

## Auditing and assessing subject knowledge in initial teacher training using online methods.

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### Summary

This paper reports on the development of online tools for auditing and assessing subject knowledge in English and Mathematics in primary and secondary initial teacher training courses. The objective was to design, implement and test online tools for formative and summative assessment. When used formatively the tools provide immediate feedback to trainees including links to support materials. A version of the audit tool was adapted for use as an online, summative English examination (without the immediate feedback). In addition the data was also used to inform tutors about areas for development across the cohort.

**Keywords:** Audit, Online Assessment, Formative, Summative, Feedback, English, Mathematics, Knowledge

### Introduction

Interest in Personal Development Planning (PDP) is currently widespread across the education sector, defined as 'a structured and supported process undertaken by an individual to reflect upon their own learning, performance and/or achievement, and to plan for their personal, educational and career development' (Qualifications and Curriculum Authority, 2008). In the Newport School of Education, we are developing an approach that includes several linked components:

- knowledge audits (literacy and numeracy) that help to generate specific learning targets;
- records of learning strengths to identify established capabilities, talents, knowledge and skills;
- SMART (Specific, Measurable, Achievable, Relevant, Timed) target setting;
- construction of a *Curriculum Vitae* (CV) and portfolio.

In initial teacher training courses, it is common practice that the PDP process should include action planning, reflection on achievement and the regular monitoring and recording of progress against targets. This covers a range of professional requirements including subject knowledge improvement. In this paper, online tools are developed and implemented to support formative assessment (i.e. assessment **for** learning), summative assessment (i.e. assessment **of** learning), curriculum development and professional development planning.

Summative assessment, perhaps exemplified by General Certificate of Secondary Education (GCSE) grade requirements for entry to Initial Teacher Training (ITT) is regarded as a problematic guide to the quality of subject knowledge.

For example, French (2003) considers that 'formal subject qualifications and narrow testing or auditing procedures are insufficient to determine whether student teachers have acquired this more broadly defined subject knowledge. Assessment needs to be placed in the context of tasks designed to enhance subject knowledge, where advice can be offered to help students extend and deepen their knowledge. Formative assessment is much more productive than summative assessment with student teachers just as it is with pupils' (p. 6).

The present paper also contributes to wider concerns that students from all phases of education, including ITT, should be equipped to address areas of knowledge that are regarded as essential for employability and lifelong learning (Cajkler and Hislam, 2002, in relation to English; Smith, 2004, in relation to mathematics).

Formative assessment constitutes a learning experience in its own right. In the context of this project, the instantaneity of the feedback that students receive from their audits (see below) enables them to engage directly and productively with their own learning. Summative assessment is usually undertaken at the end of a period of learning in order to arrive at a grade that reflects the student's performance overall. The tools generated in this paper were also modified for examination purposes.

The research reported here has built on earlier work carried out since 2001, involving building and using versions of computer-based self-assessment tools in mathematics, English, ICT and science. Some of these have been reported (e.g. Longman, 2002; Green et al., 2005), but ongoing work in the Newport School of Education has been important for further development, involving the construction and piloting of web-based

applications, using Active Server Pages (ASP) and Microsoft Access in the early stages of development, and more recently 'QuestionMark Perception' (QMP, 2008).

The research has been successful in producing prototype online tools; however, their integration into the wider practices of PDP in the Newport School of Education will take longer and will form the basis of future research.

## Methods

Online subject knowledge audits in secondary mathematics and primary English provide diagnostic feedback on subject knowledge to trainees and tutors. For trainees, the feedback incorporates links to support materials that help to focus on areas for development. In addition, a version of the diagnostic audit was devised and implemented as an online examination in English for Primary Studies trainees. The data generated from these audits and the examination were analysed to provide module tutors with information relevant to curriculum planning for each cohort by highlighting the areas needing focussed work.

### *QuestionMark Perception*

QuestionMark Perception (QMP, 2008) is licensed and supported by the University of Wales, Newport. It was adopted as the 'platform-of-choice' for this project because, initially, it appeared to offer suitable functionality, in particular support for authoring data capture forms and reporting on results. However, as a result of this research it was found that QMP had a number of limitations for our purpose.

