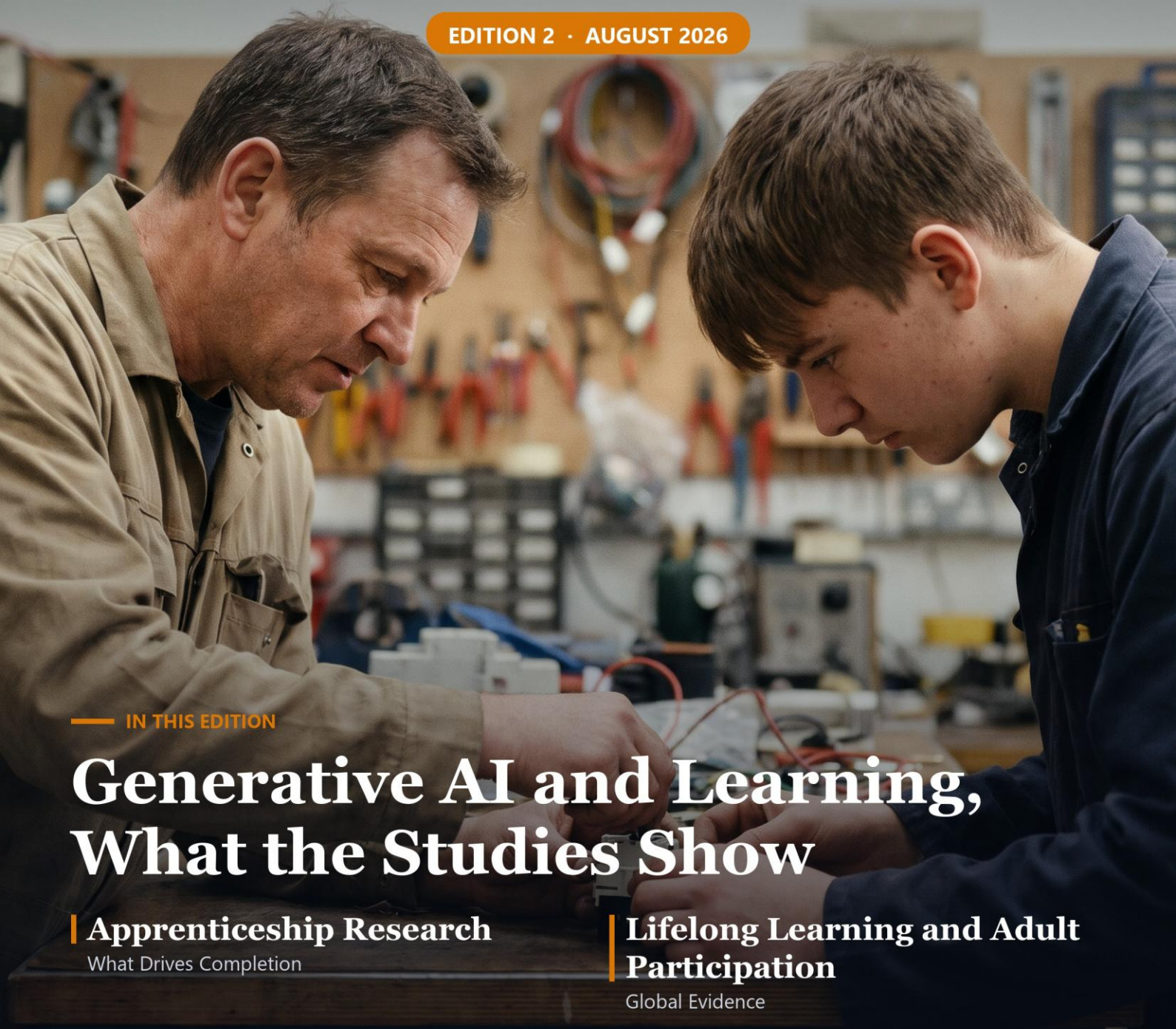
TeachWise

RESEARCH FOR EDUCATORS

Research for educators: what the studies found, and what it means for practice

EDITION 2 · AUGUST 2026



IN THIS EDITION

Generative AI and Learning, What the Studies Show

Apprenticeship Research
What Drives Completion

Lifelong Learning and Adult Participation
Global Evidence

Gender and Occupational Segregation in VET
What the Evidence Shows About Women in Trades and Men in Care

The Science of Learning for Adult Educators
Retrieval, Spacing and Worked Examples

Edited by Sukh Sandhu | teachwisemag.com

EDITION 2 | AUGUST 2026

Contents

Edition 2: August 2026 3
Generative AI and Learning, What the Studies Show 4
Apprenticeship Research: What Drives Completion 13
Lifelong Learning and Adult Participation: Global Evidence 22
Gender and Occupational Segregation in VET: What the Evidence Shows About Women in Trades and Men in Care 30
The Science of Learning for Adult Educators: Retrieval, Spacing and Worked Examples .. 38
Follow us on LinkedIn 46
About TeachWise 48

EDITORIAL

Edition 2: August 2026

By Sukh Sandhu, Editor-in-Chief

5 articles on what the research says, and what it means for the people who teach and train.

Welcome to Edition 2 of TeachWise. Each article in this edition reads a body of research on education and training, sets out what it found using the reports' own figures, notes its limits, and ends with what it might mean for practice, labelled as our interpretation.

In this edition

- Generative AI and Learning, What the Studies Show
- Apprenticeship Research: What Drives Completion
- Lifelong Learning and Adult Participation: Global Evidence
- Gender and Occupational Segregation in VET: What the Evidence Shows About Women in Trades and Men in Care
- The Science of Learning for Adult Educators: Retrieval, Spacing and Worked Examples

Research rarely gives simple answers, and evidence from one setting does not always transfer to another. Where that matters, we say so.

Thank you for reading. Tell us which research you would like us to read next.

Warm regards,
Sukh Sandhu
Editor-in-Chief, TeachWise

TEACHWISE

Generative AI and Learning, What the Studies Show

By Sukh Sandhu

Since late 2022, claims about generative AI in education have run far ahead of the evidence. By November 2026 there is finally a body of controlled studies worth reading, and its message is more nuanced than either the enthusiasts or the sceptics suggest: well-designed AI tutors can produce real learning gains, unrestricted chatbots can leave students worse off once the tool is removed, and teachers can save planning time without obvious loss of quality. This article separates the strong evidence from the weak, sets out what each key study actually did and found, and draws out what trainers, teachers and leaders can reasonably do with it.

At a glance

Report	Publisher	Year	Method	Sample
Bastani et al., *Generative AI without guardrails can harm learning*	PNAS	2025	Field experiment in a high school	Nearly 1,000 maths students, Türkiye
Kestin et al., *AI tutoring outperforms in-class active learning*	Scientific Reports	2025	Randomised crossover trial	194 university physics students, Harvard
De Simone et al., *From Chalkboards to Chatbots*	World Bank (working paper)	2025	Randomised controlled trial	Senior secondary students, Edo State, Nigeria
Roy et al., *ChatGPT in Lesson Preparation*	EEF and NFER	2024	Randomised controlled trial	259 teachers in 68 schools, England
OECD Digital Education Outlook 2026	OECD	2026	Synthesis of research and policy	International

Why this evidence is hard to read

Three features of the research make it easy to misread.

First, many studies measure **performance while the AI is available** rather than **learning that lasts after it is removed**. The OECD's *Digital Education Outlook 2026*, published in January 2026, makes exactly this point: completing tasks with generative AI

does not necessarily translate into learning, and the advantage can disappear when access is removed, as in an exam.

Second, much of the literature consists of short studies, small samples, single classrooms or laboratory tasks.

Third, "AI" covers very different things, from unrestricted chatbots to hint-giving tutors, tools that coach human tutors and planning assistants. Results from one do not transfer automatically to another.

For this article we treat evidence as **stronger** when it comes from randomised or well-controlled trials in real courses, measures learning independently of the AI, and is peer reviewed or carefully documented. We treat it as **weaker** when it relies on self-report, small or laboratory samples, outcomes measured with the AI present, or meta-analyses that pool studies of mixed quality.

The stronger evidence

Unrestricted AI can act as a crutch: Bastani et al. (2025)

Hamsa Bastani and colleagues ran a field experiment with nearly a thousand high school maths students in Türkiye, published in *Proceedings of the National Academy of Sciences* in 2025. Students practised with one of two GPT-4 based tools or with no AI. "GPT Base" behaved like a standard chatbot. "GPT Tutor" was prompted with teacher-designed guidance to give incremental hints rather than full solutions.

During practice, access to GPT-4 raised performance substantially: grades improved by 48% with GPT Base and 127% with GPT Tutor. The crucial test came afterwards, in an exam without AI. Students who had practised with GPT Base scored 17% lower than students who never had access. The authors report that these negative effects were "largely mitigated" by the safeguards in GPT Tutor; students in that condition performed about the same as the control group.

Why it matters: this is the clearest experimental evidence that unrestricted access can harm learning even while it boosts visible performance. **Limits:** one school, one subject, one term, and outcomes are short term.

A well-designed AI tutor can outperform active learning in class: Kestin et al. (2025)

Gregory Kestin and colleagues, writing in *Scientific Reports* in June 2025, compared an AI tutor with in-class active learning in Physical Sciences 2, an introductory physics course for life sciences students at Harvard, in the Fall 2023 semester. The design was a crossover: 194 students experienced both conditions on different topics, so each acted as their own comparison.

The AI tutor ran on GPT-4 but was heavily engineered. It was built around research on effective tutoring, used expert-written prompts and relied on pre-written answers to keep it accurate. Students learned more with the AI tutor. The regression analysis gave an effect size of 0.63, which the authors argue understates the effect because of a ceiling on the post-test; their quantile regression gave a range of 0.73 to 1.3 standard deviations.

The median time on task in the AI condition was 49 minutes, against an in-class lesson treated as 60 minutes of learning. Students also reported higher engagement and motivation with the AI tutor.

Why it matters: it shows what is possible when AI tutoring is designed around pedagogy and compared with a strong teaching method. **Limits:** a selective university, one course, two weeks, and an AI tutor supplied with correct answers. The authors themselves say they "do not presume that structured AI tutoring will always outperform in-class active learning in all contexts".

Gains at scale in a low-resource setting: De Simone et al. (2025)

A World Bank team led by Martín De Simone and Federico Tiberti evaluated a six-week after-school programme in Edo State, Nigeria, in which first-year senior secondary students used Microsoft Copilot (powered by GPT-4) with teacher guidance to support English learning. A World Bank blog reports that 800 students attended sessions twice a week in computer labs over June and July 2024. The study was released in May 2025 as World Bank Policy Research Working Paper 11125.

The abstract reports an effect of 0.31 standard deviations on an assessment covering English, knowledge of AI and digital skills, and 0.23 standard deviations on English, the main outcome of interest. The authors estimate this equates to 1.5 to 2 years of "business-as-usual" schooling, and report the largest effects for female students and students with higher prior achievement.

Why it matters: it is a randomised trial in an authentic school setting with a learning outcome measured independently. **Limits:** it is a working paper, the intervention was short, and the headline 0.31 combines English with AI and digital skills that the programme itself taught.

AI that coaches the human: Tutor CoPilot

Rose Wang, Susanna Loeb, Dora Demszky and colleagues tested a different model: AI that supports human tutors in real time rather than replacing them. Their working paper, first released in 2024, reports a randomised trial involving 900 tutors and 1,800 students from under-served communities in the United States, with tutors randomly given access to Tutor CoPilot. Students whose tutors had access were 4 percentage points more likely to master topics, and students of lower-rated tutors gained 9 percentage points. The authors estimate the tool cost about US$20 per tutor per year. A later EdWorkingPaper version, dated November 2025, reports a trial with more than 700 tutors and 1,000 students and the same 4 and 9 point gains.

