

Royal Society of Biology Response to the Children, Young People and Education Committee Inquiry on Teacher Recruitment and Retention

June 2025

1. Introduction

The Royal Society of Biology (RSB) welcomes the inquiry and is pleased that the Children, Young People and Education Committee is taking forward this important issue. Addressing the challenges of teacher recruitment and retention is essential to the sustainability and quality of science education in Wales, and therefore to the ability to meet growing workforce demands for scientific training and skills, as well as ensuring that the population is equipped with essential scientific understanding for the modern world.

As the leading voice for biology in the UK, RSB is committed to ensuring that all young people benefit from high-quality biology education, delivered by well-supported subject-specialist teachers. Our response is grounded in our [education policy priorities](#) (2023–2028) and our [broader strategic vision](#) (2025–2030) to strengthen the national voice for biosciences, increase professionalism in education, and support the bioscience workforce.

We are committed to supporting excellent teaching and learning across the UK. In Wales, as well as our focus on teaching in the sciences, we engage with national policy and curriculum developments to ensure that biology education is inclusive, forward-looking, and fit for the future.

2. Barriers to Recruitment

The persistent shortage of specialist science teachers, particularly in biology, chemistry, and physics, poses a significant challenge for the effective delivery of STEM education in Wales. In 2023/24, only 27% of science teacher training places were filled, exacerbating subject-specialist shortagesⁱ.



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According to the Wales Annual Education Workforce Statistics (AEWS) 2024ⁱⁱ, only 7.2% more teachers entered the workforce in 2024 compared to 2020, with new registrants declining year-on-year since 2022. In 2024, there were just 2,514 new school teacher registrants — a drop from 2,767 in 2023. This downward trend signals that recruitment is not keeping pace with attrition, and long-term workforce replenishment is at risk.

While the most recent Education Workforce Statistics provide useful data on teacher entry trends, there are notable limitations in the publicly available data for Initial Teacher Education (ITE) in Wales. According to the Welsh Government HE Statistics Team, data on enrolments in secondary biology ITE courses is available only up to 2021/22. This historic data, published on StatsWalesⁱⁱⁱ, shows continued low uptake in biology-specific training pathways.

There is also a lack of application-level data and limited granularity on primary-level science teacher training, which hampers deeper analysis of subject-specific recruitment challenges.

Welsh-medium STEM teaching faces additional pressures due to the limited number of Initial Teacher Education (ITE) candidates training to teach science in Welsh, posing a barrier to the Welsh Government's goal of reaching one million Welsh speakers by 2050^{iv}. Research from Bangor University^v highlights gaps in Welsh-medium STEM education, including limited access to resources and a shortage of qualified STEM teachers who can teach through the medium of Welsh. Furthermore, data from Medr and StatsWales confirms that Welsh-medium science ITE remains extremely limited. In 2021/22, enrolments in secondary ITE science subjects taught through the medium of Welsh were very low^{vi}, underlining the scale of the challenge in aligning bilingual STEM teaching with national Welsh language goals.

Teachers RSB has interacted with indicate that many trainee teachers in Wales are opting to seek employment in England due to concerns about the future of triple science at GCSE, perceived deficiencies in the WJEC exam board, and the absence of a national curriculum at KS3, leading to inconsistencies in delivery. Teachers have also expressed concerns about the lack of competition between exam boards in Wales, which they feel limits the quality of available qualifications

and teaching resources. ITE providers in England near to the Welsh border that RSB works with report small numbers of Welsh trainees every year, suggesting a continued cross-border flow of early career teachers. This anecdotal evidence is echoed in historical data (from 2016/17) which showed that a significant proportion of ITE graduates from Wales pursued teaching employment in England^{vii}. The lack of current evidence presents a barrier to fully understanding workforce mobility and retention post-qualification. More up to date and comprehensive data are required in Wales to fully explore this issue. RSB would be happy to work with the Welsh government to explore such data.