A key element of any assessment for learning approach is a range of methods for collecting data about learning. However, on its own, data is not enough, and it has to be presented in structured ways to make clear the underlying patterns and issues. Assessment for learning should provide for two kinds of audience: the learner and the teacher.

It was found that QMP is well designed for the data capture element of online self-assessment tests but somewhat inflexible in terms of reporting. It does not lend itself well to the presentation of feedback to the learner. The style of reports that can be produced using the built-in authoring tools is limited. Nor is QMP very subtle in the way in which cohort level data is generated and displayed and, although statistical information is available, it is not presented to the teacher in an accessible style. The basic design model of QMP appears to be oriented toward a 'polling' model of data capture in which the data subject does not expect to see the individual results of data entry.

### *Online Methods*

*Mathematics subject knowledge audit.* The rationale for the design of the mathematics audit was:

- the pre-course expectation for Year 1 *mathematics* trainees is mathematical knowledge equivalent to GCSE grade A or above obtained from a higher tier paper;
- GCSE level content is not covered as part of the course (only the teaching and learning of it);
- trainees tend to overestimate their own ability, particularly at GCSE level;
- therefore, an audit that monitors this knowledge base is an essential tool for trainees to evaluate and update their knowledge of secondary school mathematics.

This audit was initially designed with questions grouped into three sections:

- number and algebra;
- shape, space and measures;
- data handling.

Each question is multiple choice offering four options comprising the correct solution plus three typical misconceptions. The audits include questions randomly selected from three possibilities for each item plus randomisation of the order of the multiple choices. Therefore, at repeated 'sittings' (it is intended that the audits would be done twice a year) each user has a one in twelve chance of being presented with the same question/answer combinations.

Trials were conducted with trainees, secondary mathematics teachers and Year 12 pupils as well as selected university staff to ensure accuracy and coverage. Feedback from these trials included some issues with presentation and length of time to complete the audit. The latter was reflected in a noticeable decline in achievement by the whole cohort in the later questions. As a result, cosmetic changes were made to the layout of some questions, but more importantly the audit was separated so that each section became a standalone audit.

Submission of an audit generates immediate feedback on performance and includes verbal hints and hyperlinks to further learning materials. These are particularly successful aspects of the audit process as they support the user in taking responsibility for their own learning, thus enabling assessment for learning.

*English subject knowledge audit.* The rationale for the design of the English audit was that:

- an entry requirement for Year 1 trainees is English language knowledge equivalent to GCSE grade B (from either tier);
- trainees are not all subject specialists but all will be teachers of English;
- a system that monitors this knowledge base is an essential tool for trainees to evaluate and update their knowledge of English language.

As with mathematics the online audit was created with questions grouped into three sections:

- lexical understanding
- grammatical understanding
- textual understanding.

Questions are presented in a combination of multiple choice format and text entry where sometimes it is appropriate for sentences and phrases to be re-typed. As in the mathematics audit, questions are drawn randomly from a bank to minimise the chance that a repeat audit presents the trainee with the same questions. The question banks range from three items to as many as ten and over time it is planned to increase the size of each question bank.

Trials were conducted with trainees, secondary English teachers and Year 12 pupils as well as selected university staff to ensure accuracy and coverage. As with the mathematics audit, user and tutor feedback informed future developments. Again, submission of an audit generates immediate feedback on performance with hyperlinks to support materials.

*Online examination.* An online English examination was devised for Primary trainees. This was conducted under strict examination conditions and was in two parts:

- a test of trainees' knowledge and understanding of functional English, e.g. grammar, spelling and punctuation. This part of the examination was a version of the audit but without random question selection and without user feedback;
- an essay using a basic word processor (no spelling or grammar check available) on a seen question of pedagogical significance.

