (2023)	Sweden	SEC	Qualitative	2
7	Brownell et al. (2018)	United States	SPE	Qualitative	3
8	Buchanan (2012)	Australia	SEC	Qualitative	1,2,3
9	Burke and Ceo-DiFrancesco (2022)	United States	PRI, SEC	Qualitative	2
10	Chapman et al. (2021)	United States	SPE	Qualitative	3
11	De Witte et al. (2023)	European Union	PRE, SEC	Literature review	1,3
12	Dreer (2021)	Germany	SEC	Quantitative	3
13	Dupriez et al. (2016)	Belgium	PRI, SEC	Quantitative	2,3
14	Eckert (2020)	United States	SEC, HIG	Literature review	1,2,3
15	Gooden et al. (2023)	United States	SEC	Literature review	3
16	Gorard et al. (2007)	England, Wales	SEC, HIG	Mixed methods	1,2,3
17	Gorard et al. (2021)	United Kingdom	HIG	Quantitative	1,2
18	Hudson and Hudson (2019)	Australia	PRI	Qualitative	2
19	Hutchison (2012)	United States	SEC	Qualitative	1,2
20	Ingersoll and Tran (2023)	United States	PRI, SEC	Quantitative	3
21	Inspectie van Onderwijs (2023)	Netherlands	PRI, SEC, SPE	Qualitative	3
22	Kuijpers et al. (2024)	Netherlands	SEC	Mixed methods	2
23	Lampert et al. (2023)	Australia	SEC	Qualitative	3
24	Lindqvist and Gidlund (2024)	Worldwide	n.s.	Literature review	1,2,3
25	Love and Love (2022)	United States	SEC	Quantitative	1
26	Martinie et al. (2023)	United States	SEC	Qualitative	1,2,3
27	McHenry-Sorber et al. (2023)	United States	PRI	Qualitative	3
28	Meijer (2021)	Netherlands	PRI, SEC, VOC, HIG	Literature review	1,2,3
29	Mendez (2023)	United States	PRI, SEC	Qualitative	3

Continuation Table:

No.	Authors (year)	Country	Sector[a]	Method	Teacher pipeline[b]
30	Morettini (2014)	United States	SEC	Qualitative	2
31	Patil (2023)	Australia	SEC	Literature review	1,2,3
32	Pauwels et al. (2022)	Belgium	SEC	Quantitative	1,2
33	Peyton et al. (2021)	United States	SPE	Quantitative	3
34	Podolsky et al. (2016)	United States	PRI, SEC	Literature review	3
35	Rahimi and Arnold (2024)	Australia	SEC	Quantitative	3
36	Rhinesmith et al. (2023)	United States	PRI, SEC	Literature review	2,3
37	Richards and Gurley (2023)	United States	PRI, SEC	Qualitative	3
38	See and Gorard (2019)	United Kingdom	SEC	Quantitative	1,2,3
39	Seeliger and Lindqvist (2023)	Germany	PRI, SEC, SPE	Qualitative	1,3
40	Shine (2015)	Australia	SEC	Qualitative	3
41	Sims (2020)	United Kingdom	SEC	Quantitative	3
42	Stokes (2007)	Australia	SEC	Quantitative	1,2
43	Straková and Simonová (2024)	Czech Republic	SEC	Quantitative	2,3
44	Struyven et al. (2013)	Belgium	PRI	Quantitative	2
45	Sutcher et al. (2019)	United States	PRI, SEC	Quantitative	1,2,3
46	Van Rooij et al. (2020)	Netherlands	SEC	Quantitative	2,3

[a] PRI = primary education, SEC = secondary education, HIG = higher education, SPE = special education, VOC = vocational education.
[b] 1 = Recruitment/enrolment, 2 = Pre-service teachers, 3 = In-service teachers.

Measures identified in the literature are grouped into five categories (**Table 3**): (1) workplace support and improvement, (2) financial incentives and rewards, (3) training and development, (4) recruitment of (pre- and in-service) teachers, and (5) stakeholder engagement. This order reflects the frequency of mention in the included studies (highest to lowest), indicating the relative attention each measure receives. **Table 3** also shows the teacher pipeline phase where each measure has the greatest direct impact. Most measures relate to the in-service phase (50%), followed by pre-service (35%) and recruitment (15%). All measures and their effects are discussed in the following sections. Given the included studies, attributing effects to a single measure is extremely difficult, if not impossible; therefore, we restrict our conclusions to potential short- or long-term effects.