Why it matters: it suggests AI may be most useful when it lifts the quality of the least experienced human educators. **Limits:** working paper status and a modest absolute effect.

Saving teachers' time: the EEF trial (2024)

The Education Endowment Foundation's *ChatGPT in Lesson Preparation* trial, evaluated independently by the National Foundation for Educational Research and published in December 2024, randomised 68 secondary schools in England. Key Stage 3 science

teachers in the treatment group (129 teachers in 34 schools) used ChatGPT with a guide to planning; the comparison group was asked not to use generative AI.

Teachers using ChatGPT spent 56.2 minutes per week on lesson and resource preparation, compared with 81.5 minutes in the comparison group, a saving of 25.3 minutes or 31%. The EEF gives the result a high security rating. An expert panel that did not know which resources had been made with ChatGPT found no apparent difference in quality.

Limits: it measured teacher time and resource quality, not student learning, and teachers mostly used ChatGPT for discrete tasks such as creating questions and adapting materials.

Table 1. Selected controlled studies of generative AI in education

Study	Setting	Comparison	Main result
Bastani et al. (2025)	High school maths, Türkiye	Chatbot or hint-based tutor vs no AI	Exam scores 17% lower after unrestricted chatbot; harm largely mitigated with tutor design
Kestin et al. (2025)	University physics, United States	Designed AI tutor vs in-class active learning	Effect size 0.63 (0.73 to 1.3 by quantile regression)
De Simone et al. (2025)	Senior secondary English, Nigeria	After-school AI-supported sessions vs none	0.23 SD on English; 0.31 SD on combined assessment
Wang et al. (2024)	K to 12 tutoring, United States	Tutors with AI coaching vs without	Topic mastery up 4 percentage points; 9 points for lower-rated tutors
Henkel et al. (2024)	Primary and lower secondary maths, Ghana	AI maths tutor via messaging vs none	About 0.36 to 0.37 SD after eight months
Roy et al. (2024)	Teacher lesson preparation, England	ChatGPT with guide vs no generative AI	Preparation time down 31%; no evidence of a difference in quality

Sources: the published papers and reports listed at the end of this article. Henkel et al. report 0.37 in the arXiv version and 0.36 in the later published version.

The Ghana study by Owen Henkel and colleagues involved about 1,000 students in Grades 3 to 9 across 11 schools, who used Rori, a maths tutor delivered on WhatsApp, in two 30-minute sessions a week for eight months. Results cover only the first year.

Writing and feedback: promising, but watch what is measured

Writing is where the risk of confusing a better product with better learning is greatest.

Feedback that students act on. Meyer, Jansen, Fleckenstein and colleagues ran a randomised study with 459 upper secondary students of English as a foreign language in Germany, published in *Computers and Education: Artificial Intelligence* in 2024. Students who received feedback generated by GPT-3.5-turbo on an argumentative essay revised more successfully than students who revised without feedback (d = 0.19), and reported

higher task motivation (d = 0.36) and more positive emotions (d = 0.34). The comparison was no feedback, so it shows AI feedback beats none, not that it matches a teacher.

Feedback quality compared with teachers. Steiss, Tate, Graham and colleagues compared ChatGPT feedback with feedback from 16 trained human evaluators on 200 secondary student essays, published in *Learning and Instruction* in 2024. Humans gave higher quality feedback on four of five criteria (clear directions for improvement, accuracy, prioritising essential features and supportive tone), while ChatGPT was comparable on alignment with criteria. It did not test whether students learned from the feedback.

Better essays, not more learning. Fan, Gašević and colleagues randomly assigned 117 university students to write and revise an essay with ChatGPT, a human expert, a checklist tool or no support, published in the *British Journal of Educational Technology* in 2025. The ChatGPT group improved its essay scores most, but there was no significant difference in knowledge gain or transfer. Process data led the authors to warn of "metacognitive laziness", meaning learners offload the monitoring and evaluation that normally drive learning.

Brain activity and ownership. A widely reported MIT Media Lab study led by Nataliya Kosmyna, posted as a preprint in June 2025 and revised in December 2025, used EEG with 54 participants writing essays with an AI model, a search engine or no tools. Participants using the AI model showed the weakest brain connectivity and the lowest sense of ownership of their essays. It is a small, non-peer-reviewed laboratory study, and its "cognitive debt" framing is an interpretation, not proof of lasting harm.

The weaker evidence, and why a big number is not enough

Meta-analyses can mislead when the studies they pool are short and varied. A widely cited example is Jin Wang and Wenxiang Fan's meta-analysis in *Humanities and Social Sciences Communications* (May 2025), which pooled 51 studies published between November 2022 and February 2025 and reported a large positive effect of ChatGPT on learning performance (g = 0.867). On 22 April 2026 the journal retracted the article over "discrepancies in the meta-analysis" that undermined the editor's confidence in its validity and conclusions. Its figures should no longer be cited as evidence.

The wider lesson still holds. Pooled studies in this field vary widely in design and duration, and often measure performance on tasks completed with AI support. The Bastani and Fan studies show why that matters: performance with AI can rise while independent learning stays flat or falls. An effect size near 0.9 is larger than the effects in most of the field trials above, which was itself a reason for caution even before the retraction.

Table 2. A rough guide to the strength of evidence

Type of evidence	Examples in this article	How much weight to give it
Randomised trials in real courses measuring learning without AI	Bastani; Kestin; De Simone; Henkel	Strongest available, but context-specific
Randomised trials of teacher outcomes	EEF lesson preparation; Tutor CoPilot	Strong for the outcome measured
Short or single-site experiments	Meyer; Fan	Useful, but narrow
Quality comparisons and	Steiss; Kosmyna	Suggestive; not evidence of

Type of evidence	Examples in this article	How much weight to give it
laboratory studies		learning impact
Meta-analyses of early, mixed studies	Wang and Fan (retracted 2026)	Treat headline effects with caution; check for retractions
Surveys of use and attitudes	TALIS; Gallup; HEPI	Good for prevalence, not for impact

Classification is our own, based on each study's design.

What the international guidance says

OECD. The *Digital Education Outlook 2026* distinguishes general-purpose generative AI from educational generative AI designed or used for pedagogical purposes, which it finds shows "more sustained learning benefits". It argues that educational AI can augment human teaching and tutoring rather than replace teachers, and calls on systems to encourage the development of tools designed for learning, alongside equitable infrastructure and sustained professional learning.

UNESCO. UNESCO's *Guidance for generative AI in education and research* (2023) set out a human-centred approach, setting out steps for governments that include regulating data privacy and validating tools for use in education, and proposing 13 as a minimum age for the use of AI tools in the classroom. In 2024 UNESCO followed with AI competency frameworks for students and for teachers, describing the knowledge, skills and values needed to use AI ethically and effectively.

Australia. Australian schools work within the *Australian Framework for Generative AI in Schools*, agreed by education ministers in 2023, which sets out principles covering teaching and learning, human and social wellbeing, transparency, fairness, accountability, and privacy, security and safety.

How educators and students are actually using it

Table 3. Surveys of generative AI use

Survey	Population	Year of data	Key figures
OECD TALIS 2024	Lower secondary teachers, OECD systems	2024	36% used AI in their work (OECD average); Australia 66%
Gallup and Walton Family Foundation	2,232 US public school teachers	2025	Six in 10 used an AI tool for work in 2024 to 2025; 32% used AI weekly and estimate saving 5.9 hours a week
HEPI and Kortext, *Student Generative AI Survey 2026*	1,054 UK full-time undergraduates	December 2025	95% use AI in at least one way; 94% use it to help with assessed work

Sources: OECD (2025) Country notes: Australia; Gallup (2025); HEPI Report 199 (2026).

Three details stand out. TALIS shows teachers mostly use AI for planning and summarising rather than assessment, and that seven in ten worry it lets students pass off

others' work as their own. The Gallup time saving is teachers' own estimate, not a measurement; the EEF trial's measured saving is much smaller. And in the HEPI survey, 68% of students say AI skills are essential to thrive, but only 48% feel their teaching staff are helping them develop those skills.

Limits of the evidence base

- **Short horizons.** Almost no study follows learners for more than a term. Effects on long-term retention, skill development and motivation are largely unknown.
- **Narrow contexts.** Most trials are in school maths, English or university science. There are very few rigorous studies in vocational education and training, workplace learning or adult basic education.
- **Design matters more than brand.** The best results come from tools built around pedagogy, with guardrails and teacher involvement, not from simply giving learners a chatbot.

What this means for your practice

Our interpretation of the evidence, not the authors' or the OECD's recommendations.

1. **Distinguish doing from learning.** When learners use AI, check what they can do without it. Build in unassisted tasks, oral questioning or observation so that assessment captures the learner's own competence.
2. **Prefer guided tools over open chatbots for learning tasks.** The strongest gains came from tutors designed to give hints, ask questions and withhold full answers. Where you can configure a tool, set it to coach rather than complete.
3. **Use AI to free your time, then reinvest it.** The EEF trial supports using AI for quizzes, activity ideas and adapting resources, with your review of every output. Spend the time saved on feedback and direct contact with learners.
4. **Treat AI feedback as a first pass, not the last word.** AI feedback beats no feedback but trails skilled human feedback on accuracy and prioritisation. Use it for drafts and reserve your own feedback for judgements that matter.
5. **Teach learners to monitor their own thinking.** To counter "metacognitive laziness", ask learners to plan before prompting, explain why they accepted or rejected AI suggestions, and reflect on what they learned.
6. **Be honest about the evidence gap in VET.** Few trials involve vocational or adult learners. Pilot carefully, compare against current practice and collect your own evidence before scaling up.

