# Data rich, information poor:  creative and innovative approaches to results analysis to support teaching and learning

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## Abstract

Through the introduction of e-assessment technologies, there is now more education assessment data available than ever before.  In particular, the item-level data provided by onscreen marking and e-testing provides a much richer and granular dataset for reporting and analysis, both internally within an awarding body, and externally with students and teachers.  There is also an increasing demand from those working across the education sector for more information and feedback analysis from summative assessment.

Drawing on the experience of working with awarding bodies and government agencies, and the increasing use of item-level assessment data across the UK education system, this paper describes how item-level data is now being used to provide teachers and students with real information and knowledge through online reporting and analysis tools.   Evidence is presented to show how this data can be used creatively to support teachers and students in making important education decisions which have a real impact on teaching and learning.  A critical success factor in the reporting of item-level data is the onscreen presentation of data and the quality of the analyses provided.   Using real life examples, some principles for the innovative presentation, analysis and contextualisation of item-level assessment data will be outlined and evaluated.

Assessment bodies face a common set of challenges in implementing systems for the widespread distribution and analysis of item-level data.  These challenges and barriers will be explored and
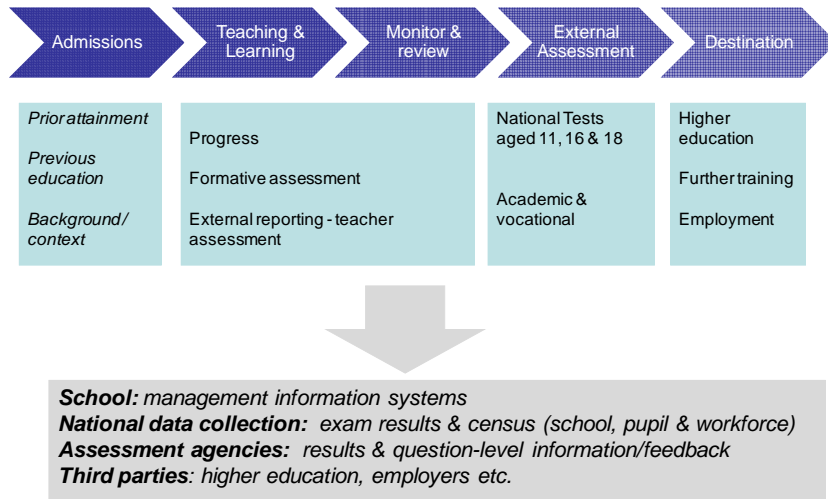
models provided to support organisations wanting to provide a richer analysis of assessment data to help improve teaching and learning.

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Background and Context

There can be no doubt that, in the education world, there is a now much more data available to schools, teachers and students. Within assessment, the growing use of e-testing and e-marking technologies generates more than just a mark, grade or result, providing assessment agencies, teachers and students with a much richer and granular set of item-level data which has the real potential to support and improve ongoing teaching and learning. Technology is now available to facilitate the integration of once disparate data sets to provide a wider breadth of analysis (i.e. comparisons, benchmarks and contextualisation) and that can be disseminated through reports and analyses to professionals working throughout the education sector with secure, web-based reporting systems.

Outside assessment, the development of a next generation of school management information systems and the ability easily collect data from schools at a national level, means that data is now an important element in supporting school improvement and accountability in education across the world. Data allows a much more targeted approach to investment, intervention and support, with a shift away from a one-size-fits-all approach, to one where the different needs of schools can be identified using a combination of data analysis and professional knowledge.

