Industrially-owned modules for HE
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Abstract
This project allowed industrial partners to work in collaboration with academics in the design and delivery of specific modules. The project successfully developed three ‘company-sponsored’ modules with representatives from civil engineering (BAM Nuttall), chemical engineering (SABIC) and project management (Jacobs Engineering) companies who were able to draw upon their experiences of the strengths and shortcomings of recently appointed graduates in order to enhance the employability focus of the modules. The evaluation provided evidence that students benefited from the explicit involvement of industrial partners and supported the assertion that “relevance motivates” (Lamb et al., 2010). The principles and approaches adopted in this project should be transferable across the wider HE STEM sector.

Keywords: industrially-owned modules, relevance motivates

Background
The School of Science and Engineering at Teesside University operates an external advisory board consisting of scientists and engineering company managers, employers and representatives of professional organisations. The board meets regularly with the school's senior management team, which includes the Dean and Assistant Deans, to review courses, training and employment opportunities for our students and to advise on curriculum and new course development. The school has been implementing a number of ambitious plans to achieve this, including the redesign of all 25 of its undergraduate courses around an innovative structure based on a core of sequential integrating problem-solving modules which require students to demonstrate their ability to apply their learning in context before progressing to the next academic stage (Figure 1). The industrially-owned modules are one further element which we hope will provide further relevance and contextualisation of the learning and are consistent with this approach.

This project piloted a novel model of industrial involvement in the design and delivery of undergraduate engineering programmes by allowing relevant (volunteering) engineering companies to take ownership of particular modules within the curriculum which relate directly to their organisation’s core business and badge them as ‘company-sponsored’ modules. The three industrial partners, Jacobs Engineering (formerly Aker Solutions), SABIC (Europe) and BAM Nuttall, are large multinational organisations that have a wide range of material from which to draw for their activities. In addition, they are significant UK graduate recruiters and are able to draw upon their experiences of the strengths and shortcomings of recently appointed graduates to help in the design of the modules. All of the company representatives (Giles Gillett, Jacobs Engineering; Mike Ducker and Tony Elgood, SABIC; Mike Tweedle; BAM Nuttall) were drawn from the School of Science and Engineering’s external advisory board.
The project involved two degree-specific modules (Risk Assessment and Control & Simulation) as well as a cross-disciplinary module (Engineering Management & Leadership) undertaken by all engineering undergraduates in the school. The two subject-specific modules were designed to be delivered in a year-long mode (October to May), whereas the cross-disciplinary module was designed to be delivered in two blocks (block 1, October to January, and block 2, February to May), with the first block delivered to students on the Chemical Engineering, Civil Engineering and Civil Engineering with Disaster Management routes, followed by the second block to students on the Mechanical Engineering, Electrical & Electronic Engineering and Instrumentation & Control Engineering degrees. All three modules are compulsory (core) elements of the degree programme (Table 1).

Table 1. Industrially-owned modules, industrial partner and degree utilisation

<table>
<thead>
<tr>
<th>Module title (FHEQ level)</th>
<th>Industrial partner</th>
<th>Degree route utilisation (full-time student numbers enrolled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Assessment (5)</td>
<td>BAM Nuttall</td>
<td>Civil Engineering (43)</td>
</tr>
<tr>
<td>Control &amp; Simulation (5)</td>
<td>SABIC</td>
<td>Chemical Engineering (30)</td>
</tr>
<tr>
<td>Engineering Management &amp; Leadership (5)</td>
<td>Jacobs Engineering</td>
<td>Chemical Engineering; Civil Engineering; Civil Engineering w Disaster Management; Mechanical Engineering, Electrical &amp; Electronic Engineering; Instrumentation &amp; Control Engineering (162)</td>
</tr>
</tbody>
</table>

Rationale

Involving the industrial partners who agreed to work with us in the development and delivery of modules around their business needs within the curriculum is consistent with the strategy set out in *Higher Ambitions* (BIS, 2009) for universities to provide the high level skills needed to remain competitive. This specifically identifies the need for business to be more engaged in the “design of programmes”. Furthermore, there is considerable evidence to suggest that, where the curriculum has been enriched by industry-relevant modules, student engagement and increasingly important metrics (such as retention, NSS scores and employment in graduate careers) improve (Lamb et al., 2010). This project is considered to be as an extension of the employability-led agenda within the school which permits the link between theory and practice to be further reinforced within the
curriculum and to permeate across all programmes. It is intended as a pilot which could eventually roll out to every course in our engineering portfolio and a number of science courses as well.

Our aim was to increase student interest and motivation (“relevance motivates”, as stated in the Royal Academy of Engineering Engineering Graduates for Industry report (Lamb et al., 2010)) and also to better equip students to understand the context and application of their learning.

The key objectives were to:
- Ensure the link between theory and practice is further reinforced across our programmes
- Achieve explicit industry-led input into the design of the curriculum
- Improve student engagement
- Provide a flexible model for the creation of industry-owned modules in partnership with academics.

