

Electronic Marking: How it could bring substantial benefits to Quality Control and help minimise Cultural Bias in Public Examinations in a Multicultural Society.

Abstract

DRS have been implementing the electronic marking and capture of high stakes public examinations for many years including the majority of A levels and GCSE papers in the UK. Last year AQA, the UK's largest awarding body, processed marks from approximately 8 million examination papers.

Although utilising e-Marker® to reduce the cost of running public examinations is an obvious factor considered by examination authorities, it is the substantial increase in mark capture and marking quality that is increasingly driving the list of benefits from introducing electronic marking. Quality Control is a basic element within electronic Marking.

Images of candidates' scripts are held securely and distributed as questions, or parts of questions, to markers for marking. Marking judgements made by senior examining personnel, combined with sophisticated algorithms, enable those marking standards to be built into a marking process that continuously checks marking standards with a regularity that simply could not be achieved in a paper-based system. Situations where cultural bias may be possible can be minimised by electronic script distribution, auto marking and by anonymity of candidates.

This paper outlines the Quality Control processes and the guards against Impartiality and Bias that electronic marking brings through the introduction of e-Marker® as well as the substantial gains through overall process improvement.

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Martyn's area of expertise is firmly in the Education Sector and in the use of processes and technologies to assist in the capture of education data for the provision of examination and marking services for large scale tests, examinations and assessment. He was one of those "Founding Fathers" of large scale Electronic Marking for assessment organisations and examination boards in the UK.

Those of you who were able to attend the IAEA conference in Rio de Janeiro over 8 years ago in 2001 had the opportunity to hear Martyn's first paper describing the opportunities that these new processes and technologies could present for the future. These opportunities are now very much a reality and part of the standard processes within the UK's major awarding bodies, handling tens of millions of examination candidates, and now rapidly gathering pace around the world,

1. Background

- 1.1 DRS has successfully implemented electronic marking with several awarding body clients in the UK, and this year will, handle over 8 million GCSE and A level examinations. The general benefits of using electronic marking are becoming more widely recognised both within the UK and internationally.

- 1.2 Key to the approach adopted by DRS and its clients is the focus on improving the quality of marking through the use of technology. Marking judgements made by senior examining personnel, combined with sophisticated algorithms, enable those marking standards to be built into a marking process that continuously checks marking standards with a regularity that could not feasibly be achieved in a paper-based system.
- 1.3 Another key set of benefits that stem from these improved processes relate to the fact that cultural bias can potentially be removed from marking by using electronic distribution of images of scripts. It provides anonymous marking and auto marking which details individual answers – not just the correct ones. The potential is also an improvement in the validity and fairness of the questions themselves.
- 1.4 In addition, those awarding bodies that have embarked upon exploring electronic marking have found that the change programmes initiated have led to a wider review of operational processes, leading to further streamlining and improvement that may not have been envisaged when considering electronic marking initially.
- 1.5 This short paper outlines examples of process improvement gains, the implications on minimising cultural bias as well as examples of quality processes that can be implemented.

2. Electronic marking

- 2.1 Electronic marking makes use of scanned images of candidates' examination and test scripts to support the marking process. Images of candidates' scripts are held securely and distributed as questions, or parts of questions, to markers for marking across the internet or intranet. Marks are captured at the time of marking and constant checking of marking standards takes place in real time.
- 2.2 Use of the images of candidates' answers now provides many more degrees of freedom to support more rapid processing of marks and a variety of quality control measures. Paper-based systems are constrained by the physical limitations of the scripts – which can only be in one place at a time.
- 2.3 By dividing the candidates' scripts into segments, electronic marking provides significant improvements over conventional marking by:
 - removing marking bias, related to the leniency or severity of a marker's judgement for an individual candidate and for groups of candidates;
 - enabling markers to focus on topics related to their expert knowledge;
 - allowing markers to focus only on marking and not be diverted by administrative or procedural matters;
 - marking that does not meet the appropriate quality tolerances can be identified in real time and markers stopped from marking that item and provided with further training;
 - removing clerical errors (such as addition errors by markers and transposition errors to marksheets) inherent in a paper-based system.

A fundamental improvement is enabling the regular checking of marking quality and ensuring that they start on standard ...and remain there.

- 2.4 In addition, other processes can be supported, such as providing electronic training materials to markers to augment or substitute the current marker standardisation meetings that take place prior to marking. This electronic process is commonly known as e-Standardisation.

