HELPING STUDENTS TRANSITION FROM GROUP WORK TO INDIVIDUAL PROJECTS

Laura J Leslie, Sarah Junaid

Mechanical Engineering and Design, Aston University

Paul C Gorman

Languages and Social Sciences, Aston University

ABSTRACT

Previous research conducted at Aston University revealed that students found it difficult to transition from a group, CDIO-based projects in earlier study years to working independently on their individual final year projects (FYPs). The aim of this study was to explore whether the required skills that we try to develop through group CDIO projects can be sufficiently recognised by students and whether their confidence levels match staff perceptions regarding those skills. Over two academic years, students in their final year of study across our Mechanical Engineering degree programmes completed questionnaires at the start (QNR1, n=109) and end (QNR2, n=74) of their year in order to obtain their confidence levels in skills related to the CDIO standards. Students were also evaluated on skills by their academic project advisors at the end of their FYPs (n=84). The results show that in almost all cases, students were more confident in their own abilities than staff perceived their abilities to be. The greatest differences were found in 'Leadership' (50 % difference) and 'Critical Thinking' (41 % difference). Results from QNR2 (2016/17 and 2017/18) showed a reduction in confidence levels by the students, indicating that their self-evaluation of skills had reduced following individual FYPs. This academic year we have attempted to prepare students more for the challenge of the final year and bring their expectations and preparations more into line with the academics' perspectives. The results show that student confidence levels were lower this year in QNR1, reflecting what may be a more realistic outlook on their abilities. We also explored what other factors affect student confidence and abilities, including their active use of the CDIO process. We conclude that students find it difficult to transfer skills to their FYP and that staff intervention can bring their expectations and confidence to a more realistic level, and assist the transition.

KEYWORDS

Skills development, Project-based-learning, Problem-based-learning, Mechanical Engineering, Standards: 1, 2, 3, 5, 7, 8, 10, 12.

INTRODUCTION

Students in Mechanical Engineering and Design at Aston University have a unique learning and teaching environment, where the CDIO philosophy is discussed, and the acronym employed, by staff and students from week 1 of study. The Conceive-Design-Implement-Operate process is put into place for students to work through in a series of mini exercises that build into four major project modules over the first two years of study. Then, in the final year of study, students work individually on their own projects, named Final Year Projects (FYPs), with an academic advisor to help guide them.

Independent learning and students' abilities in this skill has been debated in the UK higher education sector and beyond (Hockings, Thomas, Ottaway, & Jones, 2018). Research has shown that students struggle with the transition from School to University, particularly in terms of their ability to learn independently (Thomas, Hockings, Ottaway, & Jones, 2015) and they have high expectations of the levels of academic support in their learning (Lai, Yeung, & Hu, 2016). Previous work at Aston identified that students struggled with the transition from group projects to their individual FYPs, feeling ill-prepared (Leslie, Gorman, & Junaid, 2018). Confidence levels dropped during the final year and students felt that although their FYP was their responsibility, they relied on their advisor throughout the project phases.

The aim of this research was to determine how students rate their abilities, how this may differ from the staff perspective and to identify key factors related to skills confidence. This was achieved through the following objectives:

- Asking students to rate their confidence in a range of CDIO related skills
- Asking staff to rate their students in those skills
- Comparing the staff-student confidence
- Identifying key skills/attributes which were linked to performance
- Equipping students with the mindset and realistic approach to independent work

METHODOLOGY

Over the academic years if 2016/17, 2017/18 and 2018/19, two questionnaires, QNR1 (n=109) and QNR2 (n=74) were completed by three cohorts of students. QNR1 was delivered at the beginning of the students' final year of study, and QNR2 towards the end of the academic year. These QNRs coincided with the students embarking on their individual FYPs and after submission of the FYP dissertation.