The anticipated outcomes of industrial involvement in the design and delivery of modules associated with undergraduate engineering programmes were as follows:
- Improved motivation of students premised on the clear relevance of the taught curriculum
- Improved retention, NSS and employment outcomes
- Development of a series of industry-owned and badged modules
- Dispersal of this approach across all of the school’s science and engineering undergraduate awards
- Adoption of this type of model by the wider HEI sector.

The approach

Three industrial partners agreed to work with us to develop new modules around their business needs, which they would ‘badge’ and ‘own’ within the curriculum. Initial meetings with the industrial representatives were used to introduce them to the structure and organisation of the School of Science & Engineering’s undergraduate engineering portfolio. An outcome of these meetings was the identification of a set of criteria which would be used to select the three pilot modules. The criteria were as follows:

- Must align with the area of industrial expertise of the partner
- Must be either a first or second year module (level 4 or 5)
- Ideally, should be a module which covers content that students struggle to grasp the relevance of or struggle with academically
- Ideally, the module will not be a group project module.

The industrial representatives were provided with specifications of the six disciplines offered at undergraduate level and a comprehensive module catalogue from which to identify modules to which they would be interested in contributing.

In the second round of meetings, representatives from the industrial partners met with subject group representatives of each engineering discipline to identify the specific modules to be developed. The three pilot modules identified were Risk Assessment, Control & Simulation and Engineering Management & Leadership. All three modules were associated with the second year of study of full-time students (FHEQ level 5, see Table 1). The three industrial partners felt that the modules selected for the pilot clearly reflected their expertise and covered content that students struggle to grasp the relevance of or struggle with academically. In the case of the Risk Assessment module, the industrial partner felt that students frequently underestimated how the application of this discipline underpinned the commercial activity and reputation of the whole sector. The industrial partner wanted to be involved in the development of the Control & Simulation module primarily because they recognised lack of experience in this area as a shortcoming of recently appointed graduates. The selection of these two modules, which are delivered to two separate engineering disciplines, conforms to the original proposal. It was initially planned that the project would focus on developing two modules which would be delivered to differing degree
cohorts; however, the addition of a third partner allowed the inclusion of Engineering Management & Leadership, a module which cuts across all of the engineering disciplines. The expertise of Jacobs Engineering (Aker Solutions) made their involvement in this module appropriate as they were able to draw on a wealth of business experience in multidisciplinary projects relevant to students from all of the different disciplines. Identification of specific modules permitted the individual module leaders to liaise with their corresponding industrial partner to review the content, assessment strategy and learning outcomes associated with the module specifications whilst simultaneously considering professional body requirements/expectations. Only minor modifications were required to the module specifications and, where necessary, these were dealt with by the school’s Academic Standards Committee. The detailed module development, particularly in relation to defining the nature of the industrial partner’s contribution, occurred during the summer prior to the delivery of the modules. These agreed contributions currently include activities such as guest lectures and provision of case studies and pilot plant data to support the taught provision and assessment strategy (SABIC). BAM Nuttall suggested that greater emphasis be placed on some of the existing indicative content, for example, environmental and commercial risks being covered by guests from industry. Jacobs were instrumental in the redesign and development of the learning strategy for the management module and then endorsed the assessments to the students. The students were informed of the involvement of the industrial partner in the development and delivery of the module, and the rationale for this involvement, in the first taught session. This typically included an introduction to the module delivered by the industrial representative.

**Evaluation**

Student feedback for these new modules was elicited in late December 2011 (as we approached the end of the first term). It should be noted, however, that it was not possible to complete these modules within the timescales of this project (the required project end-date of January 2012 was too early in our academic cycle) and therefore evaluation is based on an interim assessment of the students’ perceptions of the modules, principally carried out using a short questionnaire. An identical questionnaire was used for each module. The questionnaire was distributed to the three student cohorts by one of the project leads prior to the start of a taught session not associated with the modules under development as part of the project and in the absence of the academic leads. Prior to completion of the questionnaire, the project leader gave a brief presentation explaining why students were being asked to participate in the evaluation of the project. This process required approximately 30 minutes to complete. Details of the student cohorts completing the questionnaire are provided in Table 1. The questionnaire consisted of three sections. The initial section focused on establishing background information on the students completing the questionnaire (e.g. home or international students). The second section of the questionnaire consisted of ten goal-oriented statements relating to the project objectives. Students were asked to indicate their degree of agreement using a Likert scale (‘strongly agree’ to ‘strongly disagree’). Questions 1 and 2 focused on how students perceived the principal of industrial involvement in the development and delivery of the module. Questions 3, 4 and 5 focused on whether industrial involvement in the development and delivery of the module content and assessment had contextualised the material and increased student interest, motivated engagement and enhanced the relevance of the topics covered. Questions 6, 7 and 8 queried whether the involvement of the industrial partner had improved the relevance of the material covered in relation to their degree, professional expectations and personal development. Questions 9 and 10 were used to assess overall satisfaction with the module and inclination to recommend it to another student. The proportion of students agreeing with the statements posed by the questionnaire is presented in Figure 2 both for individual modules and overall for all modules. The final section of the questionnaire permitted students to make brief suggestions about any particular contribution they would like industrial partners to make and asked if there were factors, other than the involvement of an industrial partner in the development and delivery of the module, which positively or negatively influenced their experience.
Stacked columns, based on student responses, are composed of the following categories: strongly agree (SA), agree (A), neither agree nor disagree (NAD), disagree (D) and strongly disagree (SD). The data are drawn from full-time students studying Chemical Engineering, Civil Engineering and Civil Engineering with Disaster Management. 

