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On Student Skill Development through Integration of Industrial Expertise in Module Delivery*

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This case study sought to develop an engineering module which would bring in experts from industry to educate future engineering specialists in aircraft product development in order to address the industry standards and codes of practice. The industry staff lectured on key aspects of aircraft design integration and collaborated with the academic involved in teaching this module. The proposed development was mapped against the current accredited MSc/MEng curriculum. The industry partners participated in the aircraft design project development and its technical quality assessment during the academic year. The student learning experience and employability was enhanced through the application of the theory in a practical module assessed according to industry requirements.

Keywords: higher education; employability; assessment; aerospace engineering; aircraft design

1. Introduction

The practice of embedding employability into a curriculum has been a continuous concern for the higher education (HE) sector [1–8]. The 2006 HEFCE report on *Engaging Employers in Higher Education* stressed the need for the HE sector to improve collaboration with employers in order to enhance employability skills and address the growing "skills gap" challenge facing the aerospace sector and other engineering related industries. The widening gap becomes a demographic issue as global aerospace industry shift do occur due to lack of local suitable talent. The result is companies put more resources into training and re-educating graduates to fill key jobs, although the companies outreach programmes are increasing in number for visibility purposes.

In this case study, the practical experience of delivery and assessment of a specialist module in the aerospace engineering MSc/MEng curriculum at Brunel University, London, is presented. This course is accredited by Royal Aeronautical Society and Institution of Mechanical Engineers UK. In the core module *Aerospace Vehicle Analysis and Design*, key aspects of fixed wing aircraft design are delivered in partnership with industry and business. This hybrid "experience-led" teaching approach is to provide scope for an in-depth examination of student through a comprehensive individual project on aircraft conceptual design. The proposed approach pursues two threads towards hybrid teaching, by providing means to capture programme curriculum enrichment, and also enhance and sustain university—industry long term partnership [7, 8]. The project sought to bring in experts from industry to provide the opportunity to educate future engineering specialists who can appropriately weigh technical, practical, business and management considerations in aircraft product development, whilst meeting the industry rigours, standards and needs.

The programme offers a working understanding of specialised information coming from industry expertise and provides an overview on real industrial environments. This module leads to an enhanced design overview of technical decision-making and vehicle morphology analysis, taking stock of business case and risk, as well as systems integration, by presenting the industrial decision-making approach, integrated with management integration, regulatory and operational considerations, marketing requirements and objectives. Highly complex cross-functional aerospace system architectures are governed by the edicts of technical, practical and business management. The specialised information is supported by advanced computational tools currently used in project delivery by academics (i.e. *Advanced Aircraft Analysis,* highly used in academia and industry), along with dedicated advanced CAD programs (i.e. *SHARX, AEROPack)*.

The rationale for this project was to close the gap between academia and industry in terms of hands-on experience and prepare students for the complex technical environment of industry. A core module is used as a vehicle for collaboration with industry in terms of delivery and assessment, with the objective to encourage "deep" learning, making it relevant to industry and producing a strong and competent work force. The aircraft design project given by the industrial partners required the students to

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engage with a complex situation, be active in their learning and structure their knowledge and learning processes, enhancing the student experience and promoting quality learning. The interaction between industry specialists and academics provided an opportunity to introduce experience–led teaching into the aerospace engineering programme and prepare this degree to be fit for the future.

2. Teaching—learning methodology

The current module consists of a combination of weekly formal lectures and practical seminars, whereby a number of tutorial schedules are tailored to students' progress on theory, software skill development and portfolio of academic deliverables. The ultimate phase in students' academic development comes as a comprehensive aerospace project, a deliverable that tests not only technical judgement, but also economic and management skills.

In order to stimulate students' interest for the project, an industrial setting through a *fixed wing aircraft design* brief, project management, standards compliance, quality assurance and verification, documents are prepared by the industry partners, the *Future Projects Group* of Airbus UK. Support from the industrial partners during the academic year was given through specialised lectures complementing the initial syllabus. The main phase of the project was achieved through a session of preliminary design review (PDR) by means of poster presentations carried out by the students a fortnight before final project submission.

At the PDR, each individual was given the opportunity, by means of a few joint staff panels, to present their preferred conceptual design option and the rationale for the choice to an invited audience of industrial and academic specialists. Each individual was expected to present details of a "Loop Zero" baseline design, which comes closest to meeting the specifications from the project issued by Airbus. At the presentation, the students were encouraged to convey an understanding of the nature of the specifications and the market (including competitor aircraft analysis). Finally, an account of the logic and rationale employed for down-selection from the pool of candidate aircraft morphologies was expected.

The PDR presentation was a "walkabout review", where each student was visited by a number of parties of reviewers made up of industry representatives and academic staff (five or six per group). Each party (panel) discussed with each student for approximately 20 minutes. All students were advised to be prepared to respond to questions and have suitable supporting material (not necessarily all on "public" display).

The students received feedback based on their technical acumen; critical review and understanding of their own research work, including critical steps in project management, communication and presentation skills.