Table 3 *Measures taken to address teacher shortages across the teacher pipeline*

Measures	Recruitment	Pre-service	In-service
Workplace support and improvement			
Mentoring, induction programs and team teaching (*n* = 31)		■	■
Improved teaching environment (*n* = 30)		■	■
Workload reduction (*n* = 13)			■
Support staff utilisation (*n* = 10)			■
Mental health and emotional support (*n* = 10)			■
Financial incentives and rewards			
Increased salaries (*n* = 20)			■
Relief of financial burdens (*n* = 18)		■	■
Targeted bonuses and extras (*n* = 10)		■	■
Housing assistance (*n* = 3)			■

Continuation Table:

Measures	Recruitment	Pre-service	In-service
Training and development			
Alternative, flexible or improved teacher training programs (*n* = 25)	■	■	
Professional and career development (*n* = 24)			■
Recruitment of (pre- and in-service) teachers			
Targeted recruitment campaigns and efforts (*n* = 18)	■	■	
Status, attractiveness, and value of the profession (*n* = 16)	■	■	
Alternative (unqualified) teaching staff (*n* = 6)			■
Stakeholder engagement			
Collaboration initiatives (*n* = 14)		■	■
Government actions and policy changes (*n* = 7)	■	■	■

Note. The number of studies addressing each measure is indicated by *n*.

4.2 Workplace support and improvement

Support for and improvement of the workplace primarily focus on guiding, supporting, and retaining teachers. This is particularly crucial for beginning teachers to help them remain in the profession. These efforts not only reduce workload but also enhance overall well-being. The following subsections provide a detailed analysis of the measures in this category.

4.2.1 Mentoring, induction programs and team teaching

Across 31 studies, initiatives such as mentoring, induction programmes, coaching, and team teaching are considered essential for supporting novice teachers. These measures facilitate a smooth transition into practice and foster a sense of support (e.g., Buchanan, 2012; Chapman et al., 2021). They may also benefit experienced teachers by helping them navigate professional challenges (Sutcher et al., 2019). Mentorship and coaching, in particular, are recognised for building confidence and competence, thereby strengthening self-efficacy and enhancing job satisfaction (e.g., Richards & Gurley, 2023).

4.2.2 Improved teaching environment

Thirty studies highlight improving teaching environments and employment conditions through measures such as smaller class sizes, better infrastructure and resources, innovative didactic approaches (e.g., blended and active learning), and stronger leadership (e.g., De Witte et al., 2023). These improvements enhance teacher effectiveness and satisfaction, which may improve teaching and learning (Admiraal, 2022). By creating a more supportive work environment, these measures also aim to attract and retain teachers (Shine, 2015).

4.2.3 Workload reduction

Evidence from 13 studies highlights workload reduction - through streamlined administration, smaller classes, and extra planning time - as critical for teacher satisfaction and retention (e.g., Sims, 2020). By alleviating excessive workloads, such measures ease stress and enable professional development, supporting a sustainable and effective workforce (e.g., Gorard et al., 2021; Gooden et al., 2023).

4.2.4 Support staff utilisation

Evidence from 10 studies shows that support staff, including administrative personnel and teaching assistants, alleviate teacher workload by handling non-teaching tasks and offering classroom assistance (e.g., Sims, 2020; Inspectie van Onderwijs, 2023). This enables teachers to concentrate on instructional activities, improving efficiency and job satisfaction, while also enhancing the learning environment (De Witte et al., 2023; Mendez, 2023).

4.2.5 Mental health and emotional support

Ten studies emphasise the need for supportive work environments that prioritise teachers' mental health and well-being.. Initiatives such as counselling services, stress management programmes, and fostering a positive school culture are identified as effective strategies (e.g., Chapman et al., 2021; Dreer, 2021). These measures may enhance job satisfaction and self-efficacy, ultimately improving teacher retention and overall performance (Sims, 2020).