Sources

- Bastani, H. and others, "Generative AI without guardrails can harm learning: Evidence from high school mathematics", *PNAS*, 122(26), 2025, https://doi.org/10.1073/pnas.2422633122
- Kestin, G. and others, "AI tutoring outperforms in-class active learning: an RCT introducing a novel research-based design in an authentic educational setting", *Scientific Reports*, 15, 17458, 2025, https://doi.org/10.1038/s41598-025-97652-6

- De Simone, M., Tiberti, F. and others, *From Chalkboards to Chatbots: Evaluating the Impact of Generative AI on Learning Outcomes in Nigeria*, World Bank Policy Research Working Paper 11125, 2025, https://openknowledge.worldbank.org/entities/publication/15e1ff08-15ae-4f7a-b2a8-d146e6c113ee
- De Simone, M. and others, "From chalkboards to chatbots in Nigeria: 7 lessons to pioneer generative AI for education", World Bank blog, 18 September 2024, https://blogs.worldbank.org/en/education/From-chalkboards-to-chatbots-in-Nigeria
- Wang, R. E. and others, *Tutor CoPilot: A Human-AI Approach for Scaling Real-Time Expertise*, arXiv, 2024, https://arxiv.org/abs/2410.03017; later version, Annenberg EdWorkingPaper, 2025, https://edworkingpapers.com/ai24-1054
- Henkel, O. and others, *Effective and Scalable Math Support: Evidence on the Impact of an AI-Tutor on Math Achievement in Ghana*, arXiv, 2024, https://arxiv.org/abs/2402.09809
- Roy, P. and others (NFER), *ChatGPT in Lesson Preparation: A Teacher Choices Trial*, Education Endowment Foundation, 2024, https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/choices-in-edtech-using-generative-ai-chatgpt-for-ks3-science-lesson-preparation-2024-teacher-choices-trial
- Meyer, J., Jansen, T., Fleckenstein, J. and others, "Using LLMs to bring evidence-based feedback into the classroom: AI-generated feedback increases secondary students' text revision, motivation, and positive emotions", *Computers and Education: Artificial Intelligence*, 6, 100199, 2024, https://doi.org/10.1016/j.caeai.2023.100199
- Steiss, J., Tate, T., Graham, S. and others, "Comparing the quality of human and ChatGPT feedback of students' writing", *Learning and Instruction*, 91, 101894, 2024, https://doi.org/10.1016/j.learninstruc.2024.101894
- Fan, Y., Gašević, D. and others, "Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance", *British Journal of Educational Technology*, 56(2), 2025, https://doi.org/10.1111/bjet.13544
- Kosmyna, N. and others, *Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task*, arXiv preprint, 2025, https://arxiv.org/abs/2506.08872
- Wang, J. and Fan, W., "The effect of ChatGPT on students' learning performance, learning perception, and higher-order thinking: insights from a meta-analysis", *Humanities and Social Sciences Communications*, 12, 621, 2025, retracted 22 April 2026, https://www.nature.com/articles/s41599-025-04787-y; retraction note, https://doi.org/10.1057/s41599-026-07310-z
- OECD, *OECD Digital Education Outlook 2026*, 2026, https://www.oecd.org/en/publications/oecd-digital-education-outlook-2026_062a7394-en.html
- Miao, F. and Holmes, W. (UNESCO), *Guidance for generative AI in education and research*, 2023, https://unesdoc.unesco.org/ark:/48223/pf0000386693_eng
- UN News, "UNESCO calls for regulations on AI use in schools", 2023, https://news.un.org/en/story/2023/09/1140477

- OECD, *Results from TALIS 2024: Country notes: Australia*, 2025, https://www.oecd.org/en/publications/results-from-talis-2024-country-notes_e127f9e2-en/australia_75d1e7a1-en.html
- Gallup, "Three in 10 Teachers Use AI Weekly, Saving Six Weeks a Year", 2025, https://news.gallup.com/poll/691967/three-teachers-weekly-saving-six-weeks-yea.aspx
- Stephenson, R. and Armstrong, C., *Student Generative AI Survey 2026*, HEPI Report 199, Higher Education Policy Institute and Kortext, 2026, https://www.hepi.ac.uk/reports/student-generative-ai-survey-2026/

TEACHWISE

Apprenticeship Research: What Drives Completion

By Sukh Sandhu

Completion rates tell us how many apprentices finish. They do not tell us why some workplaces keep almost every apprentice they sign while others lose most of theirs within a year. A body of Australian and international research now answers that second question with some confidence. It points away from the classroom and the incentive cheque and towards the employer, the supervisor and the first twelve months on the job. This article reads the 2024 Strategic Review of the Australian Apprenticeship Incentive System, the Australian Centre for Evaluation's assessment of the COVID-era wage subsidies, NCVER's synthesis on non-completion, England's 2023 apprenticeship evaluation surveys and Austria's ten-year tracking of apprenticeship leavers, and sets out what each means for trainers, assessors and the people who support apprentices.

Report	Publisher	Year	Method	Sample
Skills for tomorrow: Shaping the future of Australian apprenticeships (Strategic Review final report, Ross and Paul)	Department of Employment and Workplace Relations	Dated 2024, released 24 January 2025	Evidence review, unpublished DEWR data analysis, consultation	More than 145 submissions; more than 600 people consulted
Rapid evaluation of the BAC and CAC wage subsidies (as reported in the Strategic Review)	Australian Centre for Evaluation	2024	Econometric modelling of administrative data	National apprenticeship commencements, 2020 to 2022 subsidy period
Understanding the non-completion of apprentices (Bednarz)	NCVER	2014	Literature review	NCVER and national surveys, industry studies
Apprenticeship evaluation 2023: learner and non-completer surveys	Department for Education, England (IFF Research)	September 2024	Survey, July to September 2023	4,919 learners; 506 non-completers
Training and labour market success of apprenticeship	ibw Austria, reported by Cedefop ReferNet	June 2023	Linked administrative data	383,336 apprenticeship leavers, 2011 to 2020

Report	Publisher	Year	Method	Sample
graduates and dropouts (ibw research brief 114)				
Mentoring program for Indigenous trainees (Mangan and Trendle)	*Education Economics* 27(3)	2019	Propensity score matching	Indigenous trainees, matched comparison group

Why look past the completion rate

NCVER's *Apprentice and trainee completion rates 2025*, released in July 2026, put the six-year completion rate for trade apprentices who began in 2019 at 58.7%, while the four-year rate for non-trade apprentices and trainees who began in 2021 fell to 42.7%. The question here is which features of the employer, the apprentice, the support system and the incentive design are associated with finishing, and how strong the evidence is for each.

One caution applies throughout. Most of this research is observational: higher completion with large employers may reflect who they recruit and which occupations they train in. The strongest causal evidence concerns financial incentives, because policy changes create natural experiments; evidence on supervision and mentoring comes mostly from surveys, case studies and expert reviews.

The Strategic Review: a fair deal at work

The Strategic Review, led by Dr Iain Ross and Lisa Paul, was asked whether the incentive system was effective and efficient in supporting both the uptake and the completion of apprenticeships. Its final report makes 34 recommendations. For educators, its most useful contribution is a plain summary of what the evidence says about completion.

> *"The extent to which the apprentice regards their employment experience as representing a 'fair deal' is central to completion." (Strategic Review final report, p. 81)*

The review draws together several long-standing findings (pp. 81 to 82):

- About 80% of cancellations are initiated by the apprentice, and drop-out rates are highest at the start.
- Workplace issues such as poor conditions, harassment and lack of support have an immediate effect and are likely drivers of the high share of non-completions in the first 6 to 9 months.
- Because most terminations occur early, the review reads the pattern as a sign of poor matching between apprentices and employers.
- Adequate workplace support matters most in the first 4 to 12 months, when apprentices are most at risk.
- Apprentices usually have more than one reason for leaving, so "no single solution will address the problem".

It also lists features of the training experience that previous research has linked to retention (p. 82, citing Harris and colleagues 2001): close integration between off-the-job training and the job, trainers seen as experienced, efficient and supportive, all parties valuing the skills being built, and apprentices being helped to develop persistence. At-risk learners need additional services, including language, literacy and numeracy support and pastoral care.

Employer type and size

The review's own analysis of unpublished departmental data adds new figures on group training organisations (GTOs). Apprentices employed through GTOs tend to have completion rates 5 to 9 percentage points higher than those employed directly by small and medium host employers, and 2 to 5 points higher than those with large employers (p. 60). But the average hides a wide spread.

Completion rate measure, GTO commencements 2015-16 to 2018-19	Lowest GTO	Highest GTO
Trade occupations	21.6%	98.1%
Non-trade occupations	10.3%	89%

Source: Strategic Review final report 2024, p. 61, review analysis of unpublished DEWR data.

The review notes that differences in occupations and apprentice characteristics "do not fully explain the extent of the variation", and concludes that GTOs do not all provide the same quality of service (p. 61). The same logic applies to direct employers. Large employers have higher completion rates than small and medium enterprises, which the review links to dedicated human resources functions and investment in support (p. 79). New employers, those who had not commenced an apprentice in the previous five years, have lower completion rates than other employers of similar size, but new employers who go on to hire more apprentices reach similar or higher rates (p. 79). Around 51% of new small employers, 67% of new medium employers and 70% of new large employers hired more apprentices in later years.

Who is less likely to finish

Group (2019 commencing cohort unless noted)	Completion rate	Comparison group
Women in male-dominated trades	51.0%	Men: 57.7%
First Nations apprentices (all occupations)	48.3%	Non-First Nations: 55.6%
Apprentices with disability (overall)	51.8%	Slightly higher without disability

Source: Strategic Review final report 2024, pp. 83, 228 and 237, review analysis of unpublished DEWR data.

For First Nations apprentices the gap is wider in trades (14.1 percentage points) than in non-trades (3.7 points) (p. 228). The review also cites NCVER survey data that around 14% of women gave poor working conditions as the main reason for discontinuing,

compared with 7% of men, and that women in trades were almost twice as likely as men to report observing bullying (46% compared with 24%) (p. 83). Apprentices in regional and remote areas are the exception among priority groups, with completion rates around 4% higher than those in major cities (p. 246).

Incentives: what the subsidy natural experiment showed

During the pandemic the Australian Government ran apprenticeship wage subsidies that cost more than $7.5 billion. The Boosting Apprenticeship Commencements (BAC) program paid 50% of an apprentice's wage for the first year, up to $7,000 a quarter, for apprentices who started between 5 October 2020 and 30 June 2022. The Completing Apprenticeship Commencements (CAC) program paid a tapered subsidy in years two and three. The Australian Centre for Evaluation (ACE) evaluated both for the review, and its findings, as summarised in the review (pp. 72 to 78), are the most rigorous recent Australian evidence on how money affects completion.

BAC and CAC finding (ACE 2024, as reported in the review)	Figure
Additional commencements caused by BAC	About 191,000 (95% CI 154,000 to 222,000)
Increase over modelled level without BAC	About 70%
Growth in commencements per quarter, small / medium / large employers	98% / 95% / 29%
Change in 18-month cancellation probability, trades	0.7% less likely
Change in 18-month cancellation probability, non-trades	About 7% more likely
Total program cost	Over $7.5 billion
Cost per additional commencement	About $40,000 ($30,000 to $50,000)
Cost per additional completion	About $80,000 ($60,000 to $90,000)

Source: Strategic Review final report 2024, pp. 73 to 77, citing ACE 2024 pp. 7 to 30.

The subsidy did what it was designed to do: it brought in many more starters, mostly through small, new employers. It did not lift completion. In non-trades, where the baseline six-quarter cancellation rate was already 30% to 40%, commencing under the subsidy made cancellation more likely. ACE identified "sharp practice": businesses converting existing workers into trainees to collect the subsidy, in some cases without telling the worker they had been enrolled in a qualification (p. 77). The review notes that this was almost entirely a non-trade problem, partly because trade training usually requires attendance off-site, which makes paper enrolments harder to sustain, and partly because a large share of non-trade training is delivered by for-profit providers who may have had a stronger incentive to take part (p. 78).

Earlier econometric evaluations point the same way. The review cites Deloitte Access Economics (2020) finding that broad employer incentives were associated with a higher probability of cancellation and a lower probability of completion, and that moving a commencement payment from 3 to 6 months modestly reduced early drop-out but did not improve overall completion: drop-outs were simply delayed until after the payment (p. 80). The review's summary is blunt: broad, homogenous incentives are "largely ineffective" for completion (p. 86).

NCVER on the employer: "the influence of the employer cannot be overstated"

Alice Bednarz's NCVER review remains the most cited Australian synthesis on non-completion, and its central message has held up. Employment-related reasons, such as interpersonal problems with employers or colleagues, redundancy, not liking the work and changing career, are the most common reasons for leaving; problems with off-the-job training are the least common (key messages). About 80% of completers were satisfied with their employment experience overall, compared with 42% of non-completers, and 60% of those who leave do so within the first year (key messages).

Bednarz reproduces Karmel and Roberts' (2012) estimates of completion by employer characteristics, which show how strongly the type of workplace is associated with finishing.

