Supporting Engineering students at the start of their university course: an industry-university collaboration to provide tailored online mathematics resources.

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INTRODUCTION

Mathematics in Education and Industry (MEI), a small, independent, charitable UK curriculum development body, collaborated with Aston University to establish a tailored online support course of mathematics materials for several groups of undergraduate engineering students. These students were studying for a Foundation Degree in either Power Engineering or Gas Transmission. They were heterogeneous in terms of their skills and knowledge of mathematics. Many of them had not studied mathematics for some years and others expressed concerns about the level of mathematics they would encounter at Aston University. Students would access the online materials in the weeks prior to beginning lectures at the university and they continued to have access throughout their first year of their study. This approach was taken in order to reduce student anxiety and to manage their expectations of studying mathematics at university level.

This paper gives an outline of the creation of the mathematics support 'course' produced within a Moodle Virtual Learning Environment, via the industry university collaboration. Feedback from the project is presented and comparisons made with that received from a similar pilot course for STEM students.

1 BACKGROUND

1.1 English 'qualifications' prior to university

In England all students have compulsory schooling to the age of 16. In this time they usually study for General Certificate in Secondary Education (GCSE), or equivalent, qualifications. Mandatory GCSEs, i.e. ones that must be studied and which are usually undertaken during the ages of 14-16, include both Mathematics and English. However, changes are currently happening for students to be required to be in education or training until the age of 17 from 2013 and to the age of 18 from 2014[1].

[1] www.gov.uk/know-when-you-can-leave-school

At present students can then continue education post-16 and study from a wide range of academic and vocational qualifications. The most popular being (academic) Advanced levels (A levels), which are studied for two years. These are also going through change and new A level qualifications[2] will be introduced from September 2015 for most subjects (from September 2016 for Mathematics). The vocational options for post-16 study are wide and varied from BTECs to NVQs to Diplomas. The publication *'Understanding the UK Mathematics Curriculum Pre-Higher Education – A guide for Academic Members of Staff*', Lee et al (2010), gives further information on pre-university UK qualifications.

The majority of students taking A levels use them as entry-level qualifications for university. A level Mathematics is studied by students wanting to study mathematics and mathematics-related, i.e. STEM courses, at university. Students taking post-16 vocational qualifications may also choose to go on to university or may enter into employment. They may also enter employment and continue to study part-time at university alongside their work. It is these latter students which are of particular interest to the project outlined in this paper.

1.2 Transition to university study

Over the past decade there have been a number of reports of national stature into the mathematical preparedness of those studying Engineering at university, such examples include:

- Mathematics in the university education of engineers, Kent and Noss (2003)
- More Mathematically competent undergraduates, Porkess (2007)
- The importance of Mathematics to Engineering Degrees, Hicks (2007)
- 'State of the nation' - preparing for the transfer from school and college science and mathematics education to UK STEM higher education, Royal Society (2011)

A major report by a Mathematics Taskforce (2011), entitled '*A world-class mathematics education for all our young people'*, stated that:

…in this country most new undergraduates arrive at university having taken no mathematics since GCSE two or more years previously. Even if they remembered all the mathematics they once knew, it would be inadequate but, in practice, much of it has often been forgotten anyway.

For students in this project the time between when they last studied some mathematics and them studying their Foundation Degree with mathematics content in varied tremendously. This was one of the primary motivators for providing mathematical support described in this project.

2 INDUSTRY-UNIVERSITY PROJECT OVERVIEW AND DEVELOPMENT

2.1 Background

The School of Engineering and Applied Science at Aston University runs a wide range of courses and has a varied intake of students. Those studying for a Foundation Degree in Power Engineering or Gas Transmission are one such example. A condition for studying the Foundation Degree was the students were employed within a relevant industry. The programme structure meant students would attend Aston for two weeks to study a 20 credit module, then return to their work for up to a month and complete some coursework to be submitted by the end of this period. On their return to Aston for the next module, they sit a formal examination on the previous module before recommencing their studies.

With students on these degrees having to study mathematics and with most having not studied mathematics directly for a number of years, a plan was put in place to offer some further support for their university mathematics modules. Two main options for lecturers are either to produce in-house materials, which is usually ideal, but can be costly in terms of time and effort and may be limited by the availability of key staff; the second is to use materials already available. In this instance Aston decided on the latter, but with some tailoring.

[2] http://education.gov.uk/nctl/examsadmin/news/archive/a00217355/alevels

There are numerous mathematical materials available, but a key principle as noted by Golden et al (2007) is that tailored and structured materials are usually better than non-signposted, non-specific support materials. It is here that MEI, who have great expertise in this area, see Lee (2011, 2012) were invited to collaborate to provide a tailored, structure support site. Students would access a dedicated site, linked from the Aston University webpages, in the weeks prior to beginning lectures at university, as well as having continued access throughout the first year of their study.