**Figure 1: Student data collected during secondary school (age 11-18) in the UK**

| Admissions | Teaching & Learning | Monitor & review | External Assessment | Destination |
|---|---|---|---|---|
| *Prior attainment*<br><br>*Previous education*<br><br>*Background/ context* | Progress<br><br>Formative assessment<br><br>External reporting - teacher assessment | | National Tests aged 11, 16 & 18<br><br>Academic & vocational | Higher education<br><br>Further training<br><br>Employment |

**School:** *management information systems*
**National data collection:** *exam results & census (school, pupil & workforce)*
**Assessment agencies:** *results & question-level information/feedback*
**Third parties**: *higher education, employers etc.*

In the UK, the data collected about a student going through secondary school (figure 1) includes information provided as they enter the school (i.e. previous education, contextual information and prior attainment), a wealth of data supporting teaching and learning (i.e. attendance, progress and formative assessment by teachers) and the outcomes of external summative assessments in academic and vocational subjects which are taken between the ages of fourteen and nineteen.   This information stays with students as they move out of school education to employment or further or higher education.   The data controllers for the students' data (i.e. those managing and looking after the data) include the school, assessment agencies and government (through national data collections).

## Empowering informed decisions

The vast quantities of summative assessment data now available to students, teachers and schools includes not only examination results (i.e. grade, mark, qualification) but also more granular module and papers marks as well as question and item level marks.  Increasingly in the UK, these summative tests taken by pupils aged 14-19, are completed through modular courses and tests rather than just final examination at the end of the course.   This rapid expansion in the volume of raw assessment data has a limited usefulness in supporting ongoing teaching and learning unless it can be turned into information and knowledge which can easily be interpreted and presented to those working in the

education sector. Figure 2 provides a results analysis framework for extracting value from assessment data based on Ackoff's (1989) well-known knowledge management theory.

**Figure 2: Framework for Results Analysis (adapted from Ackoff, 1989)**



The critical step in extracting real intelligence is to transform the raw assessment data (i.e. marks and results) into analyses which provide information which is useful and relevant to students and teacher. Additional knowledge can be added through the contextualisation of assessment information using benchmark comparisons (i.e. comparing to similar schools or students) and use of trend analyses (analyse performance over time). More sophisticated ways to extract knowledge include being able to move beyond the analysis of raw student attainment or thresholds (i.e. % achieving a pass) and to also understand the progress of students (i.e. from a previous test or point in time) and the value added. The use of exception reporting which highlights areas of particular strength or weakness using statistical tools such as significance tests can help provide signposting to users who could easily be overwhelmed by the sheer volume of data and information available, and focus the attention on areas which require action and further analysis.
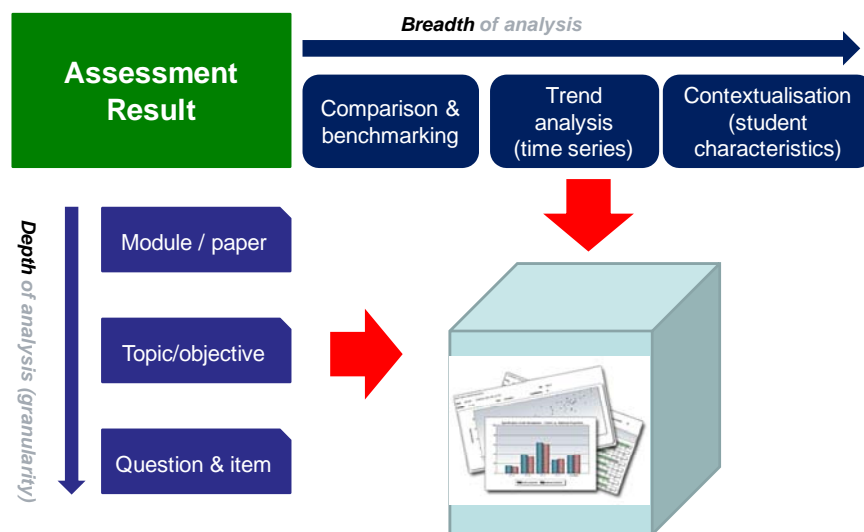
Results Analysis Tools in the UK

In the UK, schools now have access to a number of secure online results analysis systems which allow teachers (and in some cases students) to analyse the assessment data provided from external summative tests by assessment agencies.  These include:

**RAISEonline** (developed by Ofsted, the school inspection agency for schools in England and the DCSF, the Ministry of Education) provides schools with results analysis tools to analyse student performance in external summative tests at age 16 (attainment, threshold, progress and value-added) at a school level and for groups of students as well as analysing item-level assessment data for national and optional tests for students aged 8 to 14.