4.2.6 Effects of workplace support and improvement

Reducing teacher workload through measures such as administrative support, teaching assistants, smaller class sizes, and improved technological resources can promote work–life balance, job satisfaction, and reduce burnout risk (Bates et al., 2024). However, these solutions often face financial constraints and, in cases like smaller classes, may even exacerbate teacher shortages (De Witte et al., 2023; Inspectie van Onderwijs, 2023). While short-term fixes offer quick relief, they risk long-term issues such as lower teaching quality and heavier workloads for remaining staff. More sustainable approaches include mentorship, induction programmes, and collaborative practices, which enhance satisfaction, motivation, and professional growth (Chapman et al., 2021). Emotional and mental health support, reinforced by strong leadership, further promotes well-being in demanding contexts (Sims, 2020).

4.3 Financial incentives and rewards

Financial incentives and rewards are key to attracting and retaining teachers by increasing the profession's appeal. Competitive salaries, financial support, and targeted bonuses help reduce barriers to entry and retention. The following subsections analyse these strategies in detail.

4.3.1 Increased salaries

Evidence from 20 studies shows that increasing teacher salaries is widely recognised as a way to make the profession more attractive. Higher pay correlates with improved recruitment and retention, as it enhances competitiveness with other careers (e.g., Shine, 2015; Rahimi & Arnold, 2024). Salary increases are also linked to greater job satisfaction, reduced turnover, and a more stable workforce, particularly in high-poverty schools and hard-to-staff subjects (e.g., Birch et al., 2021; De Witte et al., 2023).

4.3.2 Relief of financial burdens

Eighteen studies highlight the role of reducing financial barriers for aspiring teachers through measures such as scholarships and loan forgiveness (e.g., Rhinesmith et al., 2023). These initiatives aim to make teaching more accessible and appealing, particularly for candidates from specific backgrounds, such as STEM professionals or those entering high-demand fields (e.g., Hutchison, 2012; Podolsky et al., 2016). Evidence shows that such incentives significantly improve recruitment and retention by easing financial challenges during teacher education and early career stages (See & Gorard, 2019; Burke & Ceo-DiFrancesco, 2022).

4.3.3 Targeted bonuses and extras

Targeted bonuses and additional incentives, distinct from salary increases or financial relief, are offered to address specific challenges in education. Examples include transportation allowances, classroom material budgets, professional development grants, and performance-based bonuses (e.g., Bates et al., 2024). These incentives are often used to attract teachers to hard-to-staff schools, high-need subjects such as STEM, or underserved areas (e.g., Birch et al., 2021; De Witte et al., 2023). While studies suggest they can improve recruitment and retention in these contexts, their long-term impact is limited, as they do little to address everyday challenges teachers face (De Witte et al., 2023).

4.3.4 Housing assistance

Only three studies mention housing benefit programmes, mainly in rural or high-cost areas. These initiatives aim to reduce living expenses, making it easier for teachers to live and work in the communities they serve (Rhinesmith et al., 2023). Evidence suggests housing assistance can be an effective tool for attracting and retaining teachers where housing costs pose a significant barrier (Brownell et al., 2018).

4.3.5 Effects of financial incentives and rewards

Financial incentives, such as higher salaries and targeted bonuses, can help attract teachers, particularly in shortage areas like STEM and schools in remote or vulnerable regions (Rhinesmith et al., 2023). These measures are most effective for recruiting beginning teachers but often have only short-term impact (Mendez, 2023). While financial incentives make the profession more appealing, evidence shows they are insufficient for long-term retention without additional support and improved working conditions (Sutcher et al., 2019). Moreover, competing incentives in other sectors may outpace those in education (Inspectie van Onderwijs, 2023). Housing assistance can attract teachers to rural or hard-to-staff areas, but its success depends heavily on other amenities and workplace conditions (Brownell et al., 2018).

4.4 Training and development

Training and development are essential for strengthening the teaching workforce by improving preparation, enhancing professional skills, and creating career growth opportunities. Flexible and alternative training programmes help attract diverse candidates, while ongoing professional development and clear career pathways support retention and motivation. The following subsections examine these strategies in detail.

4.4.1 Alternative, flexible or improved teacher training programs

In 25 studies, alternative, flexible, or improved teacher training programmes are highlighted as effective for attracting and retaining teachers. These include part-time, blended, and accelerated courses, suited to candidates with diverse backgrounds (Birch et al., 2021). Initiatives such as personalised programmes, alternative certification, and apprenticeships aim to attract career changers and underrepresented groups (e.g., Morettini, 2014; Hudson & Hudson, 2019). A key feature is realistic, high-quality, practice-oriented training that reduces the 'practice shock' new teachers often face (Podolsky et al., 2016). Success depends on thorough preparation and ongoing support to equip teachers for classroom challenges (Sutcher et al., 2019).