The students received feedback based on their technical acumen, critical review and understanding of their own research work, following criteria from the School's assessment pro forma, e.g.:

(a) Project organisation, planning and articulation of the project aim.
(b) Technical and theoretical understanding of referenced material.
(c) Engineering analysis, synthesis and technical achievement.
(d) Discussion of results and conclusions.
(e) General comments.

Based on the feedback from the joint staff panel, a *Final Engineering Definition Report* was compiled and submitted by each student, covering studies carried out in the initial phase and additional iterations in order to meet full design specification. This process has been approached so that comprehensive feedback is received by students from key stakeholders with respect to the mind set and skills needed within the current industry climate to ensure research and technology success.

After the PDR, a thorough discussion amongst industry members and academics took place in order to identify milestones achieved on the assessment day and throughout the project, student performance and what went well and wrong with the entire process. All panel members took part in the discussion and highlighted their own points on the status, including how to improve the process in the future. The meeting was minuted in order to fully identify key stakeholders' needs, expectations and requirements, so that full project compliance can be approved in the delivery phase.

3. Teaching innovation evaluation

The overall purpose of a teaching innovation is to develop an enhanced learning environment for the students. In order to fully understand the risks and successes within the project (the initiative), two questionnaires were prepared for the industrial partners taking part in this project and for the students enrolled in this module, respectively. Both questionnaire frameworks are employed here as summative evaluation (which measures the overall impact of effectiveness of the initiative) and formative (information is gathered during the process and is used to inform improvement) [8]. Overall the evaluation is to be done on accountability (measuring results of efficiency), for development (to improve practice) and knowledge (student learning and change management).

As the project is based on teaching innovation and introduced into a module, some goals and certain rationales are kept in mind (i.e., hybrid teaching approach, employer engagement, hybrid assessment, workload, skills, etc.—see section 5 for analysis). Consequently, in order to best identify the needs, expectations and requirements of the key stakeholders (i.e., industry partners, academics and students), the innovation evaluation is based on bespoke questionnaires to articulate academic, professional and personal development along with the motivation, challenges, feedback and confidence of the stakeholders. The questionnaires have been tailored to the project's goals adapted after [9, 10].

3.1 *Questionnaire for the industry panel*

The industry panel was asked to answer the following questions:

(1) What is (are) the value proposition(s) in such collaboration proposal (i.e. academia-industry) and what outcomes do you expect this (these) to have? What are your motivations for collaboration?
(2) What difficulties do you envisage in developing collaboration with academia for the development of curriculum and student project assessment tailored to industry needs?
(3) What skill set should students have developed during such collaboration? Would it suffice for employability?
(4) Is this hybrid assessment formative and appropriate for students' development?
(5) Realistically, what can be done to improve the links with the University for curriculum development and student project assessment tailored to industry needs?
(6) To enhance student employability, what are the best ways of the ensuring student's profile (e.g., technical acumen, soft skills, numeracy, etc.) is tailored to industry needs?
(7) What do you think are the main issues in the gap between industry and academia and how to address them?
(8) What could be improved or changed to develop a sustainable collaboration with industry?
(9) What haven't we asked in order to address and understand the main hurdles regarding student employability?

3.2 *Questionnaire for students*

The following evaluation survey was used for analysis of the learning process and the impact on the student learning experience. This approach should detail any "lessons learned", both from technical and project coordination perspectives, along with skills attained. The survey can also be used as a sounding board for any strong objections to the critical assumptions adopted during the course of the project:

(1) The staff focused more on encouraging me to find information than on giving me the facts.
(2) This activity helped me to discover what was expected of me as a learner.
(3) I found this activity challenging.
(4) The staff gave me the support I needed to learn in this module.
(5) The teaching staff of this course motivated me to do my best work.
(6) The staff put a lot of time into commenting on my work.
(7) My lecturers' explanations were clear and simplified the understanding of the subject for me.
(8) The teaching staff worked hard to make their subjects interesting.
(9) This activity helped me to develop my team working skills.
(10) I learned how to plan my learning.
(11) The group was effective in developing shared goals.
(12) I can see a range of ways in which I can contribute to a group task.
(13) It was always easy to know the standard of work expected.
(14) I usually had a clear idea of where I was going and what was expected of me in this course.
(15) It was often hard to discover what was expected of me in this course.
(16) During the module I was given opportunities to establish my own research questions.
(17) As a result of this activity, I am now more confident about my ability to establish my own research questions.
(18) I felt I could get through the activity simply by memorising things.
(19) To do well in this course all you really needed was a good memory.
(20) The staff seemed more interested in testing what I had memorised than what I had understood.
(21) The assessment methods employed in this course required an in-depth understanding of the course content.
(22) There was a lot to learn.
(23) I felt I had to work hard to complete this activity.
(24) There was a lot of pressure on me to do well in this course.

