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**POPULATING THE TESTBANK:
EXPERIENCES WITHIN THE
ELECTRIAL AND ELECTRONIC
ENGINEERING CURRICULUMN**

S J Wellington, Su White and H C Davis

Populating the Testbank: Experiences within the Electrical and Electronic Engineering Curriculum

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Abstract

e3an1 is a HEFCE funded collaborative project to develop a network of expertise in assessment issues within electrical and electronic engineering (EEE). A major focus of this project is the development of a testbank of peer-reviewed questions for use both in formative and summative assessment. The resulting testbank will contain thousands of well-constructed and tested questions and answers from which teachers may select questions appropriate to their students' needs. During Autumn 2000, consultants (subject specialists) from the partner institutions met to identify important learning outcomes for their subject specialism, and then produced sets of appropriate questions (and model answers) to assess those learning outcomes.

The paper will focus on the techniques employed to get academics to contribute to the testbank. It describes the process employed to generate peer-reviewed questions in the first phase of the project. It relates our experiences of recruiting and training subject Specialist consultants were drawn initially from the partner institutions. Subject teams were established and these agreed key curriculum areas and coverage of the testbank for each particular theme. Authors used MS-Word templates to enter their questions, and these templates also required the authors to enter metadata - information about the questions such as the subject the question examines, the level of the question, the type of question, the cognitive skills required, the time expected etc. This information was used in the database to design an interface to allow teachers to select appropriate sets of questions from the testbank. Experiences of writing and codifying questions, particularly in terms of ascribing attributes such as cognitive level will be discussed, also the peer review process that was adopted. A surprising but pleasing outcome of the work of the subject teams was that there was little disagreement about the required content of the questions and

¹ e³an: Electrical and Electronic Engineering Assessment Network. FDTL Phase 3 project (No. 53/99) . Led by University of Southampton in partnership with Bournemouth University, Portsmouth University and Southampton Institute.

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when the questions were reviewed there was agreement about the standard they represented.

Introduction

The Electrical and Electronic Assessment Network (e³an) project is a three-year collaborative project funded by the Higher Education Funding Council for England. The focus of the project is to establish a network of academics in electrical and electronic engineering concerned with issues of assessment within the Electrical and Electronic Engineering (EEE) curriculum. A major activity of the network is to create a test bank of peer reviewed questions to be held on a central database (White and Davis, 2001).

Contributions to the project activity have drawn extensively on the wide range of knowledge, skills and expertise resident in the project partners and the EEE community across the UK, working in collaboration with the Learning and Teaching Support Centre for Engineering and the Institution of Electrical Engineers (IEE). Initially small teams drawn from the range of the different partner institutions began work developing the testbanks in autumn 2000. A theme leader from the core project team directed each team. The theme team was responsible for identifying and agreeing the type, content and mix of questions they consider most useful and appropriate for their particular theme. They then worked collaboratively to produce and review a full set of questions. The model of question development employed had five distinct stages in the first instance:

1. Question consultants were recruited on their willingness and ability to contribute to a given question theme.
2. Team members then met to be briefed on the objectives of the project, and to identify and discuss the context of assessment in their institution, and their particular subject theme. At this meeting there was an initial allocation of questions in terms of mix, level, and specific content, and team members were introduced to the ways in which they needed to define their questions.
3. Theme members then wrote a number of sample questions which they exchange electronically for informal peer review. This gave opportunity to identify any problems in the writing process.
4. Theme members then wrote the remainder of their allocated questions (we have a target of 300 questions per theme)
5. The final stage was a peer review meeting when the entire question bank was brought together and each theme team compared assessed and moderated their questions.

Questions being developed include those suitable for use in computer-based applications plus some which are appropriate to conventional assessment contexts (e.g. short answers, example exam questions and coursework assignments). It is envisaged that the bank contents will be used both for formative assessments and as exemplars from which academics can draw and devise their own assessment activities appropriate for their particular context. In the second phase, when the working methods have been successfully trialed and refined, consultants will be

invited from the whole range of 76 institutions directly engaged in EEE undergraduate teaching in the UK. The testbank will be extended to cover additional areas.