**ActiveResults** (OCR), **ResultsPlus** (Edexel) and **Enhanced Results Analysis** (AQA) are results analysis tools provided by the largest awarding bodies in the UK, which allow schools to analyse not just the result (i.e. mark or grade) but also item and question level data available from e-marking and e-testing.

**Figure 3: Common features of Results Analysis tools**

The common features of these results analysis tools (Figure 3) are that they allow users to drill down from raw examination results in two dimensions:

- **Depth** (granularity) – to analyse results by module, paper, topic, curriculum/assessment objective, question and item
- **Breadth** – to analyse results through contextualisation against comparisons, benchmarks or trend or trend data

The analyses and reports allow users to slice and dice the assessment data along these two dimensions focusing on all students in a cohort, some students (i.e. boys or girls) or an individual student. Feedback from schools and teachers using OCR's ActiveResults system suggests that results analysis tools can present complex assessment data in a way which is easy to understand and useful:

- 98% users found the information presented in ActiveResults easy or very easy to understand
- 86% of users found it easy or very easy to navigate their way around the ActiveResults website

## Continuous improvement

Results analysis tools provide an important feedback loop for teachers, students and awarding bodies to help improve teaching and learning and to support ongoing test development (figure 4). Students can use the results analysis tools to analyse their strengths and weaknesses from an external end-of-module test which will help them with their future learning within the course. Teachers and students can use the tool together to make important decisions on whether a student should retake a test and, if so, identify areas of learning where the student will need to improve. Teachers can use the analyses to understand how a class has performed, perhaps looking at performance by topic, assessment objective or an area of the curriculum. These analyses could support the teacher in teaching the current cohort of students and also help when the same module or course is taught in

the future. Schools can make use of results analysis by looking at performance across subjects or for different groups of students (e.g. boys vs girls or students from different social backgrounds).

**Figure 4: A cycle of continuous improvement**
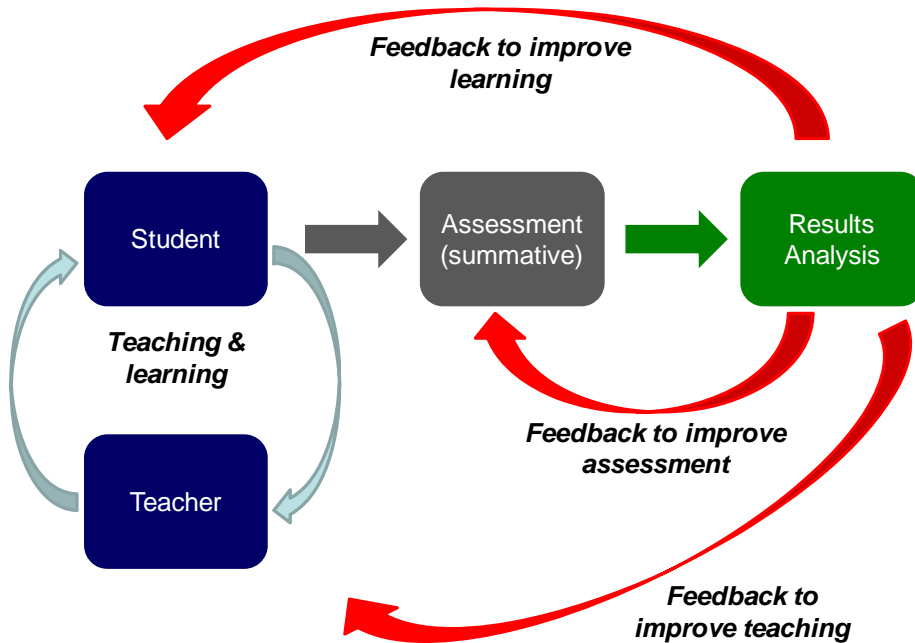


Within an assessment agency, results analysis at question and item level can be used to support both the quality of marking and grading (i.e. analysis and monitoring at a more granular level) as well as test authoring (quality and validity items/questions within the context of the overall test).