(25) The sheer volume of volume of work to be got through in this course meant it couldn't all be thoroughly comprehended.
(26) I learned about how to present my findings to an audience.
(27) I am more confident in my ability to evaluate the information I have found.
(28) I feel I am better at evaluating different sources of information.
(29) I feel I am better able to make an oral presentation.
(30) I fell more confident in my ability to solve problems.
(31) The course developed my problem-solving skills.
(32) As a result of my course, I feel confident in tackling unfamiliar problems.
(33) The course improved my skills in written communication.
(34) During the module I was given opportunities to establish my own research questions.
(35) The staff focused more on encouraging me to find information than on giving me the facts.
(36) I enjoyed working in this way.
(37) I found the activity challenging.
(38) The teaching staff of this course motivated me to do my best work.
(39) I usually had a clear idea of where I was going and what was expected of me in this course.
(40) The teaching staff worked hard to make their subjects interesting.

4. Evaluation of teaching development

The programme delivery was subject to a number of milestones which were enforced in order to track progress and evaluate the success of the project against the objectives. The employers' evaluations and suggestions will be taken into account for further continuation and development of good practice and future active involvement of the aerospace industry. The relevant recommendations and conclusions will be used for all of the courses and the development of new initiatives for further curriculum innovation within the *School of Engineering and Design*.

The impact on students' learning by means of innovative practice has been assessed through the industry/academics overlooking the design project outcomes, student feedback and student satisfaction surveys. To assess the quality of the teaching process in a metric format based on the students' perceptions and needs, the approach developed by [11] for analysis of quality in product design was used. In this approach, quality can be interpreted as the degree of user satisfaction with product attributes. The approach, linked with the *Prospect Theory* developed by [12] uses a quality measurement to reflect the relationship between the user's requirements and the adopted design. This can determine a scale and become an aid for decision-making in evaluation of the customer's preferences and product improvement.

The psychological value of customer satisfaction is based on the difference in actual distance between the required value and the design solution value. A representation of this variation is presented in Fig. 1a. A rescaled version of the curve in Fig. 1b, to be used in a standard questionnaire for a discrete scale from least to most appropriate, was determined and used for student satisfaction analysis.

5. Survey analysis and discussion

The answers given by the industry partners of the project show that industry considers that:

- A link and a continuous dialogue with academia are essential for a shared vision and to shape the future. It has been observed that recruitment of

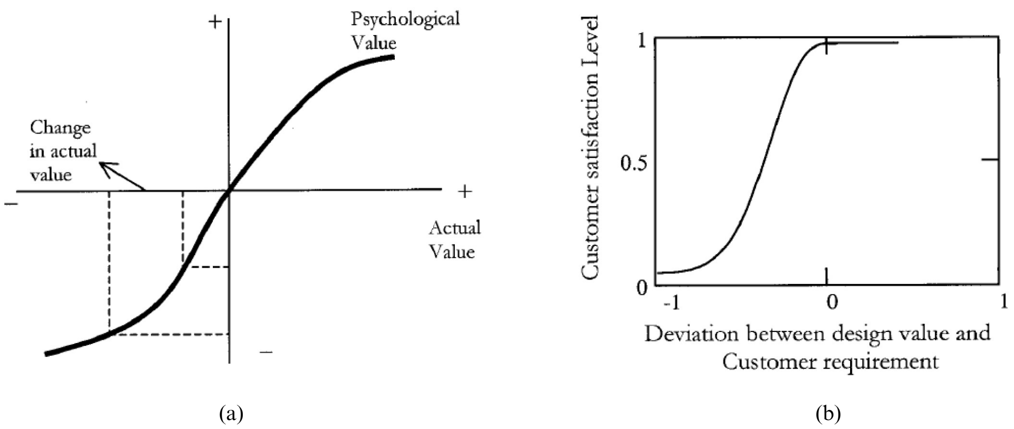

Fig. 1. (a) Psychological value versus value of the actual attribute (consumer behaviour); (b) User satisfaction level based on the actual deviation between design solution and customer requirement.

appropriately capable engineers is becoming increasingly difficult and that any collaboration with universities should result in a better quality of graduates matching more readily the expectations of their potential employers.

- Education should seek to find the compromise between academic need for breath of understanding and industry need for specialised knowledge; academia should not seek to answer to a perceived industry demand but to develop the ability to think and solve problems, to avoid indoctrinate with current methods and processes.
- The industry could help to provide direction for the development and delivery of course material in order to enable students to be more exposed to industry needs.
- When recruiting, industry would like to see someone who has a general understanding of the design aspects, can learn quickly, has good problem-solving skills in a complex environment, can think critically and laterally and articulate results. The ability to listen and communicate thoughts and ideas to others and to make and defend technical decisions can only help their chances of employment. Internships, one-year or summer industrial placements, group design projects or final year projects based on industry input, can enhance the chances of future employment by developing the skills needed by industry.
- It is difficult to establish a constant stream of information and communication between industry and university, and a tailored project such as this one seems to be an excellent endeavour.
- The assessment carried out together with industry is highly valuable, as it gives the students a taste of the real world, challenges their thought processes and gives them extra motivation, helping them to question their own work and provide a context for it. It improves the level of soft skills, making students better technically equipped for interviews.
- Industry wants to see a return on its investment, with the need for a business case for continued investment and growth, and this kind of exercise proves to be as useful for students and industry alike, giving the students a better understanding of what is expected from them in similar situations and helping them after they finish their studies.