Employer characteristic (trade contracts)	Estimated completion rate	Contracts
Private employer	49.1%	160,270
Group training	52.0%	28,417
Government (including defence)	80.3%	7,925
Employer with 1 apprentice	46.8%	50,253
Employer with 26 to 50 apprentices	61.4%	6,825
Total	50.4%	196,612

Source: Bednarz 2014, Table 11, p. 23, citing Karmel and Roberts 2012.

These are older cohorts, and the newer Strategic Review analysis puts GTOs further ahead of direct small and medium employers. The practical point is that most apprentice employers are small: in the Karmel and Roberts data, 63% of employers had only one apprentice, and employers with up to three apprentices accounted for half of all apprentices (p. 23). A system that served only large employers would lose half its places.

A study of 500 New South Wales employers (Dickie, McDonald and Pedic 2011), summarised by Bednarz, describes what high-retention workplaces look like. Employers with retention of 70% or more tended to have 50 or more staff, a human resources function, more than ten years in operation and several apprentices at once, though small experienced employers also did well, and they rated financial incentives as less important than low-retention employers did. Committed apprentices, those rating their likelihood of finishing at eight out of ten or higher, generally said they had a very good boss, were treated fairly, had a social network at work and were trusted with responsibility (pp. 24 to 25). Where there is no human resources function, one apprentice's grievance has nowhere to go: "it's the boss or no one" (p. 26, quoting Dickie and colleagues).

Mentoring: strong consensus, thin causal evidence

The Strategic Review cites the 2011 expert panel finding that mentoring and pastoral care are the most significant support strategies for boosting completion, the Productivity Commission's 2020 finding that mentoring and related supports are effective, and an OECD study suggesting such supports are more likely to improve completion than financial

incentives (p. 178). Apprentice Connect Australia providers, which replaced the Australian Apprenticeship Support Network on 1 July 2024, now focus their mentoring on priority groups and apprentices at risk of non-completion, but the review heard "mixed views" about provider performance (p. 179). It also found that no complaints against employers had been reported by providers since the new program began, which it called an apparent "system failure" given how often such issues arose in consultation (p. 177).

The review's own examples of effective mentoring are mostly industry-led: the Housing Industry Association's apprentice and employer mentoring program in Queensland, union and employer association programs, and the Australian Industry Trade College model, where 98.9% of students completed their Queensland Certificate of Education in 2022 and 78% moved into an apprenticeship (p. 179). These are program-reported outcomes without comparison groups, so they show what is possible rather than what mentoring causes.

The best Australian attempt at a causal estimate is narrower. Mangan and Trendle (2019) used propensity score matching, which compares participants with statistically similar non-participants, to evaluate a mentoring program for Indigenous trainees. They found the program increased the trainees' completion rate by approximately 10%. The study concerns one program and one group, and matching cannot rule out differences between the groups that the data did not capture, but it supports the direction of the broader consensus.

England: the 2023 non-completer survey

England's Department for Education runs a regular apprenticeship evaluation survey series. The 2023 wave, the eighth since 2011, interviewed 4,919 current and completed apprentices and 506 former apprentices on apprenticeship standards who did not complete, between July and September 2023 (p. 11). It is one of the most detailed recent international sources on why apprentices leave, and its findings sit closely alongside Australia's.

Non-completers, England 2023	Share
Left within the first 12 months	65%
Apprenticeship badly run or poorly organised (contributing reason)	49%
Training not as good as hoped (contributing reason)	46%
Not enough time for learning or training (contributing reason)	43%
Any personal or domestic factor (contributing reason)	36%
Main reason: better job offer	16%
Main reason: did not get on with employer	11%
Satisfied with apprenticeship overall (completers: 85%)	48%
Said the apprenticeship made their mental health worse	40%

Source: DfE 2024, Apprenticeship evaluation 2023: learner and non-completer surveys, executive summary, pp. 24 to 26.

Non-completers were more likely than completers to have worked for the same employer before starting (66% compared with 55%), echoing the Australian concern about existing-worker enrolments. Mentions of financial struggle rose from 22% in 2021 to 27%. Female non-completers were more likely than male non-completers to say they lacked time to learn (47% compared with 38%) or found it too difficult or were falling behind (43% compared with 27%). Only 55% of non-completers rated their training provider's support as good, down from 61% in 2021, and 32% rated their employer's support as poor. Two-thirds of those who received training had more than half of it online, and 38% wanted less (pp. 25 to 26). The survey records views of people who left; it cannot show that changing any one factor would have kept them.

Austria: when you start matters, and finishing pays

Austria's apprenticeship system tracks every leaver. The ibw research institute linked apprenticeship, exam, employment service and social insurance records for all 383,336 people whose apprenticeship ended between 2011 and 2020 without a new contract by the end of the following year (research brief 114, p. 1). Of these, 16.6% neither completed the apprenticeship period nor sat the final apprenticeship exam.

Age at starting apprenticeship, Austria 2011 to 2020	Share who dropped out
15	7%
16	12%
17	21%
24	34%

Source: ibw research brief 114, 2023, p. 1 and Diagram 1.

The age gradient is partly about prior pathways: in Austria, starting at 15 usually means going straight from compulsory school, and the brief finds that the type of prior qualification also strongly influences drop-out. The Cedefop ReferNet summary also reports that there were no significant differences by gender overall, but women dropped out more often in male-dominated occupations and men more often in female-dominated ones. The labour market consequences were stark. Three years after leaving, 84% of those who completed successfully were employed and 9% unemployed, compared with 44% employed and 24% unemployed among dropouts. Even partial completion helped: employment was 66% for those who completed the period but did not sit the exam, and 72% for those who sat it and failed.

Limits of the evidence

- **Mostly associations.** Employer size, GTO status and occupation are tangled together. A GTO advantage could reflect selection of apprentices and hosts as much as the support it provides.
- **Incentive evidence is the strongest.** The ACE and Deloitte work models counterfactuals on full administrative data. ACE notes its model would not capture every factor, and later cancellations could change its completion estimate. Its figures here come from the Strategic Review's summary.

- **Mentoring evidence is mostly descriptive.** Few Australian programs have been evaluated against a comparison group, so program-reported outcomes are encouraging rather than proof of effect.
- **Older sources.** Bednarz's review and the data it cites are more than a decade old, though later reviews have confirmed the main patterns.
- **International transfer.** England's apprenticeships include many existing workers and degree-level programs; Austria's end in a formal final exam. Neither maps directly onto Australian contracts of training.

What this means for your practice

The following points are our interpretation of the research, not recommendations made by the report authors.

1. **Treat the first year as the critical period.** In both the Australian and English data, most leavers go within twelve months. Schedule early contact and structured reviews at three and six months, and make sure the apprentice knows who to call when something goes wrong at work.
2. **Ask about the workplace, not just the unit.** The research consistently ranks the employment experience above off-the-job training as a reason for leaving. Trainers who visit workplaces are well placed to notice bullying, unpaid hours, narrow work or absent supervision, and should know where to refer concerns.
3. **Support the supervisor as well as the apprentice.** Good supervisors and a "mentor-style boss" recur in every study. Short practical guidance for supervisors on coaching, feedback and the training plan, especially for first-time and small employers, targets the group with the lowest completion rates.
4. **Be wary of enrolments that look like a payment event.** The subsidy evidence shows that converting existing workers into trainees without a real training purpose leads to cancellations. Confirm genuine intent to train, real time for learning and the learner's informed consent at sign-up.
5. **Plan time for learning inside the job.** In England, "not enough time for learning" was a contributing reason for 43% of non-completers. Agree with employers when off-the-job and structured on-the-job learning will happen, and record it in the training plan.
6. **Target support where the gaps are.** Women in male-dominated trades, First Nations apprentices and apprentices with disability complete at lower rates. Culturally safe trainers, peer networks, inclusive supervision and language, literacy and numeracy support are where extra effort is most likely to matter.
7. **Use completion data to learn, not just to report.** The spread in GTO completion rates (21.6% to 98.1% in trades) shows that practice varies more than averages suggest. Compare your cohorts by employer, occupation and start date to find where apprentices are being lost.

Sources

- Department of Employment and Workplace Relations, *Skills for tomorrow: Shaping the future of Australian apprenticeships, Strategic Review of the Australian Apprenticeship*

Incentive System 2024 Final Report, released 24 January 2025, https://www.dewr.gov.au/australian-apprenticeships/resources/strategic-review-australian-apprenticeship-incentive-system-final-report

- Department of Employment and Workplace Relations, *Skills for tomorrow: Shaping the future of Australian apprenticeships* (newsroom article), 24 January 2025, https://www.dewr.gov.au/newsroom/articles/skills-tomorrow-shaping-future-australian-apprenticeships
- NCVER, Bednarz, A, *Understanding the non-completion of apprentices*, 2014, https://ncver.edu.au/research-and-statistics/publications/all-publications/understanding-the-non-completion-of-apprentices
- Department for Education (England), IFF Research, *Apprenticeship evaluation 2023: learner and non-completer surveys, research report*, September 2024, https://www.gov.uk/government/publications/apprenticeship-evaluation-2023-learner-non-completer-and-employer-surveys
- ibw Austria, Dornmayr, H, Lengauer, B and Riepl, M, *Training and labour market success of apprenticeship graduates and dropouts: monitoring of apprenticeship graduates 2011-2020*, ibw research brief 114, June 2023, https://ibw.at/resource/download/2598/ibw-researchbrief-114-en.pdf
- Cedefop and ReferNet Austria, *Austria: monitoring apprenticeship graduates underlines the importance of training success*, 20 December 2023, https://www.cedefop.europa.eu/en/news/austria-monitoring-apprenticeship-graduates-underlines-importance-training-success
- Mangan, J and Trendle, B, "Evaluating the effectiveness of a mentoring program for Indigenous trainees in Australia using propensity score analysis", *Education Economics*, vol. 27, no. 3, 2019, pp. 308 to 322, https://doi.org/10.1080/09645292.2019.1583317
- NCVER, *Apprentice and trainee completion rates 2025*, 2026, https://ncver.edu.au/research-and-statistics/publications/all-publications/apprentice-and-trainee-completion-rates-2025

TEACHWISE

Lifelong Learning and Adult Participation: Global Evidence

By Sukh Sandhu

Governments everywhere say adults must keep learning throughout longer working lives. The best measures of whether they actually do so tell a less comfortable story. In Australia, the last ABS survey of adult learning, released in April 2026, found participation in study and training had fallen since 2020-21. In Europe, the EU's 2025 target for adult learning sits close to the most recent survey result, but its 2030 goal is far off. Globally, UNESCO's most recent report found that the adults who most need learning are the least likely to get it. This article sets out the data from the ABS, Eurostat and UNESCO, explains why the figures from different surveys cannot simply be compared, and draws out what they mean for VET providers and adult educators, whose learners are increasingly adults who want a skill, not a whole qualification.

At a glance

Report	Publisher	Year	Method	Sample
Work-Related Training and Adult Learning, Australia, 2024-25	ABS	9 April 2026	Household survey, four-yearly (final edition)	People aged 15 to 74
Total VET students and courses 2025	NCVER	22 July 2026	National VET Provider and VET in Schools collections	5.1 million VET students
Adult learning statistics (Adult Education Survey 2022 and EU Labour Force Survey)	Eurostat	Data extracted May 2026	Household surveys	Adults aged 25 to 64 in 27 EU countries
Fifth Global Report on Adult Learning and Education (GRALE 5)	UNESCO Institute for Lifelong Learning	June 2022	Country monitoring survey, policy analysis, case studies	159 countries submitting data

Why the definitions matter

Adult learning statistics usually distinguish three kinds of learning. Formal learning leads to a recognised qualification, such as a certificate, diploma or degree. Non-formal learning

is organised and structured, such as a workshop, a short course or a skill set, but does not lead to a full qualification; most work-related training falls here. Informal learning is self-directed or incidental, such as learning from a colleague, a video or a manual.