The reviewed question items are now being placed in an XML database (Davis *et al*, 2001). At its most basic level it will be possible to browse and search the database and retrieve questions in a printable format. In addition, the XML format will allow those questions suitable for use on automated test systems to be exported in a standard (IMS QTI) format (IMS, 1999). The database is designed to include additional metadata which describes the nature and level of the question content. The metadata employed for phase one of the project is summarised in Table 1. The level of discrimination defined for each question was designed to match the QAA Subject Benchmark for Engineering (QAA, 2000a). We anticipate that fine-tuning of items in terms of content and their metadata will result from this process.

Recruitment and training of consultants

Four subject areas were identified for phase one of the project:

- Analogue Electronics
- Digital Electronics and Microprocessors
- Circuit Theory
- Signal Processing

These subjects are core to virtually every course in electrical and electronic engineering, and were chosen to reflect the breadth of the curriculum, and also the teaching interests of members of the project team. A theme leader was appointed for each subject area, drawn from each of the partner institutions. A particular concern was that the material produced should, as far as practicable, be applicable to courses in electrical engineering. A subject specialist was therefore appointed to work with the four theme teams and encourage consultants to reflect “heavy current” interests.

Consultants were recruited from the partner institutions. Project team members were initially asked to identify and canvass potential contributors from their own institution for each of the four subject areas. The benefits of participating in the project include:

- An opportunity to network with colleagues having the similar teaching interests in other institutions;
- Participation in a prestigious pedagogic project may enhance the individual’s CV and will be particularly helpful to support an application for promotion or membership of the Institute for Learning and Teaching in Higher Education (ILT);
- Consultants will have early access to all the materials produced;
- It is an opportunity for Continuing Professional Development (CPD);
- Consultants receive a small honorarium.

Prospective consultants were then invited to attend a half-day training session. Individual briefings were organised for prospective consultants who were unable to attend on either one of the two dates offered.

The briefing session was divided into two main sections: An introduction to the e³an project and objective testing, and a meeting between the theme leader and members of the theme team to discuss and agree specific objectives for their subject theme area.

The introductory session included:

- An introduction to the e³an project, objectives, participants, timescales and deliverables;
- Overview of issues in student assessment, including the benefits of timely formative feedback and the outcomes-based approach to assessment advocated by the Quality Assurance Agency for Higher Education (QAA, 2000b; QAA, 2000c);
- Guidelines for writing effective objective test questions, question types: multiple choice, multiple response, numeric answer and text response. The design of effective objective test questions is an acquired skill (Zakrzewski, 2000). Some general guidelines were presented (CAA Centre, 1999; McKenna, 1999), along with examples drawn from the electrical and electronic engineering curriculum. Specific examples demonstrated how indicative questions from a “traditional” examination paper might be converted into objective test format.

The second part of the briefing session involved members of theme teams meeting with the theme leader to discuss and agree the key curriculum areas. This activity was conducted over the two separate training events, with details finalised by email. Theme leaders initially proposed the main sub-themes or topics and their indicative level. Sub-themes and individual questions were classified as “Introductory”, “Intermediate” and “Advanced”. These levels broadly correspond to the years of a three year full-time undergraduate programme in electrical/electronic engineering, however the schema is flexible enough to cope with the specialist nature of some degree programmes and acknowledge that both timing and intensity of study may vary between institutions. There was also some debate amongst members of the project team about the designation of materials as being relevant the fourth year of an MEng programme. An additional metadata item of tutor information provides an opportunity for question writers to append explanatory notes if they feel this will be appropriate.

Each theme team benefited from a broad range of expertise, with consultants drawn from four different institutions. It is recognised that some areas of any syllabus, particularly questions based on case-study material, are more difficult to write than, for example, questions requiring the use of well-defined analytical techniques. It was therefore considered essential that consultants should be asked to contribute a range of question types in order to ensure an equitable distribution of workload.

The project team was determined to ensure that the task of actually writing questions should be as easy as possible. For this reason it was decided not to request all questions, model answers and diagrams submitted in a common format. Question templates were, however, made available for Microsoft Word which was being used as an intermediary format prior to translation into XML. These templates were used by a large majority of contributing authors, although one university in the consortium did not routinely use Microsoft Word. In future years the project will have a web based batch entry system for questions which are automatically assembled into a database.