This perspective from the industry partners was correlated with the results obtained from the students during the design exercise and with their views regarding the outcomes and effects on their development. A questionnaire was developed, based on previously published research by [9] and [10], analysing the problem-based learning efficiency. The questions highlight good teaching practices, clarity of teaching objectives and engagement, as well as assessment and workloads in relation to the development of the proposed skills for an engineering module.

The questionnaire presented above was organised into six sections: good teaching practice, clear goals formulated during the project, the assessment difficulty, workload perception, skills enhanced during the project and the efficiency of student engagement. The results are presented in Fig. 2. (see Table 1 for correlation between the x axes of the histograms and the questionnaire). The values represent the average satisfaction obtained from the student responses calculated using the metric based on [11] for each question, and outlined in Fig. 1.

The analysis of the teaching practice reveals that the activity was perceived as challenging, requiring effort to understand and integrate the knowledge for the design process. The academic and industrial

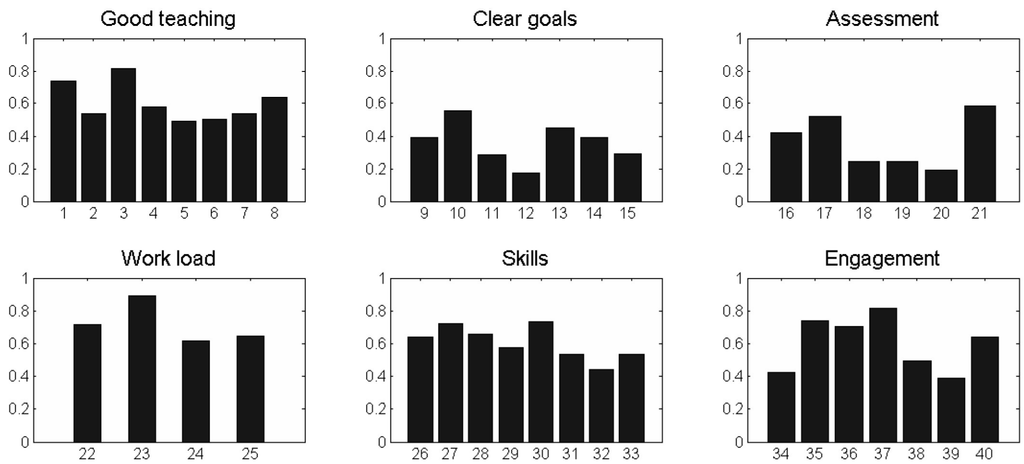

Fig. 2. Questionnaire evaluation (see Table 1 for question correspondence).

Table 1. Questionnaire criteria grouping

Criteria	Question set
Good teaching	1 to 8
Clear goals	9 to 15
Assessment	16 to 21
Workload	22 to 25
Skills	26 to 33
Engagement	34 to 40

partners were working hard to motivate the students, make the subject interesting and comment on their work, encouraging them to take ownership of the project. The aircraft design project required the application of knowledge from aerodynamics, flight mechanics, aircraft performance, etc., and filtering all of this knowledge in a creative manner at the industry level of requirement was not an easy task for students or for the academic delivering the teaching.

The fact that the design exercise was an individual task is reflected in the lower scores for the questions specific to group work, although discussion with peers during the project was helpful. The project complexity, which in its progression represents a non-linear process, is acknowledged with final goals seeming distant in different phases for the students. But these difficulties led to something special: the students learned how to plan their work better in the context of very clear requirements in terms of results and work standard.

The assessment section reveals that the design exercise required an in-depth knowledge (i.e. not just memorising things) and during the design exercise the students had the opportunity to develop their own ideas and redirect the project requirements towards their own solution.

It is recognised that the workload was high, with the students having a lot to learn and feeling the pressure to finalise the project at a high standard. But the reward was obtained through the skills developed during the project. At the end, the students felt confident that they could prepare a complex technical report, present their ideas in front of an audience and defend their work, find and analyse complex information and demonstrate an improved ability to solve difficult problems. Finally, the students enjoyed working in this way, as evidenced in the engagement section of the questionnaire.

5.1 Graphical metrics

Graphical methods to evaluate the project's success are employed here by means of residuals plots. A weighted procedure is employed by means of iteratively reweighted least squares (IRLS) on the assumption of non-constant standard deviation.

Some outliers can be easily identified within the data sets as they reside in inconsistencies with the bulk data and can dominate the regression. If dropped they can increase the correlation between the independent and dependent variables (or between the questionnaire endpoints or goals), the outliers may also contain certain questions with different interpretation by the students, hence these provide scope for further refining the questionnaire and use the best question set in order to remove doubts and uncertainties from students answers.