Surveys also differ in their reference period (the last four weeks or the last twelve months), the age range covered, and whether guided on-the-job training counts. These choices change the headline figure dramatically. Eurostat's own comparison is a warning: in 2022 the EU Adult Education Survey (AES) put 12-month participation of 25 to 64 year olds at 46.6%, while in 2024 the EU Labour Force Survey (LFS), asking a similar question, put it at 28.5%. Eurostat attributes the difference to the LFS excluding guided on-the-job training, less detailed questions, more proxy answers, differences in interviewer training, and possible over-reporting in the AES for reasons of social desirability. It considers the AES the better measure of levels and the LFS more useful for trends. Australian figures use different definitions again, so cross-country comparisons in this article are indicative only.

Australia: participation has fallen

The ABS Survey of Work-Related Training and Adult Learning (WRTAL) is the main national measure of adult learning. The 2024-25 edition, released on 9 April 2026, is the last: the ABS has ceased the four-yearly series and is exploring a possible new education and skills survey.

Its headline finding is a decline. In 2024-25, 34% of Australians aged 15 to 74 (6.8 million people) had participated in study or training in the previous 12 months, down from 39% (almost 7.3 million) in 2020-21.

Participation, people aged 15 to 74	2013	2016-17	2020-21	2024-25
Formal study	21.6%	21.0%	20.6%	19.1%
Work-related training	26.9%	21.5%	23.4%	18.6%

Source: ABS, Work-Related Training and Adult Learning, Australia, 2024-25. The ABS advises caution comparing 2013 with later years because of methodology differences.

The fall in work-related training, from 23.4% to 18.6% in four years, is the larger movement. Formal study has drifted down slowly across the whole period.

Participation drops steeply with age, and the type of learning changes as it does.

Age group	Formal study	Work-related training	Any study or training
15 to 19	80.7%	8.1%	82.3%
20 to 24	52.6%	18.1%	60.5%
25 to 34	19.4%	20.9%	35.8%
35 to 44	11.5%	24.0%	32.5%
45 to 54	7.4%	25.3%	30.3%
55 to 64	3.6%	18.6%	21.1%
65 to 74	1.0%	5.1%	6.0%

Source: ABS, WRTAL 2024-25.

From the mid-30s, work-related training, not formal study, is the main way adults learn, and it peaks among 45 to 54 year olds. Formal study among people over 45 is rare.

Who learns, and who does not

The WRTAL data reproduce a pattern found in every adult learning survey: those with more education get more of it. People holding a graduate diploma or certificate were more than three times as likely to have done work-related training (34.3%) as people with no non-school qualification (10.2%).

Highest non-school qualification	Formal study	Work-related training
Postgraduate degree	12.8%	28.5%
Graduate diploma or graduate certificate	13.5%	34.3%
Bachelor degree	15.4%	24.9%
Advanced diploma or diploma	13.1%	22.3%
Certificate III or IV	11.8%	18.1%
Certificate I or II	18.6%	13.6%
No non-school qualification	28.9%	10.2%

Source: ABS, WRTAL 2024-25.

People without a post-school qualification were more likely to be in formal study (28.9%), largely reflecting young people still studying, but much less likely to receive training at work. Other gaps follow familiar lines. Formal study was 20.3% in major cities, 16.5% in inner regional areas and 13.2% in outer regional and remote areas; total participation fell from 35.5% to 27.1% across the same gradient. Some 28% of people with disability or a restrictive condition participated, against 36% of people without. Women were slightly more likely than men to study (20% against 18%) and to do work-related training (19% against 18%).

Why adults study, and what stops them

For formal study towards a non-school qualification, the main reasons were to improve job prospects or change career (45%), to increase skills in their current job or because it was required (35%), and personal development (11%). Motives shift with age: improving skills in the current job was the main reason for 50.8% of 45 to 54 year olds, while personal development was the main reason for 46.2% of 65 to 74 year olds.

About 6% of people (almost 1.3 million) wanted to undertake formal study for a non-school qualification but experienced barriers. The rate was highest among 25 to 44 year olds, at around 9%.

Barrier to formal study (of those with barriers)	Males	Females
Too much work or not enough time	53.5%	42.5%
Financial reasons	28.8%	34.0%
Caring for children	5.9%	14.6%
Personal health reasons	5.7%	6.7%
Courses not available	6.4%	3.9%

Source: ABS, WRTAL 2024-25. Respondents could report more than one barrier.

Among people with barriers, those working full time were far more likely to cite lack of time (60%) than those working part time (34%), while part-time workers were twice as likely to cite caring for children (15% against 7%). For work-related training, too much work or not enough time was the main barrier for 44% of people who reported barriers. More learners are meeting costs themselves: 17% of people who did work-related training paid personal costs for their most recent course, up from 14% in 2020-21, and 55% of those with their own business paid, against 11% of employees.

Australian VET: adults want units, not whole qualifications

NCVER's administrative data, which count every enrolment in nationally recognised training, show a different but complementary trend. *Total VET students and courses 2025*, published on 22 July 2026, counted 5.1 million students in nationally recognised VET in 2025, about the same as in 2024. The domestic participation rate for 15 to 64 year olds declined marginally to 26.4%, as population growth outpaced enrolments.

The mix of training is changing.

Type of training, 2025	Share of VET students	Change from 2024	Students
Qualifications	38.6%	down 5.2%	1,982,745
Short courses (skill sets and accredited courses)	4.4%	up 3.5%	228,395
Stand-alone subjects (units of competency)	71.1%	up 1.7%	3,656,585

Source: NCVER, Total VET students and courses 2025. Shares sum to more than 100% because students can enrol in more than one type of training.

NCVER notes that student numbers in stand-alone subjects have grown since 2015, except for a brief decline in 2020, in line with growth at private training providers, and that 77.7% of private provider students and 88.2% of community education provider students were in stand-alone subjects, compared with 87.3% of TAFE students being in qualifications. The collection does not show why learners took these units, so not all of this activity is upskilling in the sense policy intends. But it is consistent with what the WRTAL motives suggest: many adults engage with VET in small, targeted pieces.

Europe: a target met on one measure, missed on another

The EU has set two adult learning targets: that by 2025 at least 47% of adults aged 25 to 64 should have participated in learning in the previous 12 months, and that by 2030 at least 60% of all adults should participate in training every year. The 2022 AES result of 46.6% sits just below the first; the 2024 LFS result of 28.5% sits far below both.

The AES shows the same participation gradient by education found in Australia.

Educational attainment, adults 25 to 64, EU, 2022	Participated in formal or non-formal learning (last 12 months)
All adults	46.6%
Lower secondary or below (ISCED 0 to 2)	25.1%
Upper secondary or post-secondary, vocational	40.7%
Upper secondary or post-secondary, general	44.1%
Tertiary (ISCED 5 to 8)	65.7%

Source: Eurostat, Adult Education Survey 2022 (trng_aes_102).

Adults with tertiary education were more than two and a half times as likely to learn as those with lower secondary education or less. Participation also varied enormously between countries: Sweden and the Netherlands reported over 65% in the AES, while Poland, Bulgaria and Greece were below 25%. Women participated slightly more than men (47.2% against 46.0%).

The LFS four-week measure, the longest-running series, rose from 10.1% in 2015 to 10.8% in 2019, fell to 9.1% in 2020 with the pandemic, and has grown since, although Eurostat notes a series break in 2021 and that some of the growth reflects improved questionnaires. In 2025, 14.9% of women and 12.4% of men had learned in the previous four weeks, a gender gap that has widened from 1.7 percentage points in 2015 to 2.5 points. For unemployed adults, the EU's 2025 objective was that at least 20% should have a recent learning experience; in 2025 the figure was 15.9%, up from 9.3% in 2015, and only eight countries met the target.

Informal learning is far more common than either formal or non-formal learning. In the 2022 AES, 64.2% of EU adults aged 25 to 64 reported some informal learning in the previous year, from below 30% in Greece to over 90% in Cyprus.

The global picture: reaching those who need it most

UNESCO's *Fifth Global Report on Adult Learning and Education* (GRALE 5), published on 15 June 2022 at the Seventh International Conference on Adult Education in Marrakech, remains the most recent global stocktake; GRALE 6 is scheduled for 2027. It draws on monitoring data from 159 countries. UNESCO summarised the key message plainly: the main challenge for adult learning and education is "to reach those who need it most".

GRALE 5 finding	Result
Countries reporting an increase in overall participation since 2018	Over half
Countries reporting no improvement in participation by people with disabilities, migrants or prisoners	About 60%
Countries reporting a decline in participation of rural populations	24%
Countries reporting a decrease in participation of older adults	24%
Countries where fewer than 1% of people aged 15 and over participate in education and learning programmes	23%
Countries spending 4% or more of public education expenditure on adult learning (of 146)	22 countries
Countries spending less than 0.4% of public	28 countries

GRALE 5 finding	Result
education expenditure on adult learning (of 146)	
Countries developing or implementing citizenship education policies	74%

Source: UNESCO Institute for Lifelong Learning, GRALE 5 key data, 2022.

Participation of women and young people had improved considerably, the report found, but overall participation remained insufficient. Regional differences were striking: 59% of sub-Saharan African countries reported that at least one in five adults benefit from learning, compared with 16% of countries in Latin America and the Caribbean and 25% in Europe, which UNESCO partly attributes to strong demand for adult literacy in Africa. Most countries reported progress in the quality of curricula and assessment and in the professionalisation of adult educators, with over two-thirds reporting progress in pre-service and in-service training for adult educators.

GRALE 5 relies on country self-reports, which vary in quality and definitions, so it describes national perceptions of progress more than measured participation.

What the sources agree on

Despite their different methods, the Australian, European and global sources converge on four points.

1. **Participation is unequal and the inequality is self-reinforcing.** In Australia, Europe and globally, adults with more education, in better jobs and in cities learn more. Those with the least education, in regional and remote areas, with disability, older or unemployed, learn least.
2. **Work is both the main driver and the main barrier.** Most adults learn for job reasons and through their employer, yet lack of time due to work is the most common barrier. People outside secure employment miss out on employer-provided training altogether.
3. **Adults learn in small pieces.** From the growth of VET subject enrolments to the dominance of work-related training among people over 35 and the scale of informal learning in Europe, adult learning is mostly short and targeted.
4. **Caring responsibilities shape women's access.** Women in Australia were more than twice as likely as men to cite caring for children as a barrier, even though women participate slightly more overall.

Limits of the evidence

The WRTAL series has ended, leaving Australia without a regular dedicated measure of adult learning. Its decline between 2020-21 and 2024-25 is measured over a period that included pandemic disruption in the earlier year, which may have affected the comparison in ways the survey cannot separate. Self-reported participation surveys are prone to recall and social desirability bias, which Eurostat explicitly flags. The AES runs only every six years; its 2022 data were collected in most countries between June 2022 and March 2023. Cross-country comparisons are complicated by different age ranges, reference periods and

treatment of on-the-job training. GRALE 5 is based on government self-assessment and is now four years old. None of these sources measures the quality or outcomes of adult learning, only whether it occurred.