## Implementation challenges for an assessment agency

The final part of this paper explores some of the challenges faced by assessment agencies wanting to introduce results analysis.   In order to maximise the value offered results analysis to schools, teachers and students, the availability of results at item or question level is critical, and it is therefore no surprise that in the UK, the development and rollout of national result analysis systems by the three large awarding bodies has followed the introduction of e-testing and e-marking technologies which capture data at item-level.  That said, awarding bodies are using results analysis tools to

present data for tests which have item-level data as well as tests where there is only data available at module or paper level.

Business intelligence tools have developed considerably in recent years and are used widely across business for executive dashboards through to complex operational reporting and analysis. There is now a wide range of web-based reporting tools which can be used to develop and publish secure online reports which can be made available to a wide range of users. RAISEonline, a national online reporting tool developed for schools in England, uses Microsoft SQL Server Reporting Services to deliver over 1 million complex online school performance reports each year to 22,000 schools and 100,000 registered users, working from a database with over 5 million students and 50 million examination results.

For an awarding body, it is likely that any results analysis tool will need integration with existing systems, both at the back-end (e.g. data integration) and at the front-end (e.g. integration with other web systems and for user authentication). The main challenge with the development of the results analysis system is not now the technology, but the development of a set of reports and analyses which are useful and relevant to schools and teachers, and easy to interpret and navigate.

Many assessment agencies will have multiple, legacy business systems supporting the organisation:

- test authoring, delivery and marking systems;
- customer relationship management systems (CRM);
- finance systems; and
- analysis tools

A results analysis system will need to use data which is shared and integrated across these systems. Some of these systems will require real-time data, where as others can manage with data which is updated daily or weekly. To maintain high standards of integrity, trust and reliability, it is important that any results analysis system, which will provide much more data and information to end users,

contains data which is authoritative and consistent with data provided by other business systems. The key principle here is to create a single version of the truth (SVOT) about a candidate and their test results which can be shared across business systems, including a reporting system for results analysis, using appropriate data warehousing strategies.

The biggest challenge for an assessment agency wanting to provide high quality results analysis is the ability to consider results analysis throughout the test delivery cycle, particularly at the early stages of test design and authoring. For awarding bodies which are evolving from a principle delivery model based on paper-based tests, consideration must be given to the individual items and questions which will now be analysed in more detail with the availability of question and item level data. More importantly, an awarding body will have to develop a consistent approach to providing meta-data to each question or item. Some examples of the meta-data required to enable useful results analysis by teachers and students includes the associated topic, curriculum area or assessment objective for each question. From the implementation of results analysis systems in the UK, this area stands out as the area where assessment agencies have to focus the most attention, and it is not just a technical challenge but one which sits at the heart of the assessment process.

## Conclusion

There can be no doubt about the ever increasing use and importance of assessment data and other data in education to support school improvement, teaching and learning and school accountability. This paper has explored how the results analysis tools now available to schools in the UK are providing teachers and students with reports and analyses which transform this raw assessment data into real information and knowledge. Used appropriately, there is evidence to show that these tools can be used to support teachers' professional knowledge and judgement in making more informed decisions which can have an impact on teaching and learning.

The critical external factor in the development of any results analysis tool by an assessment agency is how data will be presented to the users to ensure that the analyses are relevant, authoritative and useful. Internally, the biggest challenge for an awarding body is considering the meta-data

requirements for results analysis throughout the test delivery process, particularly during the early stages of test design and authoring.

Through collecting results at item-level, ensuring the analyses presented are well-designed and collecting meta-data consistently when authoring tests, a results analysis tool has the ability to empower teachers and students in making more informed decisions to support teaching and learning.  Similarly, results analysis combined with a more modular approach to summative testing, provides the potential for summative tests to provide the critical feedback loop traditionally associated with formative assessment.

# Bibliography

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**OCR**        *ActiveResults* (http://www.ocr.org.uk/interchange/active_results.html)

**Ofsted/DCSF**        *RAISEonline*  (www.raiseonline.org)