CAMBRIDGE ASSESSMENT

Making the most of our assessment data: Cambridge Assessment's Information Services Platform

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Abstract

As new technologies penetrate every part of educational assessment, data are being collected as never before. For example, many of Cambridge Assessment's examinations are now marked by examiners working on computers, resulting in marks captured right down to question-part level. While rich data like these are potentially valuable, to be useful they must be analysed, summarised and clearly presented, and the scale of this new demand presents a challenge to large assessment agencies.

Traditionally there were two methods of producing statistical information within Cambridge Assessment. Routine statistical information came from reports built into bespoke examination processing systems. Non-routine analysis and reports were produced by small teams of statistical experts, typically working within research units and using statistical software packages on personal computers. With increasing demand for flexible, high volume statistical reporting, a new solution was required; one which combined the resilience and scalability of a server-based infrastructure with the flexibility of having statistical experts in charge of creating the statistical content. The Information Services Platform (ISP) is Cambridge Assessment's solution for these requirements. It provides our statistical experts with access to operational assessment data and tools to automate and schedule analysis and reports, and to publish the resulting content on an Intranet Portal for use by colleagues across the organisation.

In this paper I discuss further the thinking behind the ISP and give practical examples of use. I also include a summary of findings from a survey of senior examiners who used one of the new statistical services hosted on the ISP.

The promise of better information and the challenges of providing it

One way in which new technologies have the potential to transform large scale educational assessment is by making assessment information more detailed, immediate and accessible than ever before.

For example, consider this list of information-based services that are made possible simply by the relatively straightforward innovation of having traditional scripts marked online and the marks captured at item level:

- Reporting of candidate performance at question or topic level, in addition to reporting at examination and qualification level;
- Extension of item analysis, reliability analysis and statistical screening for malpractice to constructed-response assessments, in addition to the similar analyses long done for machine-read objective tests;
- Near real-time monitoring of marking quality.

While the availability of detailed data is a prerequisite for services such as these, they also depend on data analysis, summarisation and presentation, and it is in these areas that many of the challenges lie.

In this paper I shall describe these challenges – and Cambridge Assessment's solution to them – in relation to providing our senior assessors and managers with flexible, dynamic, on-demand statistical information to help them ensure the validity, reliability and timely delivery of our assessments.

The challenges in a nutshell

The pace of change is unlikely to abate soon. As we get more experienced at harnessing new data we will develop new uses for it and refine old ones – and new opportunities will continue to be created by innovations in e-assessment. In this context flexible but scalable provision is essential, as is the need to avoid information overload on the part of the users.

Traditionally there have been two main sources of statistical information at Cambridge Assessment:

1. Analysis and reports built directly in to our bespoke examination processing system;
2. Custom analysis and reports addressing particular issues and undertaken by statistical experts using statistical software packages on personal computers.

Both of these sources have advantages and disadvantages.

Advantages and disadvantages of built-in analysis and reports

The advantages of building analysis and reports directly into our examination processing system are:

- The analysis and reports are always based on the latest data, and all authorised users have desktop access to them. Unauthorised users (i.e. those without the necessary system permissions) have no access;
- The system is very reliable and dependable, being managed in a data centre in line with formal standards and with change control and disaster recovery procedures;
- The system has sufficient capacity to process large amounts of data quickly;

- Calculated statistics and flags can easily be incorporated into subsequent processes running in the examinations processing system, and are saved.

The disadvantages are:

- Adding new statistics or reports, or making even minor changes to existing ones, is a considerable undertaking, since their impact on the wider system must be fully understood and tested before they can be used.
- All changes and additions must be made by IT developers who may lack statistical understanding or expertise in presenting statistical information clearly, and who must therefore be very closely briefed by the statisticians who do have these capabilities. The IT developers may also not have a clear understanding of how the reports and statistics will be used, making it hard for them to understand all the requirements.
- Sophisticated statistical analyses are hard to implement in software and programming languages not designed for this purpose.