2.2 Mathematics support materials

The website, a dedicated Virtual Learning Environment (VLE), would give students access to a wide range of materials relevant to their studies at university. Fig 1 shows the outline course within the VLE. The intention here is not to go into the specifics of the mathematics itself, but to consider the overview of the materials and structure.

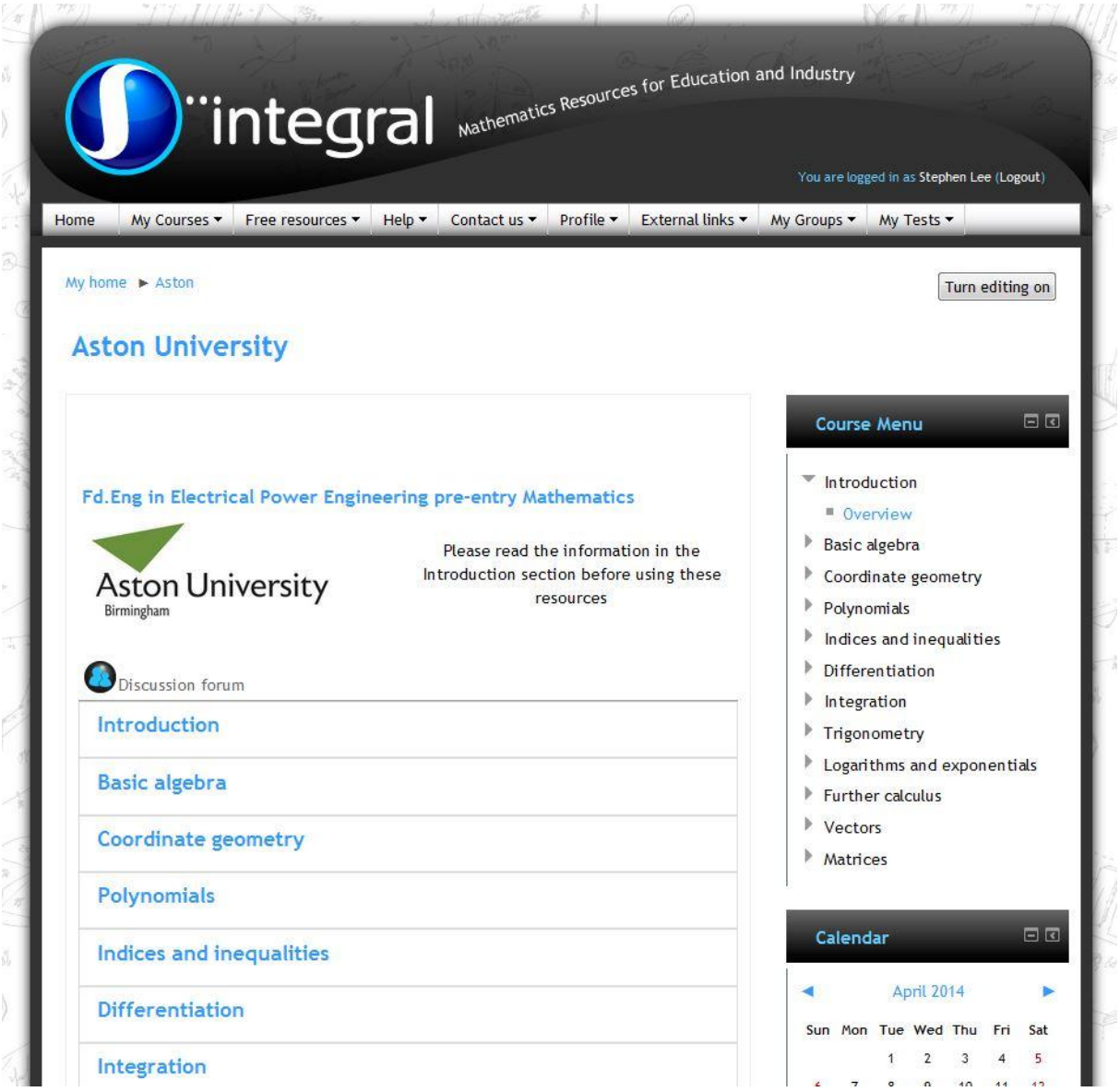

Fig. 1. Screenshot of VLE

There were 11 sections of mathematical materials (topics are as seen in the right hand side of Fig 1), along with an introduction section, which then broke down into 25 sub-sections of materials. Each of the sub-sections (apart from the introduction), had a common format that included:

- 'This section covers…' text
- Section test (multiple choice automatically marked)
- Notes and Examples document
- Crucial points document
- Exercise questions and solutions
- Interactive/active learning and other resources

The usual expectation would be that a student would read 'This section covers', attempt the section test and then from the outcome of the test determine if they need to use the materials available in the section to help them understand the topic. The materials included PDFs, Word documents, PowerPoints, Spreadsheets, Flash files, Geogebra files, JavaScript interactive questions, videos and hyperlinks to external resources (as appropriate).