Circuit and block diagrams are widely used in electrical and electronic engineering to represent circuits and systems. Consultants were encouraged to make use of their preferred drawing package to generate such diagrams, where they were used in the *question* and to ensure that all symbols complied with the guidelines issued by the Institution of Electrical Engineers (IEE, 1989). The project team recognised that the cost in time of producing diagrams and equations in specimen answers might have been a deterrent to production of questions, although their inclusion would greatly enhance the quality and value of the questions to the learner. For this reason we accepted hand written model answers and scanned them into the database for display as scanned images.

Writing and reviewing the questions

None of the consultants recruited for phase one of the project had any significant experience of either writing objective test questions, or using such material for formative or summative assessment. Most teams therefore decided to write and circulate a small number of specimen questions for informal peer review before embarking on the main activity. This allowed feedback on the style of the questions, and also the scope and level.

Theme team members then worked to prepare their agreed questions and the associated metadata. Feedback from this process confirmed that creating high quality objective test questions is a time-consuming activity. Consultants typically reported that 5 days of work had been required to complete the 50 questions.

The question review process was carried out in a single half-day session. Consultants were invited to supply four copies of their questions. All members of the theme team then reviewed the questions, concentrating in particular on the following points:

- The clarity of the question and indicative solution or marking guide;
- Suitability for the allocated theme, sub-theme and level;
- An appropriate time allocation.

It might have been expected that there would have been difficulty or disagreement between consultants due to differing interpretations of the EEE curriculum and the corresponding benchmarks across the range of participating institutions. However it

was very pleasing to note that the review process produced very little disagreement about the content or standard of questions. On reflection we believe that this was because the question focus was on the core curriculum. Areas which might have caused dissent are not core, and our approach would be to leave development of assessment tools for such areas to those academics who consider it of high importance.

The most common recommendation was that the time allocation for a particular question should be reconsidered, generally to increase the time allocated. Another issue, that is still to be fully debated, concerns the desirability or otherwise of standardising the notation employed in mathematical formulae. Experience has shown that students often prefer the use of a single system of notation, however a plurality of styles can be found in the engineering literature.

Qualitative feedback from consultants after this initial stage of the project confirms that the question templates were well-received and helped ensure that the material was provided in a form suitable for input to the database. Virtually all consultants reported that the time commitment necessary to write the questions had been higher than they had initially expected, mainly due to the effort of producing high quality electronic copy. However it was also noted that such work frequently contributed to the consultants existing plans of learning development. A pleasing feature of this initial work was that several of the consultants began to actively embrace the use of CAA, particularly for formative assessment.

The project team plans to implement, test and evaluate the questions developed to date during the academic year 2001/2002. In addition further more formal evaluation of the participants experiences will also be undertaken.

Conclusion

The use of consultants drawn from a range of higher education institutions contributed to the creation of a rich bank of questions for the first stage of the project. The use of consultants from local institutions for this initial work was helpful as it provided the opportunity for two face-to-face meetings: one to introduce the project and brief consultants; the second to review the questions produced and debrief. The discussion and debate at these meetings provided a valuable contribution to the project activity.

This initial work confirmed that writing assessment material, particularly objective test questions, is a time consuming process. The requirement to ascribe metadata to each question also challenged consultants and reviewers to reflect fully on their own approach to assessment. Work is continuing to fully populate the database and evaluate the material produced.

Acknowledgement

Electrical and Electronic Engineering Assessment Network (e³an). FDTL Phase 3 project (No. 53/99). Led by the University of Southampton in partnership with Bournemouth University, Portsmouth University and Southampton Institute. Project web site: <<http://www.ecs.soton.ac.uk/e3an>>

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Type of Item	What sort of question?	Multiple Choice Multiple Response Exam Numeric Text Hotspot
Time	Expected to take in mins	
Level	Introductory, intermediate, or advanced	Introductory Intermediate Advanced
Discrimination	Threshold Students, Good Students, Excellent Students	Threshold Students Good Students Excellent Students
Cognitive Level	Knowledge, understanding, application, analysis, synthesis, evaluation	Knowledge Understanding Application Analysis Synthesis Evaluation
Style	Formative, Summative, Formative or Summative, Diagnostic	Formative Summative Formative or Summative Diagnostic
Theme	Which Subject Theme was this question designed for?	
Subthemes	What part of that theme?	
Related Themes	What Other Themes might find this question useful?	
Description	Free text for use by people browsing the database	
Keywords	Free Text, for use by people searching the database. e.g. mention theorem tested	

Table 1: Summary of metadata defined for phase one of the project