These concerns are exacerbated by national statistics indicating over 40% of science teachers are teaching outside their subject specialism. The AEWS 2024 report does not explicitly define "subject specialism" or "deployment," but these concepts are reflected in the data. Subject specialism is inferred from analyses of whether teachers hold post-A-level qualifications (e.g. degrees or teaching certificates) in the subjects they teach. Deployment is illustrated through data on teachers assigned to teach subjects outside their area of qualification — highlighting patterns of "out-of-field" teaching often driven by staffing needs and subject-specific teacher shortages. Only 56.8% of biology teachers were trained in biology, with 41.0% trained in another subject^{viii}. However, the AEWS report does not provide a detailed breakdown of the specific subjects these teachers were originally trained in. More up to date and comprehensive data are required in Wales to fully explore this issue. Broader trends in the UK offer further insight:

- Science teachers often teach outside their specialism: For example, physics graduates might teach biology, and vice versa, often due to shortages in specific science disciplines^{ix}
- Teachers from related STEM fields (e.g., maths or computing) are sometimes deployed to teach biology or other sciences, especially in schools with staffing pressures^x
- Teachers from unrelated disciplines (e.g., humanities or languages) may also be assigned to teach science. This tends to occur in schools facing severe recruitment challenges^{xi}

These different types of "out-of-field" teaching have distinct implications. Teachers from closely related disciplines might adapt more easily, but still lack deep subject

expertise. Those from unrelated backgrounds face greater barriers, which may negatively affect the quality of science education and student outcomes.

This subject mismatch severely undermines the quality of STEM education and hampers the implementation of a robust, specialist-led science curriculum.

Whilst the Welsh Government has implemented incentive schemes to attract STEM teachers, particularly for Welsh-medium education, recruitment remains below target^{xii,xiii}. The professional status of teachers must be elevated to improve recruitment. RSB supports initiatives that strengthen teacher professional identity, including investment in subject-specific Continuous Professional Development (CPD), mentoring, and improved career progression pathways^{xiv}.

3. Factors Affecting Retention

Teacher attrition is rising in Wales. In 2024, 2,486 teachers de-registered, accounting for 6.9% of the total workforce, up from 6.2% in 2023. Over the past decade, long-term retention has also declined significantly — only 57.5% of teachers registered in 2014 remained registered in 2024^{xv}. These figures show that more than 4 in 10 teachers leave the profession within 10 years, highlighting an urgent need for improved support and retention strategies.

While teacher attrition in Wales (4% annually) is lower than in England (9-10%), retention remains a challenge, particularly in early-career phases. Subject-specific CPD and mentoring are key drivers for retention^{xvi}. RSB advocates for structured subject-specific CPD as an entitlement for all teachers, ensuring that at least 50% of professional development focuses on subject knowledge and pedagogy^{xvii}.

Workload challenges — particularly administrative burdens linked to safeguarding, Special Educational Needs and Disabilities (SEND), and the implementation of new educational reforms — continue to impact teacher wellbeing and contribute to retention issues. While many of the available data on administrative workload come from UK-wide studies rather than Wales-specific research, these findings are likely to reflect similar pressures within the Welsh context. For example, a Department for Education study in England found that teachers spend around two hours per day on administrative tasks, including safeguarding and SEND-related duties^{xviii}. Teachers are also increasingly taking on responsibilities traditionally

managed by other services, such as supporting pupil mental health and family issues^{xix}. Without addressing these systemic pressures, teacher retention in Wales may remain vulnerable.

Emerging technologies, such as artificial intelligence, present both challenges and opportunities for the profession. In the short term, concerns about academic integrity and the steep learning curve associated with new tools can act as stressors. However, AI also holds significant potential to reduce workload. A recent Teacher Choices project led by NFER and funded by the Education Endowment Foundation (2024) trialled the use of ChatGPT to support KS3 science lesson planning. With appropriate guidance, teachers were able to cut lesson planning time by over 30%, while maintaining quality and relevance^{xx,xxi}. Projects like this demonstrate the value of evidence-based approaches to AI integration and could serve as a model for research and funding initiatives in Wales.

UNESCO (2024)^{xxii} emphasises that teachers must retain creative agency over where and how AI interacts with students, highlighting that generative AI differs fundamentally from other digital tools due to its ability to mimic human behaviour. This necessitates not only the development of teachers' subject knowledge about AI but also a broader exploration of how AI can enhance curriculum development, classroom management, lesson delivery, and overall pedagogical practice. Supporting teachers in these areas is crucial for both retention and performance.