Looking at the numerical results and previous discussions, these are confirmed by the trends presented in Fig. 3, showing the correlation between good teaching practice and students' skills attained with the current teaching innovation, with a correlation factor of 0.8434. The results are somewhat expected since a teaching practice should always have elements of tailoring on certain goals (e.g., skills). These results are supported by the graphs in Fig. 4, 6–8 showing good student engagement throughout the project, acknowledging the opportunity for a pre-interview with the major employers in the aerospace engineering sector.

The motivation and drive of students to achieve the learning outcomes (goals) can be depicted in Fig. 5, which shows a very good correlation factor of 0.9083. Fig. 8 and 9 on engagement—work load and work load—skills dependency score amongst the strongest and weakest correlation factors of 0.9969 and 0.6041, showing a total commitment of students to the industry supported project, as opposed to their confidence in achieving a perceived skill set through an industry tailored work load. The high engagement correlation shows students' interest in grasping more the opportunity to understand and work on prospective employer's requirements. The plots show a few outliers which indicate that some questions are either badly conceived or some students were simply dissatisfied with the amount of workload they faced.

The scatter in the residuals shown in Fig. 3–9 adequately describes the systematic variation in the data, with a nearly even spread trend, apart from the regions where outliers occur. The scatter also outlines the validity of the initial error assumption of constant variance across the data in most of the cases, which would allow the OLS to perform well. But this would not suffice in drawing a silver-bullet conclusion on the fitness of the models (goals), and the IRLS technique is also performed in conjunction with the outliers present in the data. Overall, all cross goal dependencies show good degree of accuracy (i.e., correlation), underlining the teaching innovation practice was a success and provides scope for further improvement.

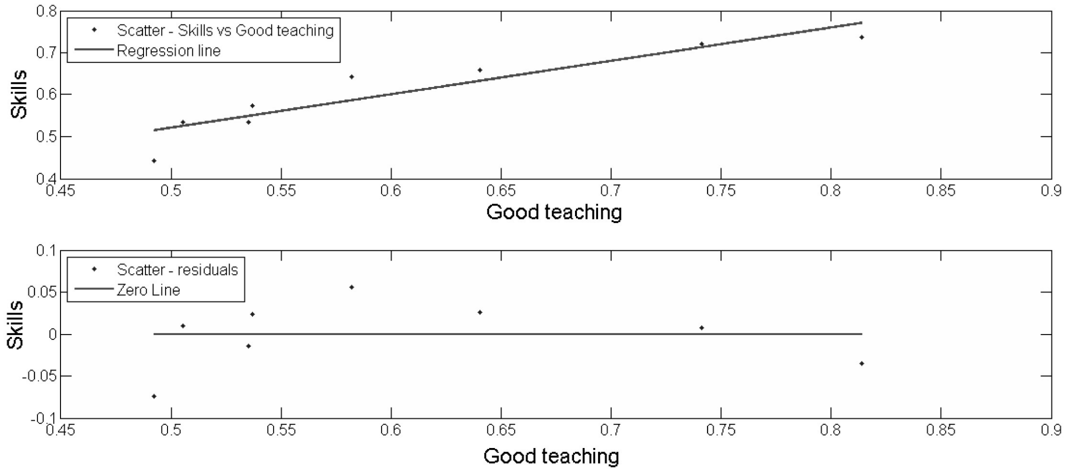

Fig. 3. Correlation between good teaching practice and skill development.

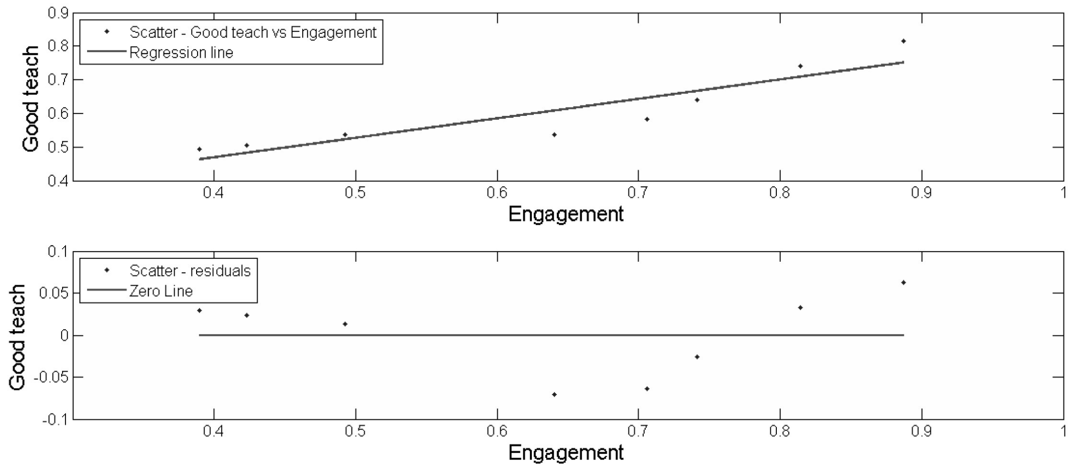

Fig. 4. Engagement vs. Good teaching.