A) All modules (n=74), B) Control & Simulation (n=16), C) Risk Assessment (n=19), D) Engineering Management & Leadership (n=39).

Figure 2. Student responses to the statements posed on the questionnaire

The student perception of the principal of involving industrial partners was very positive (questions 1 and 2). More than 90% agreed or strongly agreed that their involvement in the development and delivery of the modules included in this pilot was a good idea. Furthermore, contextualisation of the learning, by involving the industrial partners in the design and delivery of the modules, appears to have had a positive impact on student engagement with them (questions 3 to 5); more than 55% agreed or strongly agreed that the involvement of industrial partners in the modules had enhanced their interest, motivation and engagement with module content and assignments. Questions 6 to 8 queried whether the involvement of the industrial partner had improved students’ appreciation of the relevance of the material covered in relation to their degree, professional expectations and personal development. The majority (65% agreed or strongly agreed) perceived the involvement of industrial partners as a positive influence in their assessment of the modules’ relevance to their studies and future careers. The number of students who remained undecided (neither agreed nor disagreed) increased for both of these categories of question. This increase probably highlights students who have decided to refrain from making a judgement prior to completion of the module.

Despite the positive perception of industrial involvement in the development and delivery of the modules, a minority of students appear to be dissatisfied with or feel unable to recommend these modules to other students (less than 15%; questions 9 and 10). The highest levels of dissatisfaction are associated with the cross-disciplinary Engineering Management & Leadership module (Figure 1D). This dissatisfaction can largely be explained by student comments on factors (other than the involvement of an industrial partner in the development and delivery of the module) which negatively influenced their experience. Irrespective of degree cohort, students used this section to state that the timetabling of the taught session (6-8 pm) had a negative impact on their experience. The timetabling of these sessions was governed by the availability of the external lecturer and does expose a potential shortcoming of the more widespread involvement of industrial lecturers in programme delivery as they have to work around their other commitments. The final section of the questionnaire permitted students to make brief suggestions about any particular contribution they would like industrial partners to make. The majority requested either an increase in the number of guest lecturers or the opportunity to undertake site visits.
Discussion, summary

Failure to engage with effective mechanisms of delivering employability skills as part of an award is likely to adversely affect the currency of a UK-based engineering degree. Universities will require a variety of delivery models which encompass varying degrees of commitment on the part of the industrial partner in terms of time and money. This project has successfully developed three industrially-badged modules. This model allows industry to make an upfront investment to tailor the design and delivery of a specific module to meet their needs. The extent to which they wish to participate in the delivery is then determined in partnership with the academic lead. This model does not preclude other parts of the curriculum engaging in more intensive interaction with industry, up to and including course sponsorship. It appears, at least from the perspective of the interim evaluation, that engineering students are in favour of the explicit involvement of commercial companies in the development and delivery of modules on their degree programmes. In engineering disciplines, typically associated with high levels of graduate employment, the acceptance of the explicit involvement of industry is not surprising. However (although not an issue in our pilot), it was observed that students from certain other related disciplines (for example, environmental science) may oppose this type of explicit involvement by commercial companies as an adverse influence on the balance and objectivity of their course. This pilot also provides further evidence supporting the assertion that “relevance motivates” expressed in the recent Royal Academy of Engineering report Engineering Graduates for Industry (Lamb et al., 2010). Comments derived from the questionnaire suggest that students would like the involvement of the industrial partner to be extended (e.g. guest lecturers and opportunities for site visits). It was not possible to complete a full evaluation of these modules within the timescales of this project (the required end-date of January 2012 is too early in our academic cycle). This will be subsequently conducted and used as part of ongoing evaluation of the success of the project. In addition to a final questionnaire, we will attempt to measure the difference between student performance on this module against average performance for the respective cohorts on other modules and compare this data against trends in previous years on the modules which these new developments will have replaced.

Further development

This approach to engaging industry/employers in the design and delivery of our curriculum will be embedded in future occurrences of these modules and extended to include other modules and disciplines. Although this pilot study was specific to the particular modules and courses within our own university curriculum, the principles and approaches should be transferable across the wider HE STEM sector. The school’s operation of an external advisory board, which meets regularly with the school’s senior management team, has been critical to this development as it permitted a route via which industrial partners could be recruited. It is envisaged that the continued operation of the advisory board will be critical to sustaining and extending the project across new modules. Similarly, the participation and support of the senior management team meant this development could strategically select modules, in line with the HEA’s recommendations in the Embedding Employability into the Curriculum document (Yorke and Knight, 2004), rather than permitting them to occur at potentially variable levels across awards.

References


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