Wales' 'aims-based' curriculum is particularly well-aligned with this holistic approach, offering flexibility and depth for integrating AI across educational contexts. In biology, for example, there are natural curricular links to AI's role in our physical, social, and environmental health — spanning wearable health devices, AI companions, and environmental modelling tools for biodiversity and water quality. These contemporary topics not only enrich scientific literacy but also provide teachers with engaging content that supports professional autonomy and ongoing development.

This broader framing of AI competency acknowledges that effective AI integration goes beyond curriculum content alone to include ethical considerations, classroom dynamics, and the cultivation of critical digital literacies. Empowering teachers in

these multifaceted ways strengthens their capacity to innovate in teaching while maintaining control over the learning environment.

The Welsh workforce is also aging^{xxiii}. Just 3.9% of school teachers are under 25, while over 64% have been teaching for more than 11 years. With only 20.4% of teachers qualifying in the past five years, the pipeline of early-career teachers is alarmingly thin, threatening long-term sustainability, especially in biology and other sciences.

Career changers represent a largely untapped resource in addressing recruitment and retention challenges. Many career changers bring valuable skills from previous roles, including pastoral experience, careers guidance, and management expertise. However, there are currently few dedicated routes into teaching that cater to career changers, and a lack of structured support networks limits their retention. Schools should be encouraged to recognise the distinct contributions of career changers and provide tailored induction and mentoring programmes to facilitate their transition into the profession. According to Welsh Government HE Statistics, data are currently unavailable on the proportion of mid-career changers entering teaching or the career progression of science teachers into leadership roles (Welsh Government correspondence, 2025; Data not held on workload, mid-career entry, or leadership progression). Improved tracking of these pathways would support better design of retention initiatives.

4. School Leadership Recruitment and Retention

The recruitment and retention of school leaders in STEM education require further targeted research. Leadership mentoring, subject-specific leadership CPD, and workload adjustments could enhance retention in senior roles^{xxiv}. Furthermore, teachers entering the profession from different backgrounds, including career changers, may not necessarily seek leadership roles but can provide critical subject expertise and stability within departments.

5. Diversity of the Workforce

The teaching workforce in Wales does not fully reflect the diversity of the population, particularly in ethnic and gender representation in STEM subjects^{xxv}. The latest workforce data indicate that 92.5% of teachers are White, with only

0.2% identifying as Black and 0.8% as Asian^{xxvi}. Although the proportion of teachers declaring a disability has doubled since 2020, it remains at just 1.2%, suggesting further work is needed to foster an inclusive profession.

Research also suggests that minority ethnic teachers often undertake unpaid leadership roles related to diversity and inclusion efforts. Addressing these structural issues requires improved pathways for progression and targeted recruitment initiatives to increase representation^{xxvii}.

6. Impact on Learners

Staffing shortages, particularly in science, limit student access to specialist teaching, impacting learner outcomes and post-16 STEM participation. These issues are compounded by a significant number of teachers operating outside their subject specialism—meaning they do not hold an undergraduate degree or equivalent qualification in the subject they are teaching. The 2024 data^{xxviii} reveal that just 43.8% of physics and 56.8% of biology teachers were trained in their subject, reinforcing a trend that places student learning at risk, particularly in STEM. A 2022 report from Estyn found that science teaching standards vary significantly between schools due to staff shortages^{xxix}. A well-supported, diverse teaching workforce is crucial to delivering a curriculum that prepares students for bioscience careers, reinforcing the need for investment in subject-specialist science teachers.

Evidence consistently shows that students make greater progress and achieve higher outcomes when taught by teachers with strong subject knowledge. Subject specialists — teachers who hold a degree or equivalent qualification in the subject they teach — are more likely to use accurate terminology, provide deeper conceptual explanations, and respond confidently to student questions, all of which enhance learning. Research also indicates that the more time students spend with a subject specialist, the better their educational outcomes. In England, Allen and Sims (2018)^{xxx}, found a clear positive link between subject-specialist teaching and pupil attainment in science, showing that pupils taught by teachers qualified in their subject made greater academic progress than those taught by out-of-field teachers. The negative impact of non-specialist teaching compounds

over time, particularly in cumulative subjects like science and maths, where foundational understanding is critical for later success.

In the US, studies have similarly shown that students taught by out-of-field teachers consistently perform less well. For example, Clotfelter et al. (2007)^{xxx} found that a teacher's qualifications — including subject-specific training — were strongly associated with student achievement, especially in mathematics. Goldhaber and Brewer (2000)^{xxxi} reported that students taught by certified teachers in the subject they taught outperformed those whose teachers lacked such credentials.