Feedback from trainees was predominantly positive. Aside from some unavoidable issues concerning comfort, room temperature and background noise, the majority of trainees found the assessment was straightforward and caused no significant problems. However, an operational issue emerged from the inappropriate use of the 'Back' button on the browser whereby text entered into a text field, but not submitted, would be lost.

## Data Analysis

The data that forms the feedback provided to the individual is straightforward and helps a trainee address, clarify or remediate any underlying difficulties or misconceptions within the subject. However, it was found that the collective data for the whole group or cohort had very significant value for the tutor or programme leader. QMP allows for some reporting of data at the 'cohort' level but not in a format or layout that is easily accessible for the purpose of identifying strengths and weaknesses in the knowledge base of an

entire group. For this reason the report data was exported to Excel for further organisation and analysis.

A typical dataset for a group of trainees includes:

- the user identifier;
- the date;
- the time started, finished and total time taken;
- the answers as chosen or typed;
- the score obtained per question.

Excel was used to calculate descriptive statistical information such as the maximum/minimum score, the arithmetic mean and the standard deviation. A particularly useful feature in Excel is conditional formatting which allows for automated colour coding of cells that meet certain criteria. Given that the data tables generated from a cohort can be quite large and dense, such colour coding enables the ready identification of aspects of the data that require attention. For example, trainees whose scores do not reach a required standard will be highlighted according to conditions specified. Similarly, it is possible to draw attention to audit questions where the cohort, in general, scores poorly as a result of lack of knowledge or ambiguity in the wording of the question. A traffic light colour code system was used to demonstrate stratification of the groups into three percentage bands i.e. red <60%; amber 60% - 80%; green >80% (any other suitable stratification may be employed).

Figure 1 shows that six secondary mathematics trainees may have difficulties with shape and space having achieved <60%. It also shows that three trainees have a generally sound knowledge in this area having achieved >80%. From the cohort perspective it can be seen that question S39 is either ambiguous or poorly understood as only 25% answered correctly (Figure 2). Subsequently it was discovered through an evaluation of the question that the use of a shaded object was the reason for the low score. Also, of interest is question S47 which was correctly answered by the whole cohort (Figure 3). This question may be too easy and not at an appropriate level of difficulty.

Cohort level data appears to have considerable potential in relation to learning and teaching. From the tutor's perspective individual trainees who have not met the required standard can be examined for diagnostic purposes and, at the cohort level, question items can be analysed to indicate any potential general areas of weakness. This can provide tutors with a formative tool that allows them to target specific areas of knowledge and perhaps inform curriculum planning.

Some additional comments about the online English examination are worth including in this paper particularly in respect of the word processed essay component. Word processing for assessment purposes assumes a trainee population with the necessary typing skills but, although many commented on the relative unfamiliarity of using a word processor to type an essay response under examination conditions, the majority of trainees welcomed the trade-off between speed of

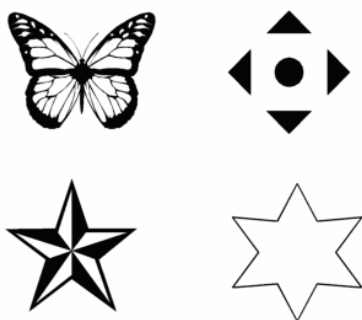
typing and ease of correction in their extended writing. All essays were saved under an individual user identifier and printed for marking. The essays were opened using MS Word and subjected electronically to readability statistics (although this was not used for assessment purposes there may be some potential here for this type of statistic to be used as an indicator in assessing trainee writing). In the marking strategy typographical errors were ignored, but obvious and repeated spelling, grammatical and punctuation errors were taken into account.

Although the two sections of the online test examined different aspects of English (the first was decontextualised, factual knowledge about syntax and

grammar) it could be reasonably expected that there should be some relationship between knowledge and use of English which would be evident in the scores obtained. This was investigated by converting scores of both sections to percentages for comparative purposes. Again, the descriptive statistics informed on the range (wider in the essay component) and mean values (very closely correlated). On the whole, trends of achievement were consistent in both sections of the examination. Where a significant disparity was indicated (>20%), the essays were selected for further scrutiny. These indicators will also allow for targeted moderation.