What this means for your practice

The following points are our interpretation of the data, not recommendations made by the publishers.

1. **Design for time-poor adults.** Lack of time is the leading barrier for working adults. Offer evening, weekend, block and online options; break programs into units and skill sets that can be completed and credited one at a time.
2. **Make stacking easy.** Many adults take single units or short courses. Map how they can build towards a full qualification, and tell learners about credit and recognition of prior learning at the point of enrolment, not at the end.
3. **Go to the learners who are missing.** Participation is lowest among people without post-school qualifications and in regional areas, yet they are least likely to get training from an employer. Partnerships with employment services, community organisations and regional employers reach people who will not come to you.
4. **Account for caring responsibilities.** Predictable timetables, recorded sessions and flexible assessment deadlines matter especially for women with young children, who report caring as a barrier at more than twice the rate of men.
5. **Help employers keep training.** The fall in work-related training is the largest movement in the Australian data. Short, workplace-based programs that fit around production, and evidence of their value, make it easier for employers, especially small businesses, to keep investing.
6. **Be clear about cost.** More learners are paying for work-related training themselves, and finance is a barrier for a third of those prevented from studying. Make fees, subsidies and payment options easy to understand before enrolment.
7. **Recognise informal learning.** Most adults learn informally. Recognition of prior learning and current competency processes that genuinely value workplace and self-directed learning respect what adults already know and shorten their path to a qualification.

Sources

- ABS, *Work-Related Training and Adult Learning, Australia, 2024-25 financial year*, released 9 April 2026, https://www.abs.gov.au/statistics/people/education/work-related-training-and-adult-learning-australia/latest-release
- NCVER, *Total VET students and courses 2025*, 22 July 2026, https://www.ncver.edu.au/research-and-statistics/publications/all-publications/total-vet-students-and-courses-2025
- Eurostat, *Adult learning statistics*, Statistics Explained, data extracted May 2026, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Adult_learning_statistics

- Eurostat, *Participation rate in education and training by educational attainment level* (trng_aes_102), Adult Education Survey 2022, https://ec.europa.eu/eurostat/databrowser/view/trng_aes_102/default/table
- UNESCO Institute for Lifelong Learning, *Fifth Global Report on Adult Learning and Education* (GRALE 5), 2022, https://unesdoc.unesco.org/ark:/48223/pf0000381666; key data at https://www.uil.unesco.org/en/grale5
- UNESCO Institute for Lifelong Learning, *Global report on adult learning and education (GRALE)*, https://www.uil.unesco.org/en/adult-education/global-report-grale

TEACHWISE

Gender and Occupational Segregation in VET: What the Evidence Shows About Women in Trades and Men in Care

By Sukh Sandhu

Australia's trades are almost entirely male and its care workforce overwhelmingly female, and the training system largely reproduces that pattern. Jobs and Skills Australia's three-part Gender Economic Equality Study, completed in late 2025, is the most detailed analysis yet of how gender segregation runs from the classroom to the pay packet. This article sets out what the study found, adds NCVER's latest apprenticeship and outcome data and the ABS Survey of Education and Work, places Australia alongside international evidence, and considers what VET trainers and leaders can realistically change.

At a glance

Report	Publisher	Year	Method	Sample
New perspectives on old problems: Gendered jobs, work and pay (Paper 1)	Jobs and Skills Australia	7 August 2025	Census 2021 analysis; new Gender Segregation Intensity Scale	All ANZSCO 4-digit occupations
Education and training divides: Gendered skills, pathways and outcomes (Paper 2)	Jobs and Skills Australia	10 September 2025	Enrolment, completion and linked administrative data	VET and higher education; top 100 VET qualifications
Speeding up progress towards gender economic equality (Paper 3)	Jobs and Skills Australia	29 October 2025	Recommendations drawing on Papers 1 and 2	Not applicable
Apprentices and trainees 2025: December quarter	NCVER	22 June 2026	National Apprentice and Trainee Collection	All contracts to 31 December 2025
VET student outcomes 2025	NCVER	17 December 2025	National Student Outcomes Survey	276,304 VET students
Education and Work, Australia, May 2025	ABS	19 November 2025	Supplement to the Labour Force Survey	People aged 15 to 74

Measuring segregation

JSA's first contribution is a measure. Its Gender Segregation Intensity Scale (GSIS) sorts occupations into four bands by the share of the dominant gender: gender balanced (under 60%), moderately dominated (60% to 74%), highly dominated (75% to 89%) and almost completely dominated (90% and above). Applied to the 2021 Census, the scale shows how concentrated Australian work is.

Table 1: The Australian workforce by gender segregation intensity, 2021

Segregation intensity	Occupations (4-digit)	Workforce	Share of workforce	Assessed occupations in shortage, 2024
Gender balanced (below 60%)	75	2,429,520	21%	25%
Moderately dominated (60% to 74%)	101	3,241,926	29%	20%
Highly dominated (75% to 89%)	100	3,334,555	29%	33%
Almost completely dominated (90% and above)	82	2,327,915	21%	67%

Source: JSA, Gender Economic Equality Study Paper 1, Table 1 (ABS Census 2021; JSA 2024 Occupation Shortage List).

Only about one worker in five is in a gender balanced occupation, and the same share is in occupations at least 90% one gender. The last column matters most for VET: two-thirds of the assessed occupations that are almost completely dominated by one gender were in shortage in 2024. JSA reports that 73% of almost completely male dominated occupations were in shortage, against 47% of almost completely female dominated occupations.

Skill level is part of the story. JSA finds that skill level 3 jobs, which generally require Certificate III or IV apprenticeship or traineeship qualifications, are the most gender segregated, and almost half (48%) of almost completely male dominated occupations are at skill level 3. Almost completely female dominated occupations are more often at skill level 1.

Table 2: Selected highly segregated occupations, 2021

Occupation	Male share	Occupation	Female share
Bricklayers and Stonemasons	99.1%	Midwives	98.7%
Plumbers	99.0%	Early Childhood (Pre-primary School) Teachers	97.6%
Carpenters and Joiners	98.9%	Dental Assistants	97.5%
Motor Mechanics	98.1%	Child Carers	95.6%
Electricians	97.9%	Receptionists	93.5%

Source: JSA, Gender Economic Equality Study Paper 1, Table 6 (ABS Census 2021).

Some large care occupations are less extreme but still highly gendered: Aged and Disabled Carers were 76.7% female and Registered Nurses 88.3% female in 2021 (Paper 1).

The training pipeline reproduces the pattern

Paper 2's central conclusion is blunt: current VET and higher education enrolments and completions indicate that training pipelines will not significantly reduce existing gender segregation or the shortages linked to it.

Table 3: VET enrolments by gender in selected training packages, 2023

Training package	Female enrolments	Male enrolments
Electrotechnology (UEE)	6%	94%
Construction, Plumbing and Services (CPC)	7%	93%
Manufacturing (MSA)	19%	81%
Information and Communications Technology (ICT)	24%	76%
Community Services (CHC)	80%	20%
Health (HLT)	82%	18%

Source: JSA, Gender Economic Equality Study Paper 2, Table 1 (NCVER, Total VET students and courses 2023).

JSA also reports that females made up 17% of VET STEM program enrolments and 12% in engineering and related technologies, while making up 56% of non-STEM enrolments. Across 69 narrow fields of education in VET and higher education, only 14 (20%) had gender balanced completions across 2015 to 2017. The ABS Survey of Education and Work shows the same split among current students in 2025: 21.4% of men studying for a non-school qualification were in engineering and related technologies, against 2.3% of women, while 27.0% of women were in society and culture and 21.0% in health. Of employed apprentices and trainees aged 15 to 74 (excluding school-based), 78% were men.

Apprenticeships: a mixed recent trend

NCVER's December quarter 2025 data show female participation in apprenticeships and traineeships falling, mostly because non-trade traineeships, where women are concentrated, have contracted.

Table 4: Female apprentices and trainees in training, as at 31 December

Year	Females in training	All contracts in training	Female share (calculated)
2021	98,355	347,660	28.3%
2022	110,350	372,885	29.6%
2023	92,540	337,245	27.4%
2024	79,175	309,080	25.6%
2025	69,440	282,430	24.6%

Source: NCVER, *Apprentices and trainees 2025: December quarter*, Figure 9 (12-month series). Shares calculated by TeachWise.

Female in-training numbers fell 12.3% in the year to December 2025, the largest fall of any equity group. NCVER notes one bright spot: while female trade commencements fell overall, commencements for women in male-dominated trades such as Electrotechnology and Telecommunications Trades Workers increased.

Men in care: the other half of the problem

Most public attention goes to women in trades, but JSA's data show the care side of the labour market is just as segregated and just as short of workers. In 2021, Child Carers were 95.6% female, Receptionists 93.5% and Primary School Teachers 85.1% (Paper 1). In VET, 80% of Community Services enrolments and 82% of Health enrolments in 2023 were female (Table 3). Many of the fastest growing almost completely female dominated occupations, including Child Carers, Early Childhood Teachers and Midwives, were also in national shortage.

Change has been slow. Paper 1 found that around 70% of occupations had the same segregation intensity in 2021 as in 2006. Some movement has occurred: Ambulance Officers and Paramedics moved from male dominated to gender balanced, and more men are now working as Aged and Disabled Carers and Pharmacy Assistants, although not enough to move those occupations on the scale.

The intersectional findings are revealing. JSA reports that culturally and linguistically diverse (CALD) men hold higher shares of health roles, including Aged and Disabled Carers and Registered Nurses, than men across the economy, and that these occupations are less gender segregated among CALD workers than in the workforce as a whole. Paper 2 adds that CALD male and female graduates earned more than other workers in aged care and disability support related occupations one year after training. In other words, the pattern of men avoiding care work is not universal even within Australia, which supports the World Bank conclusion, discussed below, that segregation is social rather than inherent in the work.

JSA also found that men are paid more than women in each of the main occupations reached through the female dominated Human Welfare Studies and Services field of education. In our reading, this suggests men considering care work face a different barrier from women entering trades: less about pay once in the job, and more about social norms that discourage entry in the first place.

Classification and recognition

Paper 1 identified a historical bias in how occupations are described. Under the old ANZSCO classification there were 66 almost completely male dominated occupations but only 16 almost completely female dominated ones, because male dominated work had been described in far more detail. Paper 2 found the new OSCA classification improves this: the share of leadership occupations that are highly or almost completely female dominated rose from 11% under ANZSCO to 17% under OSCA. For trainers in care qualifications, this matters. A system that cannot see the skills and leadership in a job is less likely to value them, and less likely to attract anyone, male or female, into it.

Outcomes after training: qualified but paid less

Paper 2 uses linked administrative data to follow people completing the top 100 VET qualifications in 2019 to 2020, one year after training. Across those at Certificate III level or above, males had higher median incomes in 82% of qualifications, while females had better employment outcomes in just under half (47%). JSA's national benchmark for completers (based on the top 500 qualifications) was a median income of $48,500 one year after training; for female completers it was $41,900.

The national survey points the same way. NCVER's 2025 outcome data show a median annual income of $78,300 for male certificate II and above completers employed full time, against $62,400 for females. The ABS shows the employment side.

Table 5: Full-time employment by highest qualification and sex, aged 15 to 74, May 2025

Highest non-school qualification	Men employed full time	Women employed full time
Bachelor degree	71.1%	53.1%
Certificate III/IV	69.6%	39.1%
No non-school qualification	42.8%	23.0%

Source: ABS, *Education and Work, Australia, May 2025*, Table 22.