Advantages and disadvantages of analysis and reports produced using desktop software

The advantages of having analysis and reports produced by statisticians using desktop statistical software are:

- New analyses and reports can be delivered very rapidly;
- Sophisticated analyses and graphics can be included easily;
- Everything is under the control of the statistician who does not need to explain his or her requirements to a third party developer, and who typically works very closely with the users of the statistics and reports.

The disadvantages are:

- This method of undertaking statistical analysis and producing reports is not scalable, since automating production is hard or impossible;
- The availability of analysis and reports depends on the availability of the statisticians. Illness at a critical time, for example, could have a significant impact on availability, since specialist statistical expertise is not easily replaced and large numbers of statisticians are not held in reserve to cover periods of absence;
- Data must be extracted from our examination processing system and imported into the statistical software running on the statistician's personal computer. The data used in the analysis, therefore, may not be the latest even when first used, and the resulting statistical information and reports cannot be updated without a further cycle of data extraction and importation and another manual run by the statistician;
- Typically, personal computers have less processing power and smaller memories than server computers, resulting in longer processing times;
- Statistical values created on a statistician's computer are hard to read back in to the examination processing system for use in subsequent processes, and may not be saved in an easily re-usable form.

Our solution: the Information Services Platform

Cambridge Assessment's solution to the problem of providing flexible, scalable, dependable and cost-effective statistical analysis and reports is a hybrid system known as the Information Services Platform (the Platform), which combines the resilience and scalability of a server-based architecture with the flexibility and efficiency of having statisticians responsible for creating the statistical content.

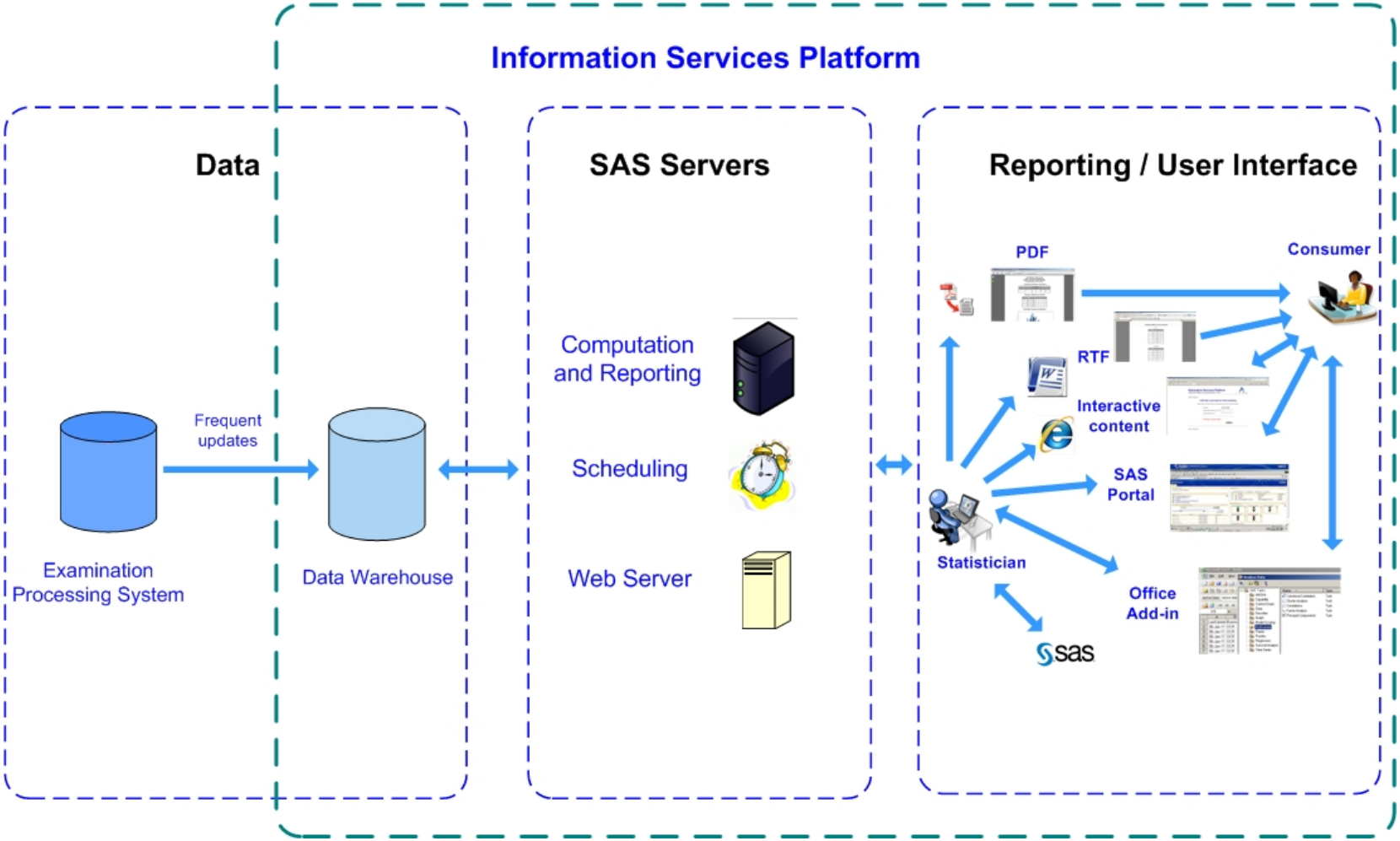
The Platform primarily consists of:

- **A data warehouse**
  This contains operational data sourced frequently and automatically from our examination processing system. Statistics calculated on the Platform can also be permanently saved in the data warehouse, where they are available for use in future analyses and reports and also can be read and used by other systems with access to the data warehouse;
- **Statistical analysis and reporting tools**
  These tools are used by statisticians to specify analyses and reports which run on our servers;
- **Automation tools**
  These are used by statisticians to automate and schedule the analyses and reports;
- **A secure Intranet Portal**, used by the statisticians for publishing statistical reports and data (content) to authenticated end-users (consumers) across Cambridge Assessment.

Figure 1 is a simplified schematic diagram of the Platform.

The core technology used by the Platform is SAS, which we have long used in Cambridge Assessment as a desktop analysis package. By using SAS technology for the Platform we were able to leverage the advanced SAS programming skills already held by many of our statisticians.

Figure 1: Simplified schematic diagram of the Information Services Platform



Uses of the Platform

We plan to use the Information Services Platform for producing most, or indeed all, of the statistical information used by our senior assessors and managers – including research and analysis for monitoring and investigating equity and access issues, and educational trends. Current uses include:

- Providing item analysis and reports for all examinations marked on screen;
- Screening marks for signs of candidate or centre malpractice;
- Statistical monitoring of marking accuracy (under development).

Item analysis was the first major application to run on the Platform, and this will now be described in more detail.

Item Level Data

With innovations in marking technology resulting in marks being captured at item level for many of our examinations, the demand from senior assessors and managers for item analysis and reports is immense. In fact the scale of this demand is so large that it is impractical for our statisticians to conduct the analyses and produce the reports manually. An automated method is required, and to meet this need an item analysis and reporting application was built on the Platform.