Student	%	S 38	S 39	S 40	S 41	S 42	S 43	S 44	S 45	S 46	S 47	S 48	S 49	S 50	S 51	S 52	S 53	S 54	S 55
A	78	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0	0
B	78	1	0	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1
C	72	1	0	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1
D	72	1	0	0	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1
E	83	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1
F	67	1	0	1	0	1	1	0	0	0	1	1	1	0	1	1	1	1	1
G	61	1	0	1	0	1	0	1	0	0	1	1	1	1	1	1	0	0	1
H	56	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	1
I	89	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
J	78	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1
K	39	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0
L	89	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
M	28	0	0	0	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0
N	56	1	1	1	0	0	1	0	0	0	1	0	1	1	1	0	0	1	1
O	56	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	0	0
P	44	0	0	1	0	0	0	0	0	0	1	1	1	0	1	1	0	1	1
Total		14	4	11	6	9	7	5	9	5	16	14	15	13	14	14	9	11	12
Percentage		88%	25%	69%	38%	56%	44%	31%	56%	31%	100%	88%	94%	81%	88%	88%	56%	69%	75%

Figure 1. Shape and space results for mathematics audit: a typical results table using Excel conditional formatting to highlight percentages (dark grey = red; mid-grey = amber; light grey = green).

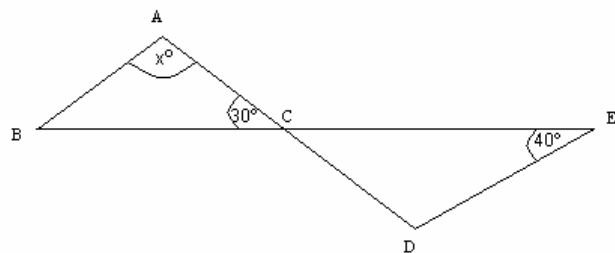


How many of the above figures have no lines of symmetry?

- None
- 1
- 2
- 4

Figure 2. Question S39 from audit.

In the figure below, if AB is parallel to DE then x =



- 70°
- 90°
- 110°
- 100°

Figure 3. Question S47 from audit.

## Conclusions

This research has enabled the creation of effective resources relevant to learning and teaching. The routine reporting and analysis of assessment data, whether formative or summative, is an important aspect of learning and teaching. This project has explored and developed both aspects of this process.

In England, in order to be recommended for the award of Qualified Teacher Status it is necessary for trainees to reach the required standard in the online Skills Tests (Teacher Development Agency, 2008). No such tests are required in Wales but ITT providers are required to ensure that newly qualified teachers can achieve at least a similar level of subject knowledge (Welsh Assembly Government, 2008)

To be effective, particularly as formative tools, knowledge audits need to be repeated at sensible intervals. This needs to be embedded in the normal timetable.

There is clearly considerable potential for such tools to support curriculum development and planning through the formative data they generate. Tutors can make use of the data to evaluate whole cohort patterns of trainees' knowledge. Where the data indicates shortfalls in understanding or take up of concepts, tutors might be able to respond by targeting particular aspects of the curriculum that they are teaching.

For the research team, the process of creating these materials has generated significant expertise and knowledge of the issues surrounding electronic methods of assessment. Subsequent research and development is anticipated and will be underpinned by findings of the project.

The use of such online tools requires time and staff development to become a natural part of course management routines. However, some aspects are controversial and here the use of online examination techniques which have proved to be viable and acceptable to trainees may require a more fundamental shift of values among staff, notwithstanding the fact that substantial parts of the marking are instantaneous!

Contacts with external agencies and teachers in partner schools have allowed a widening of interest in using the mathematics and English audits for both diagnostic and support processes. Initial feedback from the two pilots, conducted in school classrooms during the project, has indicated that school pupils, like recruits to Higher Education, tend to overestimate their level of knowledge. Indeed, we have found that the tools we have created have a wide relevance and there is an opportunity to enhance our relationship with our partner training schools by making these materials available for their use.

## ACKNOWLEDGMENTS

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