Recent Australian data reinforce this picture. A 2024 report from the Australian Mathematical Sciences Institute found that mathematics is taught by out-of-field teachers approximately 40% of the time, raising serious concerns about the depth of subject knowledge being delivered in classrooms^{xxxii}. These findings are supported by the Australian Institute for Teaching and School Leadership, whose most recent Australian Teacher Workforce Data reveal that 20% of maths, 29% of technology, and 11% of science teachers lack formal qualifications in their subject area^{xxxiii}. This shortage of subject-qualified teachers has been linked to declining student performance and confidence in core STEM subjects, as reported in The Daily Telegraph's 2025 coverage of national teacher shortages^{xxxiv}. These findings highlight that sustained exposure to teachers with strong subject expertise is not just beneficial but essential — particularly in cumulative disciplines like science and maths, where foundational knowledge underpins future success.

7. Impact on Educational Reforms

The successful implementation of the Curriculum for Wales relies on a stable, well-trained teaching workforce. Workforce shortages pose a barrier to delivering high-quality science education aligned with RSB's Evolving 5–19 Biology: recommendations and framework for 5-19 biology curricula^{xxxv}. Assessment reforms and Additional Learning Needs (ALN) legislation require sufficient teacher training and support. Without adequate staffing and subject-specific training, implementation risks being inconsistent.

8. Addressing Recruitment and Retention Challenges

RSB recommends the following actions to ensure a sustainable STEM teaching workforce:

A. Strengthening Initial Teacher Education (ITE) and Subject-Specific Training

- Ensure all ITE trainees receive subject-specific training and mentoring.
- Expand financial incentives for science graduates entering teaching.
- Create flexible pathways for career changers to enter teaching, including structured induction and support networks.
- Use subject-specific workforce data to track and address subject-specific deployment mismatches, ensuring that teachers are supported to teach within their area of expertise and not routinely assigned outside their specialism.

B. Enhancing Subject-Specific CPD and Career Progression

- Establish a national CPD entitlement for science teachers, ensuring at least 50% of professional development is subject-specific.
- Improve mid-career subject-specialist CPD opportunities, supporting retention and career development.
- Develop a national reporting mechanism to track the alignment of teacher training and deployment across subject areas, using the data to inform targeted support and CPD provision in subjects like biology where mismatch is pronounced.

C. Supporting Early-Career Teachers

- Deploy subject-specific mentors for all early-career secondary teachers.
- Reduce workload burden by ensuring new teachers are not over allocated across multiple year groups and subjects.

D. Strengthening Leadership Pathways in STEM

- Provide targeted leadership training for STEM subject leaders and mentors.

- Recognise the importance of subject leadership within school leadership structures.

E. Improving Workforce Diversity and Inclusion

- Develop targeted recruitment initiatives to improve ethnic and gender diversity in STEM teaching.
- Ensure structured career progression pathways to support underrepresented groups.

F. Leveraging AI and Digital Tools in Science Education

- Support structured AI training to help teachers integrate technology effectively and reduce administrative burden.
- Explore the use of digital tools, such as VR simulations, to enhance biology education, driven by research and evidence.

9. Conclusion

The Royal Society of Biology urges the Committee to prioritise subject-specialist recruitment, targeted retention initiatives, and enhanced subject-specific professional development to address ongoing workforce challenges. A stable and well-supported teaching workforce is essential for delivering high-quality science education, supporting the Curriculum for Wales, and preparing students for future bioscience careers.

The latest education workforce statistics reinforce the urgency of these recommendations. Declining long-term retention, reduced new entrant numbers, and widespread teaching out-of-specialism highlight systemic vulnerabilities. These must be addressed to sustain and enhance the delivery of high-quality, inclusive biology education aligned with the ambitions of the Curriculum for Wales.

A resilient, subject-specialist teaching workforce, supported by strategic investment and collaboration, is essential to securing equitable, high-quality biology education that equips all learners for successful futures in bioscience.

RSB are keen to work with the Welsh Government, the Committee and the Clerk to interrogate the data further, and to support the development of informed recommendations and commentary. We welcome this inquiry and look forward to the Committee's recommendations.

