

RECOMMENDATIONS
FOR EFFECTIVE
STATISTICS
ASSESSMENT:
**A RAPID REVIEW
OF EVIDENCE**
EXECUTIVE SUMMARY
OCTOBER 2026

Recommendations for Effective Statistics Assessment: A rapid review of evidence Executive Summary

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October 2026

*Produced by the **Centre for Statistics and Data Science Education**
on behalf of the **Joint Mathematical Council of the United Kingdom**
and the **Royal Statistical Society***

Acknowledgements:

We would like to thank the Royal Statistical Society and the Joint Mathematical Council of the UK for commissioning this report. We are grateful to the members of the Education Policy and Public Engagement Group of the RSS and the trustees of the JMC, along with the directors of the Centre for Statistics and Data Science Education, for reviewing the draft report.

This rapid review was funded in part by the Royal Society.

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Executive summary

This report provides evidence on effective statistics assessment at school level, and ways in which current assessment practice across the four nations of the UK is aligned or not to such evidence. It draws on research in statistics education, recent reports from the Royal Society, the Royal Statistical Society and the Joint Mathematical Council of the UK, international practice, and a rapid review of current mathematics and statistics qualifications in the four nations of the UK.

Organising concepts

Statistics education research has long distinguished **statistical literacy** (using the language and tools of statistics and critically evaluating statistical claims), **statistical reasoning** (making sense of and arguing with statistical information) and **statistical thinking** (understanding the whole investigative process, including handling variability and uncertainty). More recently, **data literacy** has emerged alongside these: solving real problems with real data, including data cleaning, technology use and ethics. We consider these to be organising concepts for this report. To visualise these useful but often overlapping and contested ideas from the literature, we propose a 'twin peaks' model in which statistical literacy underpins both statistical thinking and data literacy. The intention is that students of all ages and attainment levels revisit and climb both peaks iteratively, rather than younger or lower-attaining students remaining at the lower layer. We recognise also that these concepts might be hard to imagine in practice, and so we have drawn out five particular features from the literature that illustrate or exemplify the move towards coherently teaching and assessing statistical literacy, reasoning and thinking, and data literacy.

The five features

From this evidence base, the report synthesises and proposes five features of evidence-informed statistics education that should apply to statistics assessment:

1. **Literacy:** Focus on the (explicitly named and clearly defined) concepts of statistical literacy, statistical reasoning and/or statistical thinking, and data literacy (this is the overarching principle, and includes all of the below)
2. **Technology:** Embed the use of software tools to support enquiry and modelling; use the same tools in teaching and assessment

3. **Enquiry:** Focus on statistical problem-solving using the PPDAC (problem, plan, data, analysis, conclusion) cycle or equivalent
4. **Authenticity:** Use real data to solve realistic¹ statistical problems wherever possible, explicitly including a diverse range of cultural contexts including those relevant to local and global community; reduce the emphasis on technical fluency and by-hand calculations
5. **Responsibility:** Explicitly include ideas of ethics and data stewardship (using data carefully and responsibly to minimise risk and harm)

Current practice in the UK

The review found that no nation's assessment is currently well aligned with the five features, although there are pockets of good practice. Across the four nations:

- Paper-based exams dominate and are built mainly from short and medium structured items with point-based analytic mark schemes. These reward multi-step mathematical working, such as calculation-heavy significance tests, while sense-making typically earns only the final one or two predictable marks. No reviewed paper allocated substantial marks to extended statistical argument or demonstration of statistical reasoning.
- Specifications do sometimes refer to statistical thinking and data literacy, but this is rarely reflected in exam items, even in specialist statistics qualifications.
- Access to technology is generally limited to calculators. The main exception is Scotland, where some components of assessment require or allow statistical software.
- Real data and cross-curricular contexts appear sometimes, but scaffolding means students are rarely given the opportunity to solve realistic statistical problems. Pre-release materials may create opportunities for authenticity, but the item formats limit these opportunities.
- There is almost no assessment of ethics or data stewardship.
- Scotland's use of projects and internally assessed tasks in some qualifications offers more scope across several features. However, this is not universal, its written papers still favour mathematical working, and the quality of teacher-selected tasks could not be judged in this review.

¹incorporating real or realistic data and attempting to mimic aspects of the work of professional or academic statisticians.

International examples

Aotearoa New Zealand's NCEA includes internally assessed statistical enquiries in which students choose their own investigative question, use software, and are assessed with levels-of-response rubrics that give explicit weight to important concepts such as variation. The US LOCUS project shows that paper-based items, including well-designed multiple-choice questions, can assess conceptual understanding across the statistical problem-solving cycle with minimal calculation. Its items are balanced across formulating questions, collecting data, analysing data and interpreting results. Neither model meets all five features, but both offer aspects and approaches the UK nations could adapt.

Key recommendations

The report makes ten recommendations:

- 1. A range of validated and reliable item formats and contexts should be used to assess statistical thinking, statistical reasoning, statistical literacy, and data literacy.**
- 2. Assessment items intended to assess statistical thinking should require and isolate it.**
- 3. Assessment of statistical thinking, reasoning and literacy should be resourced to reflect its true cost.**
- 4. The technology used in statistics assessment should be aligned with the technology used in statistics teaching.**
- 5. Pilot and evaluate hybrid models of technology-supported assessment.**
- 6. A research agenda should be prioritised that establishes design guidelines for good practice in technology-supported summative statistics assessment.**
- 7. Statistics assessment should include opportunities for students to apply the complete statistical problem-solving cycle to authentic statistical problems and/or investigations.**
- 8. Statistics assessments should make use of real data and contain authentic tasks that mirror the work of practising statisticians, supported by technology tools where possible.**
- 9. Statistics assessment design should foreground conceptual work and reduce emphasis on procedures and techniques.**
- 10. Data stewardship and ethical use of data should be embedded within statistics assessments.**

Priorities for action

Three structural barriers stand in the way of better alignment with the five features; addressing them is likely to be the essential first step. They are:

1. Access to statistical software within assessments.
2. Paper-based exams limit opportunities for students to conduct investigative work and engage with the full PPDAC cycle.
3. Short-structured items and point-based analytic mark schemes reward **mathematical working** at the expense of **statistical thinking**.