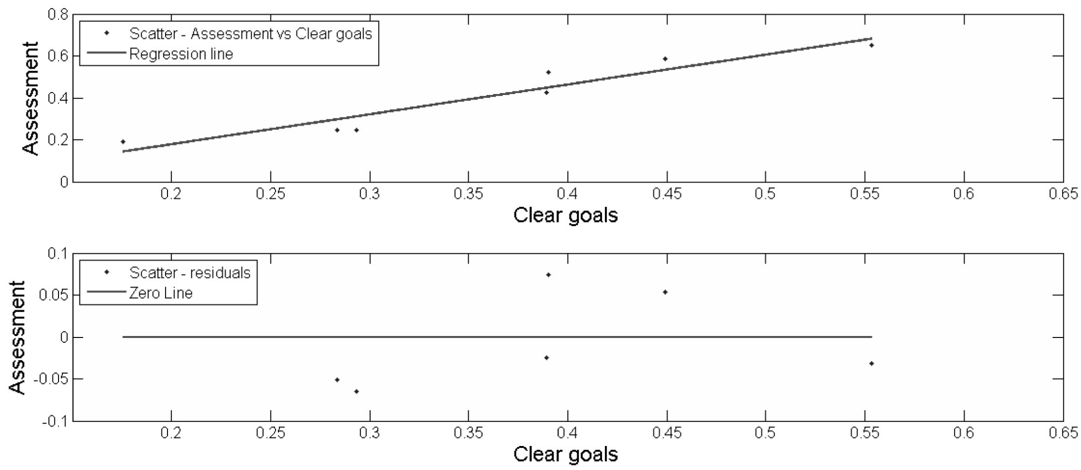

Fig. 5. Clear goals vs. Assessment.

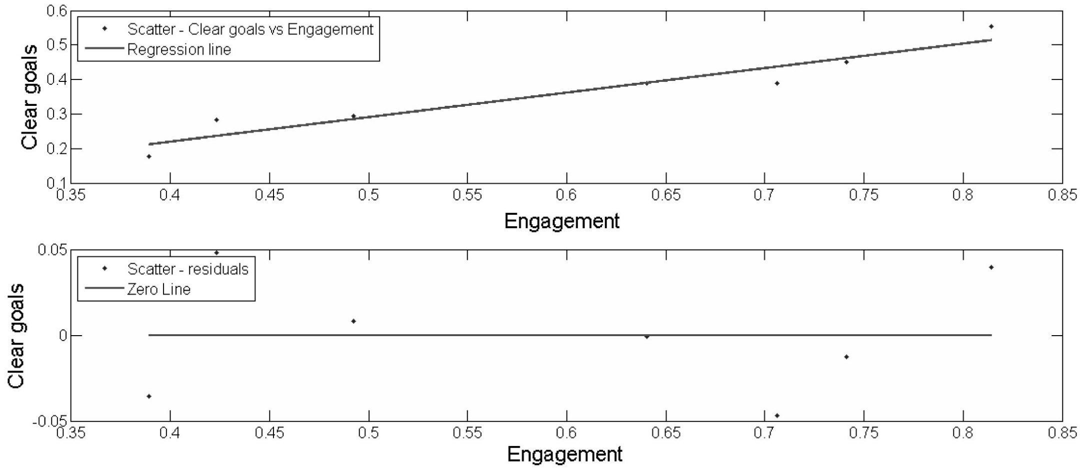

Fig. 6. Engagement vs. Clear goals.

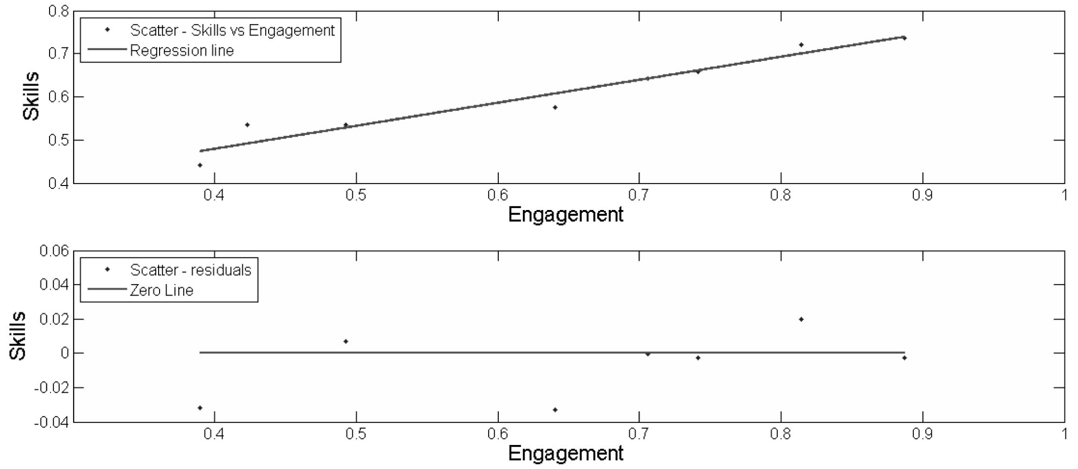

Fig. 7. Engagement vs. Skills.