ⁱ Egan, D. *et al* (2025) *A Future Teaching Profession for Wales*. Cardiff Metropolitan University. Available at: https://issuu.com/cardiffmet/docs/a_future_teaching_profession_for_wales

ⁱⁱ Education Workforce Council (2024) *Annual Education Workforce Statistics Report 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>

ⁱⁱⁱ Welsh Government (2023) *Initial Teacher Education: September 2021 to August 2022*. Available at: <https://www.gov.wales/initial-teacher-education-september-2021-august-2022>

^{iv} Estyn (2024) *Annual Report 2023–2024: Recruitment and Retention*. Available at: <https://annual-report.estyn.gov.wales/2024-2/cross-cutting-themes-recruitment-and-retention/>

^v Thomas, E., Parry, N., Caulfield, G., & Sion, C. (2021) Provision for Welsh-medium STEM Subjects. Bangor University. Available at: <https://www.bangor.ac.uk/sites/default/files/2021-09/WEB%20VERSION%20Report%20Welsh%20Medium%20Stem%202021%20Final%20Version%20V1.pdf>

^{vi} StatsWales (2023) First years on secondary ITE courses in Wales by subject and year (with filters for Welsh-medium delivery). Available at: <https://statswales.gov.wales/v/Rwun>

^{vii} StatsWales (2018) *Destinations of students completing Initial Teacher Training courses in Wales by gender, location of employment, qualification obtained and phase*. Available at: <https://statswales.gov.wales/Catalogue/Education-and-Skills/Schools-and-Teachers/teachers-and-support-staff/initial-teacher-education/Destinations/studentscompletingittcourses-by-gender-location-employment-qualification-phase>

^{viii} Education Workforce Council (2024) *Annual Education Workforce Statistics for Wales 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>

^{ix} Royal Society of Biology (2022) Written evidence submitted to the House of Commons Education Committee: Teacher recruitment, training and retention. Available at: <https://committees.parliament.uk/writtenevidence/120426/html/>

^x Roberts, J. (2023) 'Most teachers have run lessons outside their specialism', *Tes Magazine*, 21 July. Available at: <https://www.tes.com/magazine/news/general/most-teachers-have-run-lessons-outside-specialism>

^{xi} House of Commons Committee of Public Accounts (2016) *Training new teachers: Third Report of Session 2016–17*. HC 73. Available at: <https://publications.parliament.uk/pa/cm201617/cmselect/cmpubacc/73/7307.htm>

^{xii} Welsh Government (2023) *Welsh Government push to attract STEM teachers in Wales: Every day you could be one positive thing for a child*. Available at: <https://www.gov.wales/welsh-government-push-attract-stem-teachers-wales-every-day-you-could-be-one-positive-thing-child>

^{xiii} Welsh Government (2019) *Evaluation of the Welsh-medium Education Strategy: Interim report*. Available at: <https://www.gov.wales/sites/default/files/statistics-and-research/2019-03/evaluation-of-the-welsh-medium-education-strategy-interim-report.pdf>

^{xiv} Institute of Physics (2020) *Subjects Matter*. Available at: <https://www.iop.org/sites/default/files/2020-12/Subjects-Matter-IOP-December-2020.pdf>

^{xv} Education Workforce Council (2024) *Annual education workforce statistics report 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>