The set of online materials was constructed after meetings between MEI and Aston University staff, so that a selection from the whole collection of resources that MEI holds, could be selected and tailored into this particular course. This routine meant that expertise from both parties could produce the best outcome to support the specific students that would access the resources.

3 RESULTS, OUTPUTS AND LESSONS LEARNT

3.1 Results and outputs

The students haven't yet sat their examinations since receiving this additional support. However two forms of feedback have been used to date. Firstly, anecdotal evidence from classes and tutorials and secondly, mid-way through the year, feedback was sought from students by asking them to complete a short questionnaire.

Talking the second of these first – a very short, paper-based questionnaire was produced, the first section asked if they had used the resources of not, and if not why not.

Options for reasons why the 'service' was not used included: I was not made aware of this provision, I did not have the computer facilities required, I had trouble logging in, I really didn't think it was necessary or I just didn't get around to it. Of those that said they didn't use the service almost all selected the last of these options – I just didn't get around to it. This is somewhat representative of a group of students as a whole – some just don't engage to the extent that others do and no matter what help and support is available then they will not make use of it. Such students do need to be carefully monitored during their studies to make sure they are doing as well as they can, and are not at risk of falling behind and even failing.

The second section asked them to score various questions on a scale of 1 to 10. The results of several questions, and the average score for them, are given in Table 1.

Table 1. Feedback from student survey

Question	Average Score
Ease of use *(1 very hard, 10 very easy)*	9
Level of content *(1 too easy, 10 too hard)*	6
Degree of usefulness *(1 not really, 10 very useful)*	9
This facility has helped me make a good	7

start to this programme *(1 not agree, 10 strongly agree)*	

Results for the second part indicated that overall students thought the site was very easy to use, had about the right level of content, that it was very useful and that access had helped them make a good start to their studies.

The final section asked students to indicate if, and therefore how, the provision could be improved. Comments were varied but overwhelmingly positive in nature, with just a few helpful suggestions. Examples included:

- I used it a lot it is very useful to refresh the memory on some sections that I have not worked on for a while.
- I thought the system was very helpful! It helped me fell more prepared for the maths ahead of me – this stopped me worrying about the maths.

- It was very useful, however, not studying maths for 5 years I needed more direct tuition
- Quite a lot of content seemed very easy. Some of the content seemed to jump to a more difficult level.

The anecdotal evidence supports this more tangible feedback, with students making comments such as:

One of my main concerns of studying for the Foundation Degree was the level of mathematics required. The on-line mathematics system gave me the chance to have a go at maths I was worried about. It also made me realise how much work would be involved in doing this qualification. (Student A)

Maths was my biggest concern. Doing the on-line stuff helped but I still struggle with some of the topics. (Student B)

3.2 Lessons learnt and future work

The procedure for creation of this tailored, specific course, for use by Aston University, was for the complete suite of mathematical topics to be considered by Aston and the appropriate ones selected. These materials could then be 'packaged' into the required 'course' for access by the students. The procedure is usually quite straightforward, with dialogue between the 'experts' at both MEI and the university.

With MEI having worked with a number of different universities, providing support materials for various different types of student, one lesson learnt is that there is often a disparity between what is first requested as the collection of support materials and what is finally provided. By this it is meant that the 'normal' reaction is for universities to want to have access to all materials, i.e. the complete coverage of A level Mathematics and Further Mathematics materials and more that MEI has, when it is usually better to select slightly fewer, but more specific, materials related to the university material due to be taught.

The correspondence between the organisations is a key part of the collaboration. In each project there are always minor issues that arise, but it is therefore important to have key milestone dates for the various aspects of the project, i.e. what work was to be done and by when.

The general feedback seen in this project compliments more detailed feedback sought in previous collaborative projects that were similar, see Lee et al (2012). Though this project was a little different in nature to MEI's previous collaborations because of the students, i.e. industry based, part time, it gives clear indication that a collaborative project between industry and universities can work well across a multitude of situations of students requiring additional mathematics support.

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