The QNRs were designed using a combination of multiple-choice 5-point Likert scale statements and open-ended questions, allowing the student participants the opportunity to provide qualitative comments that go beyond the scope of the questions. Questions and topics for the QNRs are shown below. Topics and skills were collated based on an analysis of the CDIO Standards (The CDIO Initiative, 2010). Also collected were data around student identity including gender and future plans, as well as FYP grades and final degree classification where possible. The following statements were included in the QNR as the key skills to measure in terms of their confidence levels:

- Type of planner (Always plan, Try to Plan, Always Run Behind)
- Use of logbook
- Time on FYP (Planned and Actual)
- Frequency of meetings with FYP academic advisor (Planned and Actual)

- Responsibility and Input from academic advisor
- Logbook use
- Target grade and confidence in achieving
- Use of CDIO process
- Confidence in skills
    - Knowledge discovery
    - Engineering reasoning
    - Apply engineering science in design-implement projects
    - Consider technology during product development
    - Professional ethics
    - Self-awareness of knowledge and skills
    - Problem-solving
    - Scientific thinking
    - System thinking
    - Creative thinking
    - Critical thinking
    - Work to professional standards in an organisation
    - Teamwork
    - Communication
    - Communication in foreign languages
    - Leadership
    - Project management
    - Develop conceptual plans
    - Develop technical plans
    - Develop business plans
    - Consider wider concepts during a project (e.g. enterprise, business and society)
    - Define customer needs
    - Consider regulations during product development
    - Create designs, i.e. plans, drawings, and algorithms
    - Transform a design into a product, process, or system

Focus groups with small numbers of students in each cohort were also conducted after submission of QNR2 by a member of non-teaching staff whom the students could speak freely with.

Statistical analysis was performed with Excel (Microsoft Ltd.) using Mann Whitney test and SPSS (IBM Ltd.).

Ethical approval was gained from the local ethics committee at Aston University.

RESULTS AND DISCUSSION

Students Confidence in Skills

Students' confidence levels in a variety of skills were self-assessed via QNRs, with the results showing a variety of confidence levels across the skillset. In the first two years of this study (2016/17 and 2017/18 respectively), confidence levels fell or stayed the same for 14 out of 25 skills during between QNR1 and QNR2, as shown in Figure 1. Most notably confidence fell for 'Project Management' (19 %) and 'Professional ethics' (10 %). Also, the students' confidence in achieving their desired grade fell between QNR1 and QNR2 (Figure 2). The data that

indicated this fall in confidence was reinforced by the findings of the student focus groups, with student discussion frequently indicating a perceived academic step change from heavily supported group work in years 1 and 2 to their individual FYPs. Overall, many of the students indicated that they found themselves ill-prepared for this independent working style.

However, students increased in confidence overall for 11 of the 25 skills, with most notable increases in 'Scientific Thinking' (20 %) and 'Consider Regulations' (14 %). It is argued that the skills that were most used during their FYPs may have improved their confidence. It is also contended that the added effect of time lapse between skills actually being used could also have impacted on confidence. This could explain why there was a drop in confidence regarding 'Teamwork' due to a lack of team-focused projects in the final year, despite their CDIO experiences in the first two years of study. Research by Ericsson et al. highlighted the need for what he calls 'Deliberate Practice' to build expertise, which includes the importance of regular and focused practice (Ericsson et al. 1993; Nandagopal & Ericsson 2012). This may go some way to explain why confidence levels varied across the skills. Further analysis of individual responses may help, however, it is beyond the scope of this study. Furthermore, despite the differences observed, they were not statistically significant and therefore would require further qualitative analysis.