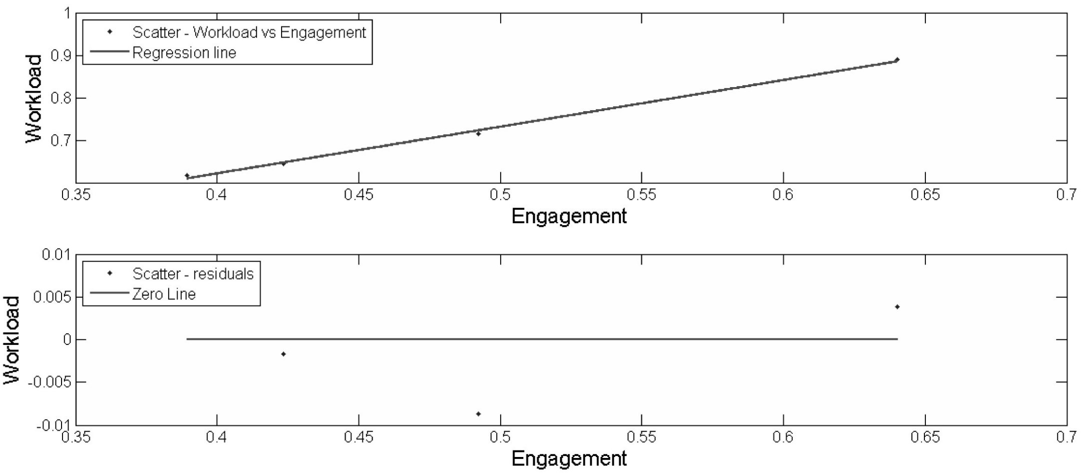

Fig. 8. Engagement vs. Work load.

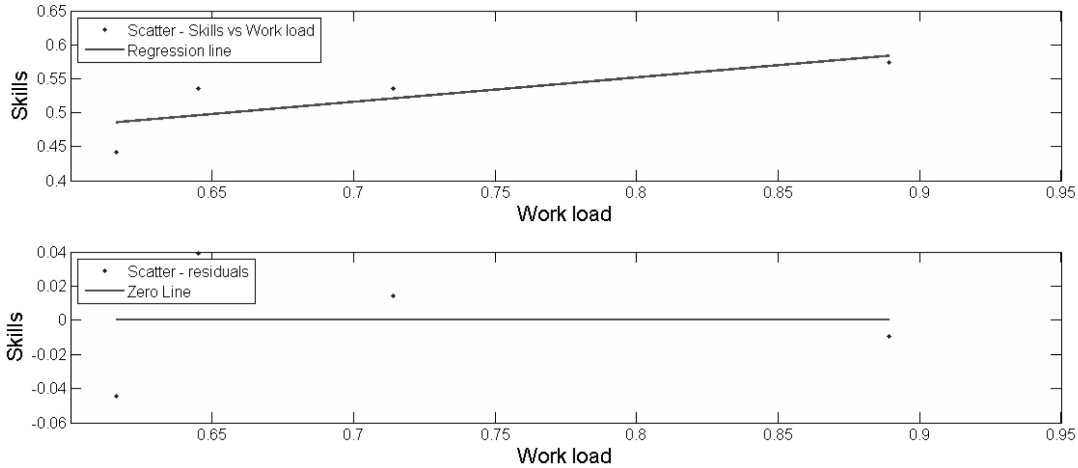

Fig. 9. Work load vs. Skills.

5.2 Numerical metrics

By means of numerical measures, the figures of merit are represented here by R^2 and root mean square error ($RMSE$). The coefficient of determination R^2 measures the variability of the prediction with the independent variable and is a non-dimensional figure with higher values, usually, leading to a better correlation of the responses. Often, however, larger correlations also occur due to data dependency, leading to residual auto-correlation and do not guarantee that the model fits the data as expected and cannot explain the underlying model. The correlation factor is defined in Equation (1) as follows:

$$R^2 = \frac{S_{f\hat{f}}}{S_f S_{\hat{f}}} = \left(\frac{n\Sigma f_i \hat{f}_i - \Sigma f_i \Sigma \hat{f}_i}{\sqrt{n\Sigma f_i^2 - (\Sigma f_i)^2}\sqrt{n\Sigma \hat{f}_i^2 - (\Sigma \hat{f}_i)^2}} \right)^2 \quad (1)$$

where S_f is the covariance between independent variable f and the approximate function $\hat{f}$ and n is the number of data points for regression.

To mitigate any false fitness, an additional statistical component is used here, namely $RMSE$, outlined in Equation (2), which is the root mean squared error exhibited by the underlying model and values closer to zero indicate a better fit:

$$RMSE = \sqrt{\frac{\Sigma w_i (f_i - \hat{f}_i)}{n-2}} \quad (2)$$

where w_i are the weights associated to the residuals.

