Analysis of Evolving Graduate/Transferable Skills in Aircraft Engineering Education

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Abstract: The specification of the degree in aircraft engineering defines a set of skills and attributes that are underpinned by industry demand. Implementation of appropriate teaching and learning strategies to achieve such skills has been a key success in the evolvement of the skills in university education. In addition, evaluation procedure for determining the importance and acquisition of skills and competencies by students was a key focus in the current study. To evaluate students' self-reflection in skills development, and the way they acquire the identified skills and abilities, a purpose-made survey was designed and conducted. The survey consists of a score-based questionnaire, where students gauged their perception of skill development through the teaching and learning methodology implemented within the course of study. The survey (and its results) demonstrated the opportunity given to students to self-reflect and recognise the importance of skills audit. Furthermore, in the case of subject-specific skill set there is a strong correlation between the development of the skills and the learning contents. The input of industry to the teaching contents partially justifies such correlation.

Keywords; aircraft engineering, higher education, degree programme, transferable skills, graduate skills, employability, skill survey.

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1. INTRODUCTION

According to Gutierrez Ortiz et al. (2021) engineering graduates will be working in an increasing complex, fast changing and uncertain world of employment. The teaching and learning strategy at UWS (University of The West of Scotland) aircraft engineering development included aspects of design activities that are not only oriented on specific learning outcomes, but also to include and facilitate transferable skills serving graduates' employability. O'Donnell et al. (2017) list and discuss two sets of transferable skills that are considered to be essential for aircraft engineering graduates; i) a sound technical knowledge of the core subjects of aircraft engineering, and ii) abilities to perform effectively and efficiently in work environment by means of effective communication, strong team-working, decision making and business and commercial awareness in engineering. The aircraft engineering industry for example, requires graduates with subject-specific technical knowledge in different areas. These areas may include; components and system design of aircraft, testing, simulation and avionics, repair and maintenance of aircraft, and also, aviation business awareness (Lappas et al., 2016).

In conjunction with the core discipline knowledge, the aircraft engineering curriculum at UWS provides graduates not only for the aircraft-specific sector but also, covers a variety of engineering fields including; mechanical design, energy and renewables, offshore, automotive, defence, etc. The embedment of transferable skills initially occurs through the diversity in core disciplines, in which aircraft engineering students share parts of their learning alongside students from other programmes, e.g. mechanical engineering. As well as the core aircraft engineering disciplines, students undertake broad-based mechanical engineering subjects. As such, students are exposed to a blend of mechanical and aircraft engineering problems, case studies, projects, and laboratory/workshop works. Case studies and projects in particular tend to provide a greater support for the development of transferable skills (The Royal Academy of Engineering, 2007; Nelson et al., 2017).

2. SKILLS EVALUATION SURVEY: METHODOLOGY

A survey tool was designed and utilised to scale students' perception on the development of certain critical skill sets and competencies linked to their programme of study. The data gathered demonstrate students' perception and reflection on the level of confidence and preparation they felt with respect to dealing with aircraft engineering subject matters. Both quantitative and qualitative data were collected concurrently by means of score-based questionnaire (Table 1). The design of questionnaire and its scale-based system resemble the one that was developed and used by Lucas-Yagüe et al. (2011). The lists of skills – presented in Figures 2, 3, 4 – that are included in the questionnaire were informed by the authors' previous studies (O'Donnell et al., 2017; Rakhshani, 2012). The types of knowledge and skills compiled in the questionnaire were selected on the basis of their importance, relevance and use