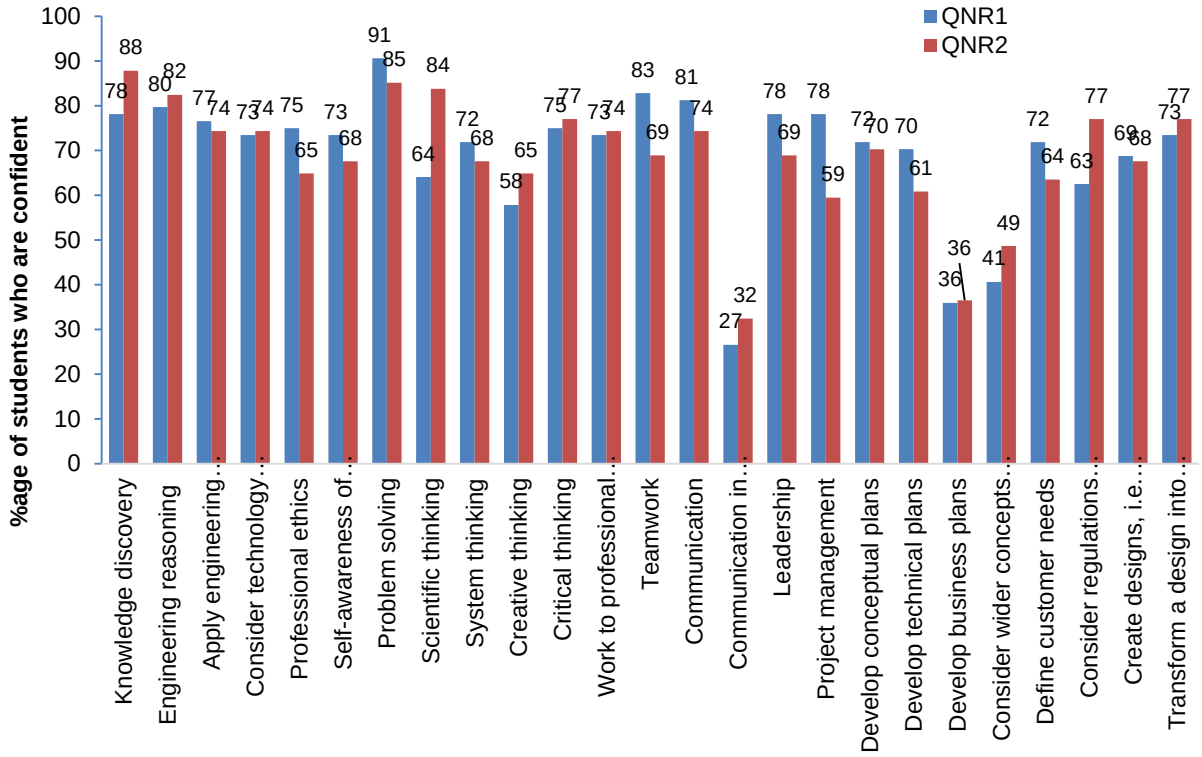

Figure 1. A graphical representation of the percentage of students with confidence in each skill listed in both QNR1 and QNR2 (data from 2016/17 and 2017/18).

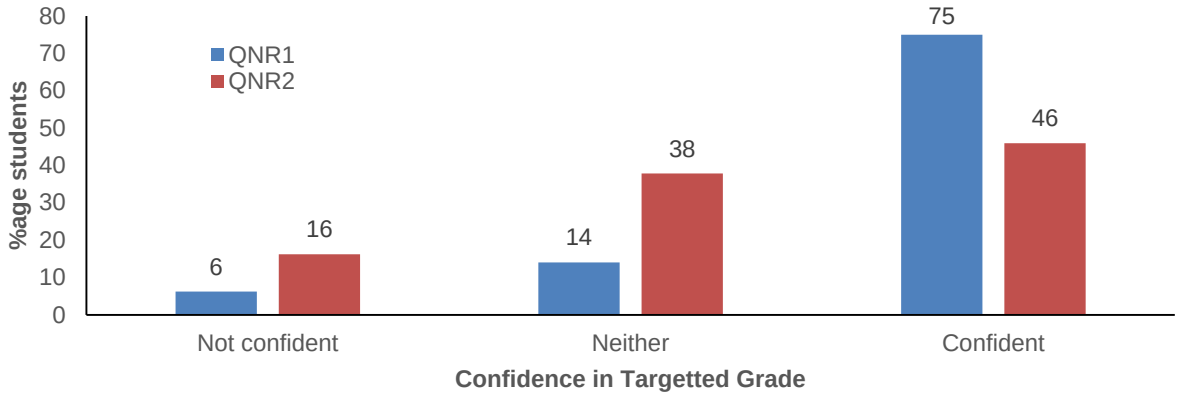

Figure 2. Student confidence in achieving target grade. Results from QNR1 and QNR2. Results show students have less confidence at the end of their FYP than at the beginning.

Staff Confidence in Skills – A Comparison Study

Comparing the confidence levels from the students' answers to the academic advisor's perceptions showed significantly contrasting data ($p < 0.05$), with staff predominantly showing less confidence in students' abilities (Table 1) in the majority of skills listed. The greatest differences between student and staff confidence levels were found in 'Leadership' at -50 %, 'Critical Thinking' at -41 % and 'Problem Solving' at -36 %. Whilst these are only perceptions of skill levels, it was interesting to observe the differences between staff and student evaluations. These findings, combined with data from our focus groups, provided additional evidence to support the theory that students were often not prepared for the level of skills required for their FYPs. However, it may also be possible that the supervisors may place higher expectations than should be expected for engineering students.