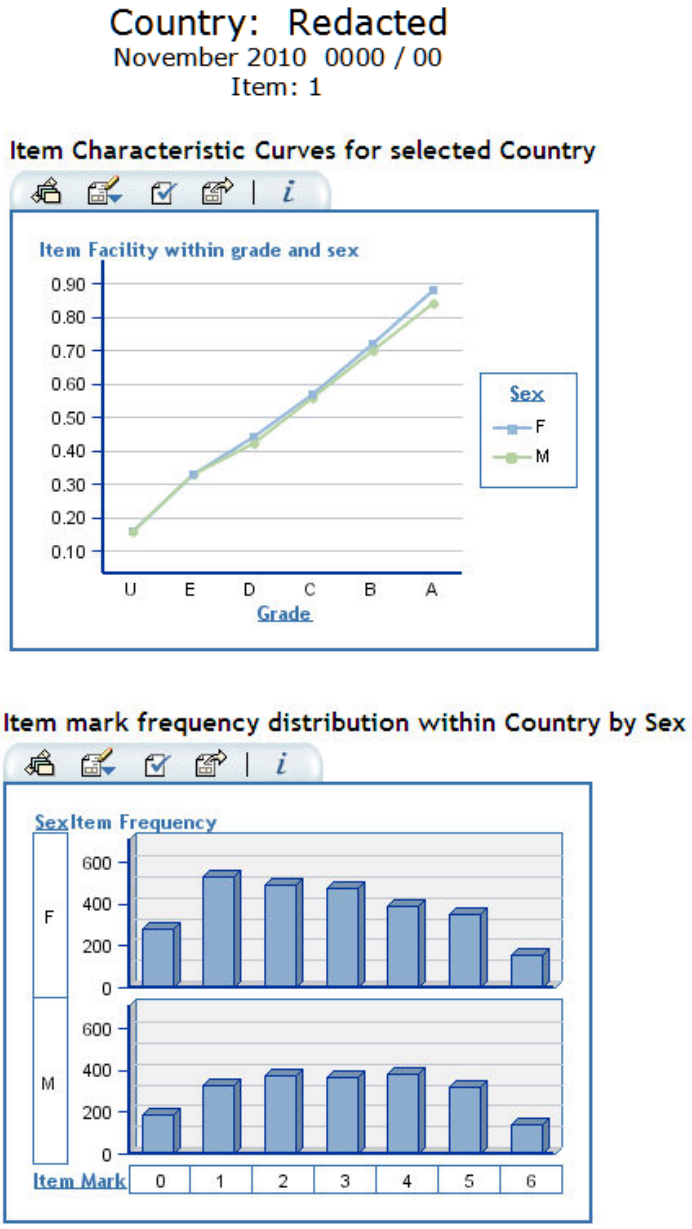
In building this application, statisticians wrote SAS programs to carry out the item analysis automatically and to save the resulting statistics in the data warehouse. The statisticians also wrote a SAS program which produces an Item Level Data report in pdf format for each examination, based on the latest item statistics in the warehouse. The programs were scheduled to run automatically once marks are received. A Web version of the reports for our Intranet Portal site was also created by our statisticians – see Figure 2 for a sample screen shot (details of the country and the examination have been redacted).

Reports are routinely produced during marking and also once candidates' grades are known. The following types of output are included in the reports:

- Item statistics (omit rate, facility overall and by quartile or grade once known, and the correlation between item marks and overall marks excluding the item);
- Item curves (plots of facility by quartile or grade once known);
- Item mark distributions;
- Overall internal reliability (Cronbach's alpha);
- Overall mark distribution and grade distribution (once known) and summary statistics (mean, standard deviation, minimum and maximum mark, all presented overall and by quartile or grade once known).

For the most detailed reports, produced once candidate grades are known, information is broken down by grade, sex, and, for our international examinations, country.

Figure 2: Sample output produced once candidates' grades are known



We have found the item analysis and reporting application running on the Platform to be very reliable, and it has enabled us to provide Item Level Data reports for all our examinations marked on screen. The scale of this undertaking can be judged from the fact that in the June 2010 examination session some 60 million marks were analysed across nearly 600 examinations, each of which required a separate report containing detailed statistics and charts.

An evaluation of senior assessors' use of the reports was undertaken and reported by Shiell and Raikes (2011). The authors collected and analysed questionnaire feedback from senior assessors working for *University of Cambridge International Examinations* and *Oxford, Cambridge and RSA Examinations*. Figure 3 and Figure 4 show the overall usefulness of the reports to the senior assessors, as reported by the assessors themselves.

Figure 3: Overall usefulness of Item Level Data – Oxford, Cambridge and RSA Examinations' respondents

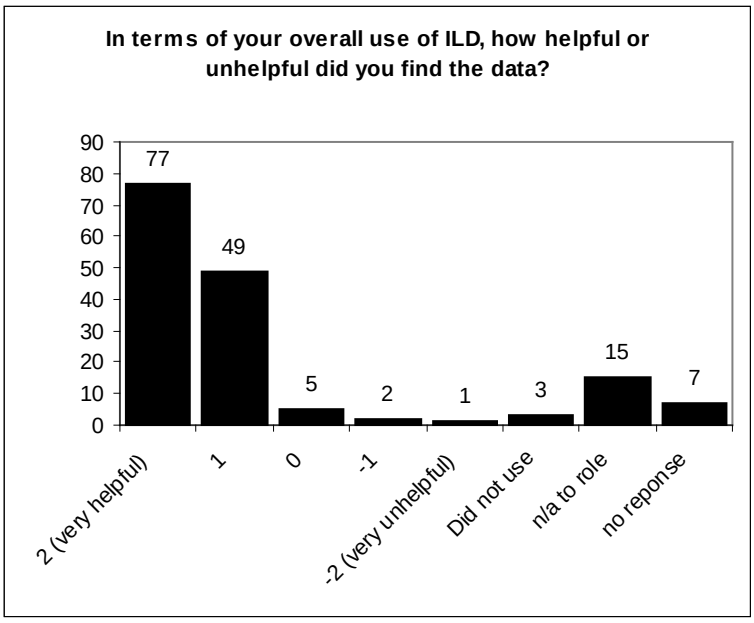
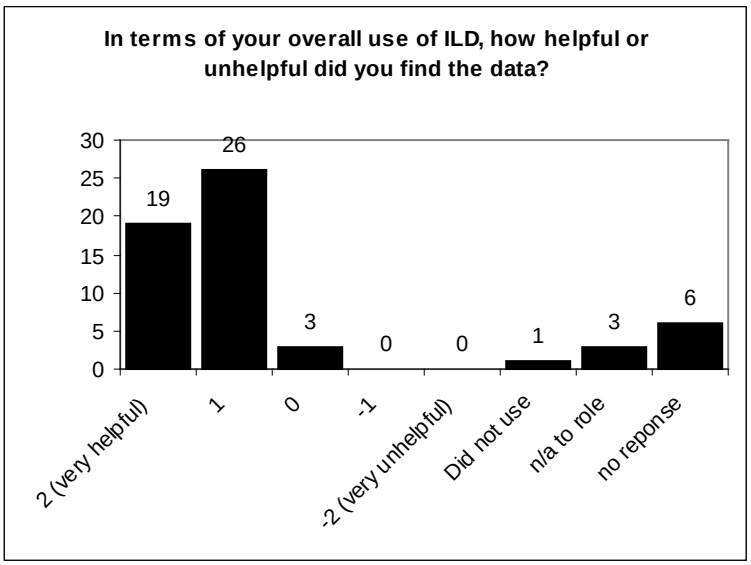


Figure 4: Overall usefulness of Item Level Data – University of Cambridge International Examinations' respondents



Shiell and Raikes (2011) provide considerable detail and conclude:

> "The questionnaire findings provide evidence that Cambridge Assessment has successfully introduced routine reporting of Item Level Data to senior…examiners, and that the reports provide helpful information that is widely used." (p.10)

Conclusion

The Platform has been very successful in enabling our statisticians to provide statistical content to senior assessors and managers in a highly reliable, scalable and flexible way. By using the Platform we are able to combine the flexibility, efficiency and responsiveness of having our statistical experts in charge of creating statistical content, whilst benefiting from the robustness and scalability of a server-based architecture. The Platform is now a core piece of Cambridge Assessment's infrastructure, central to our vision for taking full advantage of the statistical information made possible by advances in assessment technology.

Reference

Shiell, H. & Raikes, N. (2011). Evaluating Senior Examiners' use of Item Level Data. *Research Matters: A Cambridge Assessment Publication*, **12**, 7-10. The full issue and previous issues are available online at: http://www.cambridgeassessment.org.uk/ca/Our_Services/Research