The correlation factors for all goal dependencies outlined in Figs 3–9 are tabulated in Table 2. A set of guidelines on scales of magnitudes of the correlations is presented in [13], where it is suggested that correlation of 0.5 is 'large', 0.3 is 'medium' and 0.1 is 'small' effect. Cohen subjectively set some conventions of the medium effect, that should have a day to day natural consequence and be visible to people, whereas the small effect is 'noticeably smaller' but not trivial and the large effect should be the same distance above the medium effect as small was below it. Under these conventions, the correlations for all goal dependencies can be regarded as large, considering the noise produced by unhappy students and badly posed or perceived questions.

Table 2. Correlation metrics between different endpoints

	RMSE	R^2
Good teaching vs. Skills	0.0434	0.8434
Engagement vs. Good teaching	0.0523	0.8294
Clear goals vs. Assessment	0.0611	0.9083
Engagement vs. Clear goals	0.0389	0.9173
Engagement vs. Skills	0.0274	0.9376
Engagement vs. Workload	0.0083	0.9969
Workload vs. Skills	0.0436	0.6041

6. Conclusions

The motivation or the project is set within the context of narrowing the gap between academic vs. employer expectations in terms of hands on experience and enhancing the preparation of students engage in for the technical environment of industry. The effectiveness and efficiency of problem based learning is examined and outlined in order to provide scope for further curriculum enrichment and collaboration with industry. The investigation of the case study adopts a sound approach and high student engagement is observed with the learning process. The demands of the programme are high in terms of time and effort, yet both appear to be contributing to student motivation.

The innovation with this approach is in the use of the analysis technique and that a test that is usually applied to user satisfaction with a product can be readily applied here. The analytical paradigm is two pronged: it converts a core qualitative survey into quantifiable metrics in order to be in line with engineering standards, and also provides scope to identify outliers within the survey statements and questions so that the survey can be further defined and refined. The analysis provides evidence of designing and adapting student learning activities particularly in relation to student engagement and employability, with an effective focus made on the design and quality of assessment.

The increase in student employability represents a strategic programme for the *School of Engineering and Design* and the success of this project means that this will continue as an exercise to enhance the student experience, learning from its triumphs and challenges alongside our industrial partners.

This project sets a new strand in teaching innovation and is a model for bridging the skills gap between academia and industry. It reinforces the learning outcomes which form the basis for accreditation of engineering programmes in the sense that it requires planning self-learning and improving performance, the ability to operate in a multidisciplinary context, exercising their judgement, using computer software in design and demonstrating creativity in formulating a design solution.

By developing similar teaching innovation projects, a stronger partnership can be achieved with key industry players so that companies' standards can be implemented into the curriculum to develop students who are suitable for current market industry needs and better prepared for the engineering solutions in the complex socio-economic environment of the future.

Also, the innovative analysis technique is proved to have been applied more widely to module evaluation, and it provides scope to further be applied to a programme of study that has existed for a while, and it would be able offer priority areas for programme enhancement.

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References

1. A. Cade, *Employable Graduates for Responsible Employers*, Higher Education Academy, York, 01 February 2008.
2. CBI, *Stepping Higher: Workforce Development through Employer-Higher Education Partnership*, Higher Education Academy, York, 01 October 2008.
3. CBI, *Working Towards Your Future: Making Most of the Time Spent in Higher Education*, CBI, London, 2011.
4. E. Ehiyazaryan and N. Barraclough, Enhancing Employability: Integrating Real World Experience into the Curriculum, *Education and Training*, **51**(4), 2009, pp. 292–308.
5. K. Lowden, S. Hall, D. Elliot and J. Levin, *Employer's Perception of the Employability Skills of New Graduates*, Edge/SCRE Centre, 2011.
6. M. Yorke and P. Knight, Embedding Employability into the Curriculum, *Learning and Teaching Support Network,* Oxford, 2004.
7. F. Lamb, C. Arlett, R. Dales, B. Ditchfield, B. Parkin and W. Wakeham, *Engineering Graduates for Industry*, The Royal Academy of Engineering, London, February 2010.
8. R. Graham, *Achieving Excellence in Engineering Education: the Ingredients of Successful Change*, The Royal Academy of Engineering, London, March 2012.
9. P. Ramsden, *Learning to Teach in Higher Education*, 2nd Ed., Routledge, London, 1996.
10. I. Moore and S. Poikela, Evaluating Problem-based Learning Initiatives, in T. Barrett and S. Moore (eds), *New Approaches to Problem-based Learning*, Routlege, London, 2010.
11. A. Mousavi, P. Adl, R. T. Rakowski, A. Gunasekaran and N. Mimezami, Customer Optimisation Route and Evaluation (CORE) for Product Design, *International Journal of Computer Integrated Manufacturing*, **14**(2), 2001, pp. 236–243.
12. J. C. Mowen, *Consumer Behaviour*, 3rd Ed, Macmillan, London, 1993.
13. J. Cohen, A Power Primer, *Psychological Bulletin*, **112**, 1992, pp. 155–159.

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