There is a growing body of work that explores the interplay between confidence and competence. Noel Burch's Conscious Competence Ladder (Burch, 1970) identifies four stages of competence: unconsciously unskilled (being unaware of what you don't know), consciously unskilled, consciously skilled and unconsciously skilled (being unaware you have a skill). Using this model to explain the results of this study, two theories emerge. The first: it is possible that more students transition from an unawareness of their skills to an awareness of their skills level, which impacts on their confidence levels (Figure 1). An additional theory is that the supervisors themselves may be unconsciously competent and may, therefore, be unaware of the learning journey needed to acquire some of the skills listed. It is perhaps difficult for a highly skilled person to retrospectively recall the process of learning a skill, particularly with the accumulation of time and experience. This may be reflected in the difference in confidence (Table 1). It may be a combination of these two possibilities, however, it is beyond the scope of this study and would need to be explored further.

Table 1. Difference in confidence between students and supervisors in the skills list from the QNRs. Large differences in confidence are shown for most skills.

Percentage Difference in Confidence	Skill
4.2	Knowledge discovery
-18.8	Engineering reasoning
-25.3	Apply engineering science in design-implement projects
0.8	Consider technology during product development
-12.9	Professional ethics
-30.5	Self-awareness of knowledge and skills
-35.6	Problem solving
-33.3	Scientific thinking
-24.1	System thinking
-17.7	Creative thinking
-40.6	Critical thinking
-14.1	Work to professional standards in an organisation
-24.6	Teamwork
-22.5	Communication
-49.9	Leadership
-33.5	Project management
-12.4	Develop conceptual plans
-11.4	Develop technical plans
0.0	Develop business plans
-6.5	Consider wider concepts during a project (e.g. enterprise, business and society)
-16.5	Define customer needs
-3.1	Create designs, i.e. plans, drawings, and algorithms
-5.4	Consider regulations during product development
-10.3	Transform a design into a product, process, or system

Identifying key skills/attributes which were linked to performance

In order to identify key skills and attributes associated with performance, a number of cross tabulations were conducted from the results of the QNRs using SPSS.

Students are offered a number of FYP titles prior to the project, however, it is often not possible for all students to be given their first choice due to over popularity of certain projects. Data from the QNRs compares whether being given a first choice of FYP affects both the students' confidence in achieving their grade and the degree classification they actually achieved. Table 2 shows that students who were given their first choice of FYP were more confident at the end of the FYP about achieving their grade. However, Table 3 shows that there was very little difference in the actual degree classification achieved between students tackling their first or second choice of FYP.

This mismatch between confidence and attainment could also be linked to the students' self-evaluation of skills, with students only feeling confident in areas they are more familiar with and not having full realisation of the transference of skills between project themes.

Table 2. Cross tabulation of students who received their first choice FYP topic and their confidence in their target grade.

		Target Grade		
QNR	**Project Choice**	**1st (70+ %)**	**2.1 (60-69 %)**	**2.2 (50-59 %)**
QNR1	1st choice	80.0 %	20.0 %	0.0 %
	2nd choice	75.0 %	22.5 %	2.5 %
QNR2	1st choice	58.0 %	38.0 %	4.0 %
	2nd choice	33.3 %	62.5 %	4.2 %

Table 3. Cross tabulation of students who received their first choice FYP topic and their achieved degree classification.

	Target Grade			
Project Choice	**1st (70+ %)**	**2.1 (60-69 %)**	**2.2 (50-59 %)**	**3 (40-49 %)**
1st choice	23.1 %	38.5 %	30.8 %	0.0 %
2nd choice	23.8 %	33.3 %	23.8 %	9.5 %

Table 4 compares the type of planner students identified themselves as with the degree classification they achieved, showing that 'Planners' achieved better degree classifications than those who are always running behind. This suggests that the ability to plan and project manage was a key skill and that those who recognised this as a strength were more likely to attain a higher degree classification.

Table 4. Cross tabulation of the type of planner students identified themselves as and their degree classification.

	Target Grade			
Type of Planner	**1st (70+ %)**	**2.1 (60-69 %)**	**2.2 (50-59 %)**	**3 (40-49 %)**
Always Plan	26.1 %	34.8 %	39.1 %	0.0 %
Try to Plan	23.5 %	35.3 %	20.6 %	5.9 %
Always Run Behind	0.0 %	66.7 %	33.3 %	0.0 %

Students were also asked in QNR2 if they had used the CDIO process in their FYP. 84 % of students used CDIO to some extent (Figure 3). This is an indication of how the projects in earlier years have given the students a process that they can use through the CDIO method of working.

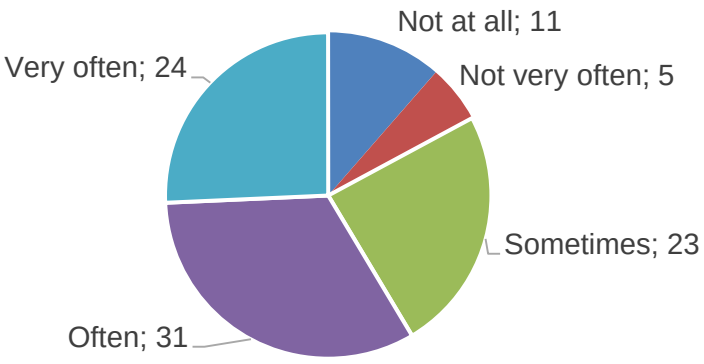

Figure 3. Students were asked in QNR2 if they had used the CDIO process in their FYP.

Equipping students with the mindset and preparing them for independent work

In the 2018/19 academic year, academic staff held a taught session aimed to help students identify the differences between group and individual projects and to emphasise the responsibility of the student in the FYP as opposed to in the previous group projects in earlier years of study. Figure 4 compares the confidence levels between the 2016/17 and 2017/18 cohorts, and the 2018/19 cohort following the intervention. The results show significantly lower confidence levels in 2018/19 ($p < 0.05$), which may be attributed to the 'skills' session hosted at the start of the FYP. This was intended to help students be better prepared for their individual FYPs and to have a more realistic evaluation of their own skills and abilities. In addition, the aim was for students to have a better awareness of how their skills could be transferred across projects.

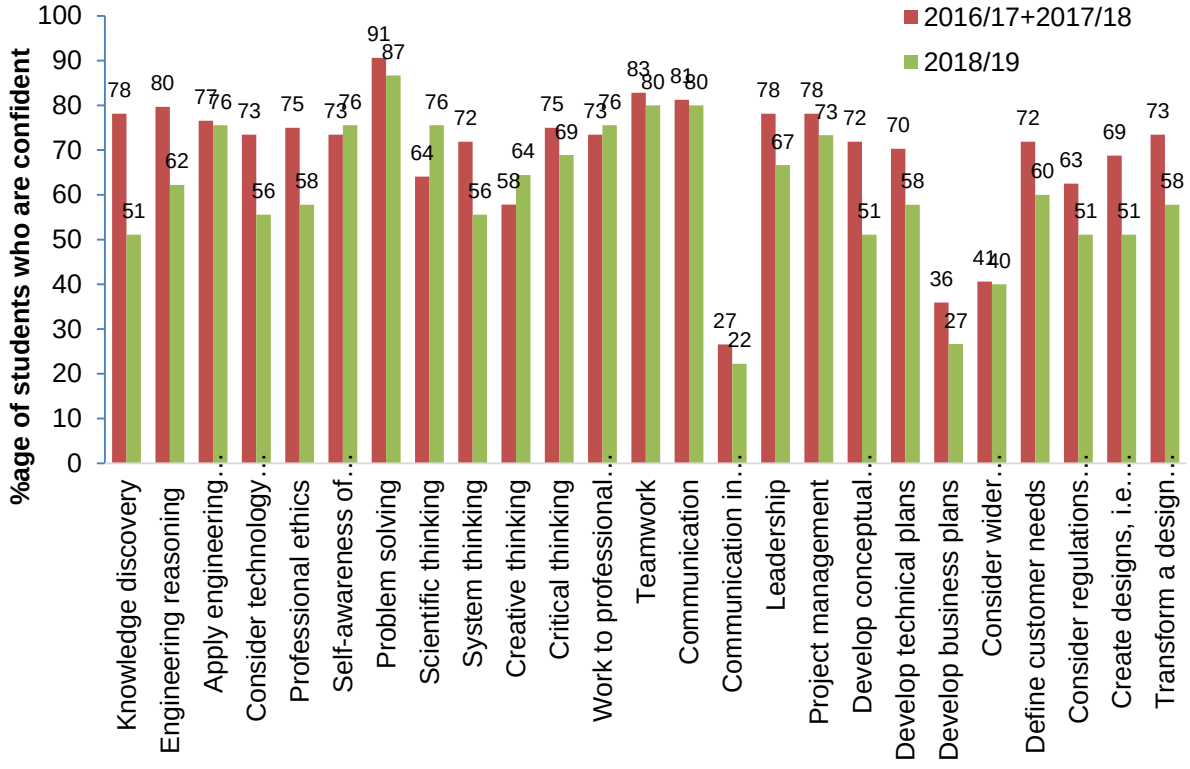

Figure 4. The percentage of students with confidence in their skills was higher in earlier years. Following the intervention of providing more detail and discussing the skills required for their FYPs in 2018/19, the confidence in skills at the start of the FYP is lower than in previous years.

CONCLUSIONS

The aim of this research was to determine how students rate their skills and abilities, how this may differ from the staff perspective and to identify key factors related to skills confidence. This was achieved through analysis of questionnaire results across 3 cohorts in their final year of study, focusing on the start and end of their FYPs, a major part of a students' Mechanical Engineering degree at Aston. An intervention was also carried out in order to aid students in

understanding the difference between group and individual work, and to appreciate how their skills could be transferred between different projects, enabling them to better self-evaluate their skillsets.

Key findings were as follows:

- Student confidence levels in their skills and abilities generally fell across the final year of study, indicating a drop in confidence when transitioning to an individual FYP
- There was disparity between the staff and student confidence in student skills, potentially indicating that students may be over confident in their abilities when facing an individual FYP, and perhaps staff may have high expectations on skill levels
- The key skill linked to performance is confidence in time management and the ability to plan
- Engaging with students to discuss their skills, the difference in types of projects and the transference of skills may be beneficial to students' appreciation of individual work and an awareness of how skills can be transferred between projects

Our conclusion is that the FYP can create a seemingly negative effect on student confidence, which we wish to avoid, through a more realistic self-evaluation of skill level and an appreciation of the different types of projects an engineer may face. An intervention can help students prepare for the differences in their FYP compared to previous group work and allow a more self-aware and self-reflective approach where individuals are better equipped to handle different projects and potentially increase success.

REFERENCES

Burch, N. 1970. Gordon Training International, URL http://www.mccc.edu/~lyncha/documents/stagesofcompetence.pdf, [Accessed: February 2019].

Ericsson, K. A., Krampe, R. Th., Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100 (3): 363-406.

Hockings, C., Thomas, L., Ottaway, J., & Jones, R. (2018). Independent learning–what we do when you're not there. *Teaching in Higher Education, 23*(2), 145-161.

Lai, C., Yeung, Y., & Hu, J. (2016). University student and teacher perceptions of teacher roles in promoting autonomous language learning with technology outside the classroom. *Computer Assisted Language Learning, 29*(4), 703-723.

Leslie, L., Gorman, P., & Junaid, S. (2018). *FROM GROUP TO INDEPENDENT PROJECT WORK: DOES CDIO PREPARE LEARNERS?* Paper presented at the CDIO 2018, Kanazawa Institute of Technology, Japan.

Nandagopal, K. & Ericsson, K. A. (2012). An expert performance approach to the study of individual differences in self-regulated learning activities in upper level college students. Learning and Individual Differences, 22: 597-609.

The CDIO Initiative (2010). The CDIO Standards v2.0, URL www.cdio.org, 8th December 2010 [Accessed: September 2015]

Thomas, L., Hockings, C., Ottaway, J., & Jones, R. (2015). Independent learning: student perspectives and experiences. *Higher Education Academy. URL https://www. heacademy. ac. uk/knowledgehub/independent-learning-student-perspectives-and-experiences*.

BIOGRAPHICAL INFORMATION

Laura J Leslie, Ph. D. is a Senior Lecturer and Head of Mechanical Engineering and Design at Aston University. Her research fields are in learning and teaching, as well as Biomedical Engineering and Materials. She has a particular interest in CDIO, active learning, teaching large cohorts and student centred learning.

Paul C Gorman is a sociology PhD student at Aston University. His research is centred on the marketisation of Higher Education in England. He has presented at numerous international Higher Education conferences over the last ten years.

Sarah Junaid, Ph. D. is a Lecturer and subject group Learning Enhancer in Mechanical Engineering and Design at Aston University, UK. Her pedagogical research interests include student learning, engineering ethics and professional skills development. She is Head of the Biomedical Engineering research group with an interest in biomechanical testing and computational modelling within orthopaedics.

Corresponding author

Dr Laura J Leslie
Mechanical Engineering and Design
Aston University
Birmingham
B4 7ET
UK
+44 121 204 3747
l.j.leslie@aston.ac.uk