4.4.2 Professional and career development

According to 24 studies, professional and career development opportunities are crucial for retaining teachers and enhancing their skills. Ongoing initiatives such as workshops, seminars, and mentorship programmes help teachers stay updated and improve practice (e.g., Gorard et al., 2007; Buchanan, 2012; Richards & Gurley, 2023). Clear career pathways and leadership roles further support motivation and retention (Sims, 2020). These opportunities also foster competence development aligned with changing classroom and teaching demands. By investing in continuous growth and advancement, these measures aim to build a more satisfied and effective teaching workforce (Admiraal, 2022).

4.4.3 Effects of training and development initiatives

Flexible and alternative training pathways can help lower barriers to entering the teaching profession, particularly for career changers, and have proven effective in increasing the influx of new teachers (Admiraal, 2022). However, their success depends largely on programme quality and employment conditions in other sectors, which influence career decisions (De Witte et al., 2023). Strong subject knowledge, pedagogical skills, and effective teaching strategies are critical for long-term success (Sutcher et al., 2019). Structured support during and after training, such as mentoring and professional development, further enhances retention by boosting self-efficacy, competence, and job satisfaction (Richards & Gurley, 2023). Providing realistic insights into the profession through internships and shadowing also helps reduce early attrition by preparing teachers to manage classroom demands with confidence (Burke & Ceo-DiFrancesco, 2022).

4.5 Recruitment of (pre- and in-service) teachers

Effective recruitment strategies help address teacher shortages by attracting diverse candidates and improving the profession's appeal. Key approaches include targeted campaigns, enhancing public perception, and alternative staffing solutions. The following subsections examine these strategies in detail.

4.5.1 Targeted recruitment campaigns and efforts

In 18 studies, targeted recruitment campaigns and initiatives to attract individuals to the teaching profession are discussed. These campaigns often focus on specific demographics, such as certain subject areas, regions, recent graduates, career changers, or professionals from specialised fields (e.g., Van Rooij et al., 2020; Martinie et al., 2023). Approaches include recruitment events that highlight the societal value of teaching and offer firsthand experiences, such as 'shadow days' (Burke & Ceo-DiFrancesco, 2022). Financial incentives and promoting benefits of the profession, such as holidays, varied work, and career development opportunities, are also common (e.g., Shine, 2015; Van Rooij et al., 2020). These efforts aim to address teacher shortages by making the profession more appealing and accessible to a diverse range of candidates (Struyven et al., 2013).

4.5.2 Status, attractiveness, and value of the profession

Sixteen studies emphasise improving the public perception of teaching by highlighting its societal relevance and impact. Enhancing the status, appeal,

and perceived value of the profession appears crucial (e.g., Admiraal, 2022; Patil, 2023). Proposed strategies include public awareness campaigns, better working conditions, competitive salaries, and career development opportunities (e.g., Bates et al., 2024). By making teaching more attractive and valued, these measures aim to draw more individuals to the profession and support long-term retention (Richards & Gurley, 2023).

4.5.3 Alternative (unqualified) teaching staff

Four studies mention employing alternative or unqualified teaching staff: individuals without traditional teaching credentials but with relevant skills or experience (Inspectie van Onderwijs, 2023). This approach is often used to fill immediate staffing gaps, particularly in high-need areas or subjects (De Witte et al., 2023). While it offers short-term relief, it may compromise teaching quality and retention if these staff members are not adequately supported and trained (e.g., McHenry-Sorber et al., 2023).

4.5.4 Effects of recruitment initiatives

Studies indicate that local or targeted recruitment initiatives, beyond financial incentives or general campaigns, are more effective in sustainably attracting teachers (e.g., Podolsky et al., 2016; Love & Love, 2022). Programmes offering firsthand teaching experiences are particularly successful in boosting long-term retention by tapping into intrinsic motivation and providing a realistic view of the profession (e.g., Hudson & Hudson, 2019; Burke & Ceo-DiFrancesco, 2022). Recruiting unqualified staff or using accelerated training for career switchers offers short-term relief but often leads to quality issues if preparation and support are lacking (McHenry-Sorber et al., 2023). Improving the status and appeal of teaching by emphasising its societal value can motivate more candidates, though these effects require long-term investment through awareness campaigns and better working conditions (Rhinesmith et al., 2023; Podolsky et al., 2016).