These gaps reflect field of study, part-time work and caring responsibilities as well as any discrimination, and the sources do not separate those causes. JSA does, however, report some striking exceptions: in some almost completely male dominated pathways, such as those leading to Electrician and to Mechanical Engineering trades, female graduates earned significantly more than males one year after training. Paper 2 also found women are more likely than men to be working in skill level 1 roles, but also more likely to be "skills mismatched", meaning employed below the level of their qualification.

The intersectional results add nuance. First Nations women appeared to fare better in pathways leading to gender balanced and female dominated occupations, while First Nations men did better in pathways to male dominated trades such as electrical, carpentry and mechanical engineering, though not in qualifications tied to mining. People with disability had the lowest outcomes overall, but women with disability had good employment outcomes in selected hospitality, veterinary nursing and early childhood qualifications, and men with disability in selected carpentry and mechanical trade qualifications.

Paper 2 adds an important finding on retention: males and females stay longer in occupations dominated by their own gender. A woman who enters a trade, or a man who enters early childhood education, is swimming against a current that continues after the training ends.

Where segregation starts

JSA's analysis repeatedly traces study choices back to school and family. It cites OECD PISA data showing that only 14% of 15-year-old girls who were top performers in science or mathematics expected to work as science or engineering professionals, against 26% of

top-performing boys. It also cites the Australian STEM Equity Monitor, which found girls were nearly half as likely as boys to aspire to a STEM career (22% compared with 43%). By the time learners reach an RTO, many choices have already been shaped.

How Australia compares internationally

JSA draws on a World Bank analysis of 80 countries (Carranza and colleagues, 2023). Using the Duncan index of segregation, Australia's labour market was more gendered than 72% of the countries studied: more segregated than the Philippines, Malaysia and Thailand, and similar to Norway and Denmark. Patterns were broadly common across countries, with mining, transport, trades and manufacturing male dominated almost everywhere, and health, teaching, services and sales female dominated.

Two details in the World Bank findings, as reported by JSA, are worth noting for educators. ICT professions were male dominated in 77 of the 80 countries, yet the building trade was not male dominated in one country, Indonesia. And the authors concluded that no job was inherently male or female: occupations that are male dominated in some countries are gender balanced or female dominated in others. Segregation is a social pattern, not a fixed fact about the work.

In our view, the similarity with Norway and Denmark, countries known for strong gender equality policies, is a caution against assuming that equal formal opportunity will by itself shift occupational choices.

What JSA recommends

Paper 3 sets out ten recommendations. These are JSA's proposals to government and industry, not research findings. The most relevant to VET are:

- **Recommendation 2:** intervene earlier in study choices through career learning in primary and secondary curriculum, including a national Years 3 to 10 career exploration curriculum and gender-aware career advice.
- **Recommendation 3:** include explicit gender targets for national priorities in future National Skills Agreements and extend the Australian Skills Guarantee beyond construction and ICT projects.
- **Recommendation 4:** a national approach to gender segregated VET pathways for shortage occupations, including a scholarship and supports package for trainers, a gender-conscious VET pathways campaign, entry-level career introduction programs, and "equity by design" in classrooms and qualification design.
- **Recommendation 7:** normalise men's involvement in unpaid and paid care, including an expanded paid parental leave model with dedicated time for each parent.

Limits of the evidence

- **Older base data.** Occupation shares come from the 2021 Census and VET enrolment shares from 2023. Shifts since then, such as growth in women entering electrotechnology apprenticeships, are not yet reflected.

- **Association, not cause.** Pay and employment gaps by gender mix field, hours, career breaks and discrimination. None of the sources isolates the effect of discrimination in VET outcomes.
- **One year after training.** JSA's VET outcome analysis looks one year after completion; longer-run comparisons rely on Census and tax data for different cohorts.
- **Binary categories.** The datasets record sex or gender in categories that do not capture all learners' identities.
- **Small numbers.** Women in some trades and men in some care roles are few in number, so percentage changes can be large on small bases and should be read with care.
- **International comparisons are indirect.** The World Bank and PISA results are summarised here as reported by JSA, and measure segregation across whole labour markets rather than VET systems specifically.

What this means for your practice

These points are our interpretation of the research, not recommendations of JSA, NCVER or the ABS.

1. **Look at your own enrolment data by gender.** Compare your share of women in trade courses and men in care courses with the national figures in Table 3. A provider that does better than the national average has something to learn from; one that does worse has a place to start.
2. **Plan for retention, not just recruitment.** JSA finds people stay longer in occupations dominated by their own gender, so the risk of losing a learner does not end at enrolment. Mentoring, peer networks and early check-ins with minority-gender learners and their employers address the point of greatest risk.
3. **Check the learning environment.** Facilities, protective equipment, imagery in resources and the language trainers use all signal who belongs. These are low-cost changes within a trainer's control.
4. **Talk to employers about placements and hiring.** Segregation persists in workplaces after training. Providers who place learners can ask host employers directly about their experience with women apprentices or male trainees in care, and support them.
5. **Work with schools early.** The evidence shows choices are shaped well before the RTO. Taster programs, VET in Schools and visits that show women electricians and male early childhood educators at work can help widen the options learners consider.
6. **Use outcome data honestly.** When promoting a trade to women, quote the real figures, including the evidence that women completing some trade pathways earned more than men one year after training, alongside the retention challenges.
7. **Value care work in how you teach it.** Recognising the skills in care qualifications, and the leadership roles within them, supports both the women who dominate those fields and the men considering them.

Sources

- Jobs and Skills Australia, *New perspectives on old problems: Gendered jobs, work and pay* (Gender Economic Equality Study Paper 1), 2025, https://www.jobsandskills.gov.au/publications/new-perspectives-old-problems-gendered-jobs-work-and-pay
- Jobs and Skills Australia, *Education and training divides: Gendered skills, pathways and outcomes* (Gender Economic Equality Study Paper 2), 2025, https://www.jobsandskills.gov.au/publications/education-and-training-divides-gendered-skills-pathways-and-outcomes
- Jobs and Skills Australia, *Speeding up progress towards gender economic equality* (Gender Economic Equality Study Paper 3), 2025, https://www.jobsandskills.gov.au/publications/speeding-progress-towards-gender-economic-equality
- NCVER, *Apprentices and trainees 2025: December quarter*, 2026, https://www.ncver.edu.au/research-and-statistics/publications/all-publications/apprentices-and-trainees-2025-december-quarter
- NCVER, *VET student outcomes 2025: qualification completers' median income after training*, 2025, https://ncver.edu.au/research-and-statistics/data/all-data/vet-student-outcomes-2025-qualification-completers-median-income-after-training
- ABS, *Education and Work, Australia, May 2025*, 2025, https://www.abs.gov.au/statistics/people/education/education-and-work-australia/latest-release

TEACHWISE

The Science of Learning for Adult Educators: Retrieval, Spacing and Worked Examples

By Sukh Sandhu

Few areas of education research are as consistent as the cognitive science of memory. Over decades, hundreds of experiments have found that people remember more when they practise recalling information, when they spread practice out over time, and when novices study worked examples before solving problems alone. Yet most of this research was done with school and university students, often in laboratories, and often measuring recall within a day or two. This article sets out what the key reviews and meta-analyses actually found, with their numbers, and asks how far the findings carry over to adult learners in vocational and workplace settings.

At a glance

Report	Publisher	Year	Method	Sample
Dunlosky, Rawson, Marsh, Nathan and Willingham, *Improving students' learning with effective learning techniques*	*Psychological Science in the Public Interest*	2013	Narrative review rating 10 techniques	Published studies across ages, materials and settings
Cepeda, Pashler, Vul, Wixted and Rohrer, *Distributed practice in verbal recall tasks*	*Psychological Bulletin*	2006	Meta-analysis	839 assessments, 317 experiments, 184 articles
Adesope, Trevisan and Sundararajan, *Rethinking the use of tests*	*Review of Educational Research*	2017	Meta-analysis of practice testing	Experiments comparing practice tests with other conditions
Yang, Luo, Vadillo, Yu and Shanks, *Testing (quizzing) boosts classroom learning*	*Psychological Bulletin*	2021	Systematic review and meta-analysis	222 studies, 48,478 students
Donoghue and Hattie, *A meta-analysis of ten*	*Frontiers in Education*	2021	Meta-analysis of the Dunlosky techniques	242 studies, 1,619 effects, 169,179

Report	Publisher	Year	Method	Sample
learning techniques				participants
Latimier, Peyre and Ramus, *Spacing out retrieval practice episodes*	*Educational Psychology Review*	2021	Meta-analysis	29 studies
Barbieri, Miller-Cotto, Clerjuste and Chawla, *The worked examples effect on mathematics performance*	*Educational Psychology Review*	2023	Meta-analysis	55 studies, 181 effect sizes

The starting point: Dunlosky and colleagues, 2013

The most cited review in this field was written for teachers and students rather than for other researchers. Dunlosky and four colleagues selected ten learning techniques that were easy to use, including some, like highlighting and rereading, chosen because students rely on them so heavily. For each, they asked whether the benefits generalised across four kinds of variable: learning conditions, student characteristics such as age and prior knowledge, materials, and the kind of test used to measure learning. They then rated each technique's overall utility.

Table 1: Utility ratings of ten learning techniques, Dunlosky and colleagues (2013)

Rating	Techniques
High utility	Practice testing; distributed practice
Moderate utility	Elaborative interrogation; self-explanation; interleaved practice
Low utility	Summarisation; highlighting or underlining; keyword mnemonic; imagery for text learning; rereading

Source: Dunlosky et al. (2013), abstract and overall assessments.

Two techniques earned high ratings because they benefited learners of different ages and abilities and improved performance across many kinds of test, including in real educational settings. The moderate techniques showed promise but had not been tested enough in classrooms. The low rated techniques were not useless; the authors found that rereading and highlighting, the most popular strategies, did not consistently improve performance, and suggested practice testing in place of rereading.

The ratings are judgements, not effect sizes. Eight years later, Donoghue and Hattie tested them with a meta-analysis.

Putting numbers to the ratings: Donoghue and Hattie, 2021

Donoghue and Hattie gathered 242 studies covering the same ten techniques, yielding 1,619 effects from 169,179 unique participants. The overall mean effect was 0.56.

Table 2: Mean effect of each technique, overall and in university samples

Technique	Dunlosky rating	Overall effect (d)	University samples (d)
Distributed practice	High	0.85	0.89
Practice testing	High	0.74	0.80
Elaborative interrogation	Moderate	0.56	0.58
Self-explanation	Moderate	0.54	0.60
Interleaved practice	Moderate	0.47	0.65
Underlining	Low	0.44	0.57
Summarisation	Low	0.44	0.19

Source: Donoghue and Hattie (2021), Tables 1 and 3. Interleaved practice was rated moderate by Dunlosky et al.; Donoghue and Hattie's Table 1 lists it as low. Imagery (d = 0.56), mnemonics (0.50) and rereading (0.47) are omitted for space.

The two high utility techniques came out on top, and the university column, the closest group to adult learners in the data, shows the same ordering for distributed practice and practice testing. The authors stress three limits that matter for adult education. First, most studies measured surface or factual learning: effects on surface outcomes (d = 0.60) were much larger than on deeper processing (d = 0.26). Second, 68% of effects were measured within a day, usually immediately. Third, the few studies of high ability students found a mean effect of minus 0.11, against 0.47 for low ability students, so these techniques may help novices and struggling learners most.