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- ^{xvi} Hutchinson, J., Kelly, J., Sibiet, L. and Zuccollo, J. (2024) *Incentives to Recruit and Retain Teachers in Wales*. Education Policy Institute. Available at: <https://epi.org.uk/publications-and-research/incentives-to-recruit-and-retain-teachers-in-wales/>
- ^{xvii} Royal Society of Biology (2023) *Education priorities 2023–2028*. Available at: https://www.rsb.org.uk/images/RSB_Education_Priorities_2023-2028_Final.pdf
- ^{xviii} Department for Education (2023) *Exploring teachers' admin time*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1171498/Exploring_teachers_admin_time.pdf
- ^{xix} House of Commons Education Committee (2024) *Teacher recruitment, training and retention: Second Report of Session 2023–24*. HC 132. Available at: <https://committees.parliament.uk/publications/44798/documents/222606/default/>
- ^{xx} Education Endowment Foundation (2024) *Teachers using ChatGPT – alongside a guide to support them to use it effectively – can cut lesson planning time by over 30 per cent*. Available at: <https://educationendowmentfoundation.org.uk/news/teachers-using-chatgpt-alongside-a-guide-to-support-them-to-use-it-effectively-can-cut-lesson-planning-time-by-over-30-per-cent>
- ^{xxi} Education Endowment Foundation (2024) *Choices in EdTech: Using generative AI (ChatGPT) for KS3 science lesson preparation – Teacher Choices Trial*. Available at: <https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/choices-in-edtech-using-generative-ai-chatgpt-for-ks3-science-lesson-preparation-2024-teacher-choices-trial>
- ^{xxii} UNESCO (2024) *What you need to know about UNESCO's new AI competency frameworks for students and teachers*. Available at: <https://www.unesco.org/en/articles/what-you-need-know-about-unescos-new-ai-competency-frameworks-students-and-teachers?hub=32618>
- ^{xxiii} Education Workforce Council (2024) *Annual education workforce statistics report 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>
- ^{xxiv} The Royal Society (2023) *Policy briefing on teachers of the sciences*. Available at: <https://royalsociety.org/-/media/policy/topics/education-skills/policy-briefing-on-teachers-of-the-sciences.pdf>
- ^{xxv} Foster, B. (2023) 'Retention, turnover, and job satisfaction among teachers: a review', *The Curriculum Journal*, 34(1). Available at: <https://bera-journals.onlinelibrary.wiley.com/doi/full/10.1002/curj.175>
- ^{xxvi} Education Workforce Council (2024) *Annual education workforce statistics report 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>
- ^{xxvii} Welsh Government (2021) *The recruitment and retention of Black, Asian and minority ethnic teachers in Wales: Report into the lived experiences of teachers and middle and senior school leaders from minority ethnic backgrounds*. Available at: <https://hwb.gov.wales/api/storage/340a0584-d8d1-48c5-a917-9477be03fcc/report-into-the-lived-experiences-of-teachers-and-middle-and-senior-school-leaders-from-minority-ethnic-backgrounds.pdf>
- ^{xxviii} Education Workforce Council (2024) *Annual education workforce statistics report 2024*. Available at: <https://www.ewc.wales/site/index.php/en/documents-eng/about/workforce-statistics/annual-statistics-digest/current/1245-annual-education-workforce-statistics-report-2024/file>
- ^{xxix} Estyn (2023) *Annual report 2022–2023: Recruitment and retention*. Available at: <https://annual-report.estyn.gov.wales/2024-2/cross-cutting-themes-recruitment-and-retention/>
- ^{xxx} Allen, R. and Sims, S. (2018) *The teacher gap: Why teachers matter and how we can get the best out of them*. Routledge. Available at: <https://www.taylorfrancis.com/books/mono/10.4324/9781315189222/teacher-gap-sam-sims-rebecca-allen>
- ^{xxxi} Clotfelter, C.T., Ladd, H.F. and Vigdor, J.L. (2007) *How and why do teacher credentials matter for student achievement?* NBER Working Paper No. 12828. Available at: <https://www.nber.org/papers/w12828>

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- ^{xxxii} Goldhaber, D.D. and Brewer, D.J. (2002) 'Does teacher certification matter? High school teacher certification status and student achievement', *Educational Evaluation and Policy Analysis*, 22(2), pp. 129–145. Available at: <https://journals.sagepub.com/doi/10.3102/01623737022002129>
- ^{xxxiii} Australian Mathematical Sciences Institute (AMSI) (2024) *The state of mathematical sciences 2024: Summary of findings*. Available at: <https://amsi.org.au/wp-content/uploads/2024/10/dp24-summary-findings.pdf>
- ^{xxxiv} Australian Institute for Teaching and School Leadership (AITSL) (n.d.) *Australian Teacher Workforce Data*. Available at: <https://www.aitsl.edu.au/research/australian-teacher-workforce-data>
- ^{xxxv} Daily Telegraph (2025) 'Graph reveals startling maths teacher shortage', *The Daily Telegraph*, 3 June. Available at: <https://www.dailytelegraph.com.au/new-south-wales-education/australias-best-teachers-fixing-our-maths-science-teaching-crisis/news-story/ba758395f73121af3523676743940091>
- ^{xxxvi} Royal Society of Biology (2021) *Evolving 5–19 biology: recommendations and framework for 5–19 biology curricula*. Available at: <http://www.rsb.org.uk/curriculum>