4.6 Stakeholder engagement

Stakeholder engagement is essential for addressing teacher shortages and improving education. Collaboration between schools, communities, and policymakers fosters support for teachers, while government actions and policy reforms strengthen the sustainability of solutions. The following subsections examine these efforts in detail.

4.6.1 Collaboration initiatives

According to 14 studies, collaboration among schools, teacher training institutes, parents, and other stakeholders is essential for creating a cohesive and supportive educational system (e.g., Hudson & Hudson, 2019). Partnerships between educational institutions and communities play a key role in addressing teacher shortages and improving teaching quality (Rhinesmith et al., 2023). Collaborative efforts include joint training programmes, community engagement initiatives, and shared resources (e.g., Ingersoll & Tran, 2023). By working together, stakeholders can foster a supportive environment, enhance professional development, and promote a sense of shared responsibility for education (Richards & Gurley, 2023).

4.6.2 Government actions and policy changes

Seven studies identify government action, policy reform, and educational investment as critical to tackling teacher shortages and strengthening education. Key initiatives include increased school funding, measures to boost recruitment and retention, and financial incentives for teachers (e.g., Peyton et al., 2021). These strategies aim to create a supportive, well-resourced environment that makes teaching more attractive and sustainable (e.g., Gooden et al., 2023). Evidence shows that effective policies can significantly improve teacher supply and educational outcomes (Lampert et al., 2023).

4.6.3 Effects of stakeholder engagement

Stakeholder engagement offers significant potential for long-term improvement in addressing teacher shortages. Collaboration fosters a deeper understanding of underlying causes and enables large-scale initiatives with greater chances of success (Inspectie van Onderwijs, 2023; Lindqvist & Gidlund, 2024). Increased investment and policy reforms, such as better salaries and working conditions, help make teaching more attractive (De Witte et al., 2023), though these measures often require time to show results (Podolsky et al., 2016). Joint efforts are also vital for awareness campaigns that promote the value of teachers through consistent messaging (Boström, 2023; Patil, 2023). However, the impact of such policies and collaborations is difficult to measure and may be undermined by poor coordination (Birch et al., 2021).

Continuous monitoring and adjustment are therefore essential to maximise effectiveness.

5. Discussion

The results show that measures can be grouped into five main categories: workplace support and improvement, financial incentives and rewards, training and development, the recruitment of (pre- and in-service) teachers, and stakeholder engagement. A very similar categorisation was identified by Sutcher et al. (2019). Based on this categorisation, it is possible to indicate which measures are most suitable for each phase of the teacher pipeline and to assess their short- and long-term effects (sections 4.2 to 4.6) in relation to the causes and consequences of teacher shortages (sections 2.3 and 2.4).

5.1 Recruitment stage

Several effective measures can be highlighted, such as targeted recruitment campaigns focusing on areas with specific teacher shortages, including particular subjects, education sectors, or regions. Another key strategy involves enhancing the profession's status and appeal through financial incentives, such as scholarships and loan forgiveness, and by emphasising the societal importance of teaching. It is crucial to outline how the profession can be made more attractive, for example, through higher salaries, reduced workloads, expanded career opportunities, and comprehensive induction programmes. Additionally, providing clear information about flexible training pathways aligned with prospective teachers' needs and prior competencies is essential.

- Short-term effects: Increased enrolment in teacher training programs and the immediate attraction of candidates to the profession.
- Long-term effects: Sustained interest in teaching careers through consistent improvements in status, working conditions, and accessible, tailored teacher training programs.
- Addressed causes and consequences: Low enrolment due to negative perceptions, financial barriers, and rigid training programs, as well as a high risk of subject- or area-specific teacher shortages.

5.2 Pre-service stage

The most effective measures in this phase are financial support during training and alternative, flexible, or improved teacher training programs. These programs should consider prospective teachers' prior experience and competencies while offering a realistic view of the profession to prevent attrition. This includes providing significant practical experience to help candidates prepare for the challenges of teaching.

- Short-term effects: Increased enrolment in teacher training programs and a more diverse pool of candidates.
- Long-term effects: Better-prepared teachers who are more likely to stay in the profession due to realistic training experiences and ongoing support, contributing to stable enrolment in teacher training programs.
- Addressed causes and consequences: Rigid certification pathways and insufficient preparation for real-world challenges, leading to high dropout rates during training and early-career attrition.

5.3 In-service stage

Workplace support (e.g., mentoring, induction programs) and improved working conditions (e.g., workload reduction, classroom and emotional support) seem crucial for (novice) teachers. These measures should be paired with professional development opportunities and financial incentives to provide career prospects for teachers and enhance the profession's image.

- Short-term effects: Reduced workload, lower stress, and increased job satisfaction lead to lower attrition rates.
- Long-term effects: Improved teacher retention, better teaching quality, and a more stable, motivated workforce.
- Addressed causes and consequences: High workloads leading to burnout, lack of professional development and career opportunities, inadequate support systems, and poor classroom and school conditions affecting educational quality.

5.4 General recommendations

Addressing teacher shortages requires a systemic approach that combines stakeholder collaboration (e.g., among schools, communities, policymakers, and government) with targeted (policy) measures across the entire teacher pipeline are essential for tackling root causes and implementing initiatives that lead to sustainable improvements in education. Such collaboration can strengthen policy development,

improve working conditions, and enhance the attractiveness of the teaching profession over time.

The recommended measures influence different stages of the pipeline—recruitment, pre-service, and in-service—and vary in their short- and long-term impact. Current interventions disproportionately target the in-service phase (50%), with fewer measures addressing pre-service (35%) and recruitment (15%). This imbalance calls for a more comprehensive strategy, as De Witte et al. (2023) emphasise that coordinated action across all stages is critical. While quick fixes such as salary increases or smaller class sizes are popular (Birch et al., 2021), they often lack sustainability. Long-term solutions require stronger collaboration, structural reforms, and the willingness to invest time and resources.

The uneven distribution of teacher shortages across regions, subjects, and school types further complicates efforts to address the issue (United Nations Department of Economic and Social Affairs, 2019; OECD, 2023). Rural and high-needs schools face the most acute challenges, making context-specific strategies indispensable. As McHenry-Sorber et al. (2023) argue, no universal solution exists; addressing shortages demands thorough contextual analysis and adaptive policy development. Effective stakeholder engagement can help ensure that interventions are tailored to local needs while maintaining coherence at the national level.

5.5 Limitations and future research

A recurring issue in the reviewed studies is the blending of results with discussions, which makes it difficult to extract clear, actionable conclusions. Many studies present their findings alongside immediate interpretations, obscuring the distinction between what was investigated and the authors' opinions. This lack of clarity hinders the assessment of the evidence's scope and reliability. To improve transparency and rigor, future research should clearly separate results from discussion.

A key limitation in the current literature is the heavy reliance on cross-sectional studies, which offer only a snapshot of teacher shortages at a specific point in time. Longitudinal studies tracking shortages and the impact of targeted interventions over time are scarce. Future research should prioritise longitudinal data to gain deeper insights into long-term trends, causes, and the effectiveness of policies.

Additionally, future studies should focus more on teacher recruitment and pre-service educators, as the current literature mainly addresses in-service teachers. Understanding the factors that influence individuals' decisions to enter teaching is crucial. Examining the pre-service phase could help inform interventions that reduce early attrition, ultimately strengthening the teacher workforce.

6. Conclusion

This review examined measures implemented in developed countries to address teacher shortages and their effects, aiming to identify an effective framework. The findings reveal that teacher shortages are a multifaceted problem requiring a balanced set of interventions across all stages of the teacher pipeline. While many measures focus on the in-service phase, such as salary increases and workload reductions, these quick fixes often lack sustainability. Long-term strategies that enhance the profession's attractiveness, improve working conditions, and strengthen teacher preparation are essential to shift the focus from short-term relief to prevention.

Moreover, the uneven distribution of shortages across regions, subjects, and school types underscores the need for context-sensitive solutions rather than universal approaches. Rural and high-needs schools, for instance, face more acute challenges, demanding tailored interventions. Addressing this complexity requires coordinated action among stakeholders and strong policy support to ensure systemic improvements in recruitment, training, and retention.

Ultimately, solving teacher shortages is not about isolated measures but about integrated, evidence-based strategies that combine immediate relief with structural reforms. Collaboration, sustained investment, and a willingness to implement solutions that demand time and resources are critical for creating a stable and motivated teaching workforce.

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