Spacing: when to practise matters as much as how much

The spacing effect, sometimes called distributed practice, is one of the oldest findings in psychology. Cepeda and colleagues' 2006 meta-analysis assembled 839 assessments of distributed practice from 317 experiments in 184 articles, mainly on verbal recall. Spaced learning beat massed learning. More usefully for planning, they found that the gap between study sessions and the delay until the final test work together: the gap that produced the best retention grew as the retention interval grew. Material needed for a week calls for shorter gaps than material needed for a year.

Latimier, Peyre and Ramus (2021) combined spacing with retrieval. Across 29 studies, spaced retrieval practice produced substantially better retention than the same amount of retrieval practice massed together (g = 0.74, from 39 effect sizes). They also tested a popular belief: that gaps between practice sessions should steadily expand. Across 54 effect sizes they found no significant difference between expanding and uniform schedules (g = 0.034). What matters most is that practice is spaced, not the exact pattern of the spacing.

There is direct evidence from adult professional education. In a randomised trial with third-year medical students, Kerfoot and colleagues (2007) emailed weekly case scenarios and clinical questions on two of four urology topics after a clinical rotation. Of 133 students, 95 (71%) completed the end-of-year test. Spaced education significantly improved composite scores, with the largest effects for students who had completed their rotation six to eight months earlier (effect size 1.01) and nine to eleven months earlier

(0.73). The intervention was short, low cost and delivered by email alongside clinical training, which makes it a plausible model for VET.

Retrieval practice: testing as a way to learn

The testing effect refers to the finding that taking a test on studied material improves later memory more than studying it again. Three meta-analyses build the case.

- **Rowland (2014)** reviewed the testing effect against restudy in a meta-analysis published in *Psychological Bulletin*. Initial recall tests produced larger benefits than recognition tests, consistent with the idea that effortful retrieval contributes to the effect.
- **Adesope, Trevisan and Sundararajan (2017)** examined practice tests against a wide range of non-testing conditions, including restudying, other practice, filler activities and no exposure. Practice tests were more beneficial than restudying and all other comparison conditions, with effects moderated by test features, participant and study characteristics, outcomes and study methods.
- **Yang and colleagues (2021)** asked whether the effect holds in real classrooms. Integrating data on 48,478 students from 222 independent studies, they found quizzing raised academic achievement to a medium extent (g = 0.499). The size of the effect depended on factors including what the comparison group did, whether test format matched the final test, whether corrective feedback was given, and how often tests were repeated.

The practical message is consistent: low-stakes recall, with feedback, repeated over time, outperforms rereading notes or watching a demonstration again. It is also distinct from high-stakes assessment. In these studies the practice test is a learning activity, not a judgement of competence.

Worked examples and the expertise reversal effect

The third body of evidence comes from cognitive load theory. Its starting point is that novices have limited working memory, so solving unfamiliar problems by trial and error can overload them, while studying a fully worked solution lets them build understanding first.

Table 3: Selected effect sizes across the evidence base

Study	Comparison	Effect
Barbieri et al. (2023)	Worked examples versus other instruction, mathematics	g = 0.48
Latimier et al. (2021)	Spaced versus massed retrieval practice	g = 0.74
Latimier et al. (2021)	Expanding versus uniform spacing	g = 0.034 (not significant)
Yang et al. (2021)	Classroom quizzing versus other conditions	g = 0.499
Donoghue and Hattie (2021)	All ten techniques, overall	d = 0.56
Kerfoot et al. (2007)	Spaced email questions, 6 to 8 months after rotation	1.01

Sources: as listed in the table; see Sources below.

Barbieri and colleagues screened 8,033 abstracts and analysed 55 high quality experimental and quasi-experimental studies (181 effect sizes) from elementary to postsecondary settings. The average effect of worked examples on mathematics performance was medium (g = 0.48). Correct examples alone produced larger effects than incorrect examples or mixed correct and incorrect examples. Unexpectedly, adding self-explanation prompts to worked examples produced a negative effect compared with worked examples without prompts.

The same theory predicts a limit. Kalyuga's 2007 review of the expertise reversal effect describes a pattern in which techniques that help novices, such as detailed worked examples, become less effective, or even counterproductive, as learners gain prior knowledge. For experienced learners, extra guidance can be redundant. This is one of the most important findings for adult education, because adult VET learners often arrive with substantial experience in parts of the content and none in others.

The middle ground: self-explanation, elaborative questioning and interleaving

Three techniques sit between the strong and weak ends of the evidence. Elaborative interrogation asks learners to explain why a stated fact is true; self-explanation asks them to explain how new information relates to what they know, or to explain the steps in solving a problem; interleaving mixes different kinds of problems within a practice session instead of practising one type at a time.

Dunlosky and colleagues rated all three as moderate. The benefits generalised across some conditions, but in 2013 elaborative interrogation and self-explanation had not been adequately evaluated in educational settings, and systematic research on interleaving had only just begun. Donoghue and Hattie's later meta-analysis found overall effects of 0.56 for elaborative interrogation, 0.54 for self-explanation and 0.47 for interleaved practice, with interleaving stronger in university samples (0.65) than in school samples.

Two cautions apply. Donoghue and Hattie found that high ability students showed negative effects for interleaved practice and summarisation, so these are not universally helpful. And Barbieri's finding that self-explanation prompts reduced the benefit of worked examples in mathematics suggests that adding more activity to a well designed example can backfire; in our view, extra load on working memory is one plausible explanation. In our view, for an adult educator interleaving looks most useful when learners already know the individual procedures and need to practise choosing between them, such as deciding which fault-finding method fits a given symptom.

What does not hold up: learning styles

Matching instruction to a learner's preferred "style", such as visual or auditory, remains widespread in training resources. Pashler and colleagues (2008) set out the test any learning styles claim must pass: learners grouped by style are randomly assigned to different methods, and the method that works best for one style must be different from the method that works best for another. Reviewing the literature, they found ample

evidence that people state preferences, but virtually no evidence for that interaction, and several properly designed studies contradicted it. They concluded there was no adequate evidence base for incorporating learning styles assessments into general educational practice.

How far does this apply to adult and vocational learners?

The evidence is strongest for the claim that these principles describe how human memory works, and memory does not change at 18. Several features of the research nonetheless call for care when applying it to VET.

- **Most participants were students.** The university samples in Donoghue and Hattie's analysis show similar patterns to the overall results, and Kerfoot's trial involved medical students, but few studies involve adults learning trades, care work or workplace procedures.
- **Most outcomes were factual recall.** VET competence involves performing tasks, using judgement and transferring skills to new situations. The evidence for deeper and far transfer is much thinner.
- **Retention intervals were short.** With 68% of effects measured within a day in Donoghue and Hattie's data, the research says more about short-term gains than about remembering a procedure months later on the job, although the spacing literature directly addresses longer intervals.
- **Prior knowledge varies.** The expertise reversal effect means one design does not suit every adult learner. Recognition of prior learning and diagnostic questioning are part of applying cognitive science well.
- **Motivation and time.** Dunlosky and colleagues noted that learners must be motivated to use techniques correctly. Adults balancing work and family may find spaced practice harder to schedule unless it is built into the course.

Limits of the evidence

- **Publication and laboratory bias.** Meta-analyses can only include published or located studies, and many experiments use simple materials under controlled conditions.
- **Heterogeneity.** Donoghue and Hattie reported very high variation between studies (I squared about 85%); average effects conceal large differences in how well techniques work in particular conditions.
- **Effect sizes are not directly comparable.** The studies use different comparison groups. A technique compared with rereading will show a different effect from the same technique compared with no study at all.
- **Domain specificity.** Barbieri's meta-analysis covers mathematics only; worked examples in practical trades have been studied far less.

What this means for your practice

These suggestions are our interpretation of the research for adult and VET settings; they are not recommendations made by the authors cited.

1. **Start sessions with recall, not review.** Replace "let's recap last week" with three short questions learners answer from memory, followed by feedback. This turns a review into retrieval practice.
2. **Schedule revisiting into the course plan.** Spread practice of key knowledge and procedures across weeks rather than concentrating it in one block before assessment. Uniform gaps are fine; the evidence does not support elaborate expanding schedules.
3. **Use short, low-stakes quizzes with feedback.** Keep them separate from competency decisions so learners treat them as practice. Corrective feedback is one of the moderators that makes quizzing work.
4. **Show, then fade.** For new procedures and calculations, give novices complete worked examples first, then partly worked examples, then independent problems. Reduce guidance as competence grows.
5. **Diagnose before you design.** Experienced learners may be slowed by step-by-step guidance they do not need. Quick pre-checks let you route them to practice problems sooner.
6. **Stop designing for learning styles.** Use multiple formats because the content calls for them, such as a diagram for a circuit or a demonstration for a technique, not to match a learner's stated preference.
7. **Use the workplace for spacing.** Short questions sent weekly to apprentices or trainees, as in Kerfoot's trial, can maintain knowledge between block training sessions at low cost.
8. **Teach learners how to study.** Many adult learners rely on rereading and highlighting. Explaining why self-testing and spacing work, and giving them tools to do it, extends the benefit beyond class time.

Sources

- Dunlosky J, Rawson KA, Marsh EJ, Nathan MJ and Willingham DT, *Improving students' learning with effective learning techniques: promising directions from cognitive and educational psychology*, Psychological Science in the Public Interest 14(1), 2013, https://doi.org/10.1177/1529100612453266
- Cepeda NJ, Pashler H, Vul E, Wixted JT and Rohrer D, *Distributed practice in verbal recall tasks: a review and quantitative synthesis*, Psychological Bulletin 132(3), 2006, https://doi.org/10.1037/0033-2909.132.3.354
- Rowland CA, *The effect of testing versus restudy on retention: a meta-analytic review of the testing effect*, Psychological Bulletin 140(6), 2014, https://doi.org/10.1037/a0037559
- Adesope OO, Trevisan DA and Sundararajan N, *Rethinking the use of tests: a meta-analysis of practice testing*, Review of Educational Research 87(3), 2017, https://doi.org/10.3102/0034654316689306
- Yang C, Luo L, Vadillo MA, Yu R and Shanks DR, *Testing (quizzing) boosts classroom learning: a systematic and meta-analytic review*, Psychological Bulletin 147(4), 2021, https://doi.org/10.1037/bul0000309
- Donoghue GM and Hattie JAC, *A meta-analysis of ten learning techniques*, Frontiers in Education 6, 2021, https://doi.org/10.3389/feduc.2021.581216

- Latimier A, Peyre H and Ramus F, *A meta-analytic review of the benefit of spacing out retrieval practice episodes on retention*, Educational Psychology Review 33, 2021, https://doi.org/10.1007/s10648-020-09572-8
- Barbieri CA, Miller-Cotto D, Clerjuste SN and Chawla K, *A meta-analysis of the worked examples effect on mathematics performance*, Educational Psychology Review 35, 2023, https://doi.org/10.1007/s10648-023-09745-1
- Kalyuga S, *Expertise reversal effect and its implications for learner-tailored instruction*, Educational Psychology Review, 2007, ERIC record EJ785056, https://eric.ed.gov/?id=EJ785056
- Pashler H, McDaniel M, Rohrer D and Bjork R, *Learning styles: concepts and evidence*, Psychological Science in the Public Interest 9(3), 2008, https://doi.org/10.1111/j.1539-6053.2009.01038.x
- Kerfoot BP, DeWolf WC, Masser BA, Church PA and Federman DD, *Spaced education improves the retention of clinical knowledge by medical students: a randomised controlled trial*, Medical Education 41(1), 2007, https://doi.org/10.1111/j.1365-2929.2006.02644.x

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