3. Quality and question types

- 3.1 The most common types of examination papers fall into two categories:
- candidates write their answers onto the question paper in spaces left for prose, mathematical formulae, diagrams or graphs (constructed or shorter form answer booklets);
 - candidates write their answers in free-form essay style onto a lined answer booklet without specific structure (free-form answer booklets).
- 3.2 Segmenting answers in a constructed answer booklet is straightforward. Segmenting answers in a free-form booklet is more difficult as it is not possible to pre-determine where a candidate will begin and end an answer, and DRS has devised an approach to achieve this.
- 3.3 In addition, the approach to quality control will need to be different, as free-form answers tend to be longer, cover several pages and include more judgemental elements to mark. This is unlike the constructed answers which are shorter and tend to have more structured marking guidelines.
- 3.4 For all answers, electronic marking can support various forms of double-marking. Providing images of the candidates' answers removes the traditional constraints of this approach where markers tend to work in a marking centre in teams moving scripts between them for double marking. For the more extensive free-form answers, a specific form of double-marking has been developed by DRS that makes use of the regular comparison of one marker's marking against another to keep marking within accepted tolerances. Automated or judgemental means of reconciling marking differences can be supported in real time. This process is called 'percentage double marking'.
- 3.5 Percentage double marking is the process where two marking opinions are compared in real-time supported by automated business rules and adjudication by a senior marker. Marking performance can be monitored manually and anonymously by a marker and then by a senior marker. In addition, marking performance can be monitored using standard items stored in the database, which are similar to seeded items described in 3.6 and 3.7.
- 3.6 For constructed / shorter answers, marking standards are checked using 'seeded items'. This is a highly efficient way of monitoring marking standards regularly making use of a pre-prepared bank of items marked by the senior marker team at the start of the process.
- 3.7 'Seeded items' are used in two ways – first at the start of each marking day to check that marking quality is correct before marking of an item is allowed; second, pairs of seeds are introduced at regular points during the marking to check that marking consistency is being maintained. A mark tolerance can be set that reflects the degree of agreement required between a marker's mark and the standard mark set for the 'seed item'. For small value items, this is usually zero – in other words, the marker has to give the same mark as the standard mark.
- 3.8 The importance of segmentation and quality control methods tailored to question types cannot be underestimated, as its implementation has consequential changes in many other areas of the marking process. This is exemplified by both efficiency gains and cost savings, which are discussed in brief in the next section.

4. Impartiality – Minimising cultural bias – Examination Malpractice

Papers are scanned and candidate details are excluded from images available for marking, this means that candidates work cannot be identified - by name or by school or by geographical region, etc.

Auto marking used with items will enable all answers to be recorded, whether they be correct or incorrect, thereby analysis can be carried out on items identifying those which may be geographically or culturally unfair, due to the high volume of the similar - although deemed to be “incorrect” - answers.

Auto marking can give extremely valuable feed back to the examination authority for the setting and wording of future items and questions.

5. Efficiency and costs

5.1 The impact on efficiency and costs can be illustrated simply by comparing the typical processes used in a paper-based marking system with an electronic one.

Table - Efficiency and Cost Comparisons

Paper-based process	Electronic process	Difference	Cost implications
Examinations taken and couriered to the markers	Examinations taken and couriered to scanning centre	Scripts only make one courier journey to the scanning centre	Cost for return of scripts to awarding body by markers removed Reduces potential for loss of scripts and associated replacement costs and reputational loss
Senior markers meet to review the marking scheme prior to the marker standardisation meetings	Senior markers meet to review the marking scheme prior to marker standardisation and set seeded items	Seeded items are selected electronically and held for regular quality checking throughout the marking period	Cost of quality removed as consistent marking standards are applied to all markers through seeding and other quality methods
Markers meet with senior markers to standardise the marking	Markers standardised using e-Standardisation procedures	No physical meeting needs to be held	Meeting venue, travel and subsistence costs removed
Markers send a self-selected sample of marking in the post to a senior marker	Quality control undertaken by anonymised automated sampling process	Markers do not know which items are the quality items and which are live items for marking	Cost of quality in improved marking standards (no wholesale re-marking and markers can be stopped for specific items, not all). Postage costs for samples removed
Markers given feedback on the sample marking and passed to mark or asked to submit further sample work	Markers given feedback on any individual item where marking has fallen outside acceptable marking tolerances	Feedback is targeted at areas where marking tolerances are not met	Real-time feedback minimises the opportunities for marking that does not meet acceptable marking tolerance to remain
Markers submit further sample work by post, if necessary	Quality control undertaken by anonymised automated sampling process	Markers do not know which items are the quality items and which are live items for marking	Cost of quality in improved marking standards (no wholesale re-marking and markers can be stopped for specific items, not all). Postage costs for samples removed

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Paper-based process	Electronic process	Difference	Cost implications
Live marking takes commences	Live marking commences as soon as standardisation has been completed	Marking starts as soon as standardisation completes with regular quality control in place. Marking does not have to wait until samples have been reviewed and passed	Overall time for marking to be completed is reduced and costs of sample checking reduced
Markers submit further samples of work for marking quality checks	Quality control undertaken by anonymised automated sampling process	Markers do not know which items are the quality items and which are live items for marking	Cost of quality in improved marking standards (no wholesale re-marking and markers can be stopped for specific items, not all). Postage costs for samples removed
Marking reviewed by senior markers at the end of marking and appropriate corrective action taken	Quality control undertaken by automated sampling process	Reviews of markers' marking at the end of the process are removed as regular quality checking identifies marking outside of acceptable tolerance at the time that it occurs	Cost of re-marking complete batches of scripts removed. (Some of the items may have been marked acceptably by markers, but this cannot be determined in the paper-based system – so all work has to be reviewed.)
Markers send scripts in to the awarding body	Script images held on the electronic marking database	No scripts are returned by markers	Cost of return of scripts to the awarding body removed
Awarding meeting to determine grade boundaries	Awarding meeting to determine grade boundaries	No change to the process, but electronic images of scripts can be made available or selection of scripts at the appropriate marks can be done swiftly without the need to extract the original copies	Cost of scripts extraction and subsequent management removed
Awards issued to candidates	Awards issued to candidates	No change	No change
Post-examination enquiries conducted with some scripts re-marked. Scripts are posted to re-mark markers	Post-examination enquiries conducted with some scripts re-marked. Re-mark markers access images already captured	As soon as a request for re-marking is received, re-mark markers are issued with an electronic request that enables them to access the images of the script to re-mark immediately	Cost of scripts extraction and subsequent despatch to and from the marker are removed
Revised awards issued, if appropriate	Revised awards issued if appropriate	No change	No change
Marks held at individual paper level – no detail held for each question	Marks held at individual paper level and at item level	Item- level marks are available	More information provided as part of overall service
Marks at paper level published to candidates	Marks at item level published to centres and candidates with comparative cohort information	Value is added to centres and candidates as well as the examining process overall by the provision of detailed item-level data	More information provided as part of overall service

5.2 As can be seen, the implications of electronic marking extend beyond the marking itself to other areas of the marking process, providing benefits both in terms of the quality of the final award for candidates and also in terms of the information provided. The streamlined system, in itself, presents fewer opportunities for error as manual checking procedures are replaced.

6. Conclusion

- 6.1 Electronic marking could be viewed by some as a fairly straightforward process (setting aside the physical script handling for scanning and storage). One in which images are created and then moved about to the markers. However, that is far from the case when the variety of examination papers, question types and marking guidelines are taken into account. A detailed knowledge and understanding of the examining and assessment process is required to ensure that a valid and reliable approach is put in place.
- 6.2 To gain the greatest benefit, electronic marking processes have to be flexible enough, and based upon sound methodology, to cope with the wide variety of question papers and item types that exist. Where this can be done, as illustrated briefly by this paper, gains in terms of marking quality, efficiency improvements and cost reductions can be realised.
- 6.3 One follows from another. However, for those who are intimately involved in the examinations and assessment industry, the order of priority is all-important. The technology must support the pedagogy. For DRS this has always been the case. Not only has the several years of implementation demonstrated the quality gains, but also there has been the satisfaction of seeing consequential tangible benefits realised also.
- 6.4 Why consider Electronic Marking – e-Marker® ?

There are several headline reasons why organisations find Electronic Marking via e-Marker® of such huge benefit.

Some of the most common given are that you should consider it if you

have a concern about the levels of your marking quality, or
are worried about geographical or cultural bias in marking, or
are under pressure to reduce your turnaround times, or
have growing numbers of examinations to mark, or
have continual issues of costs, or
do not have enough markers. or
are worried about the safety and security of completed exam papers.

- 6.5 If any of these reasons are ones that concern you, then DRS would be happy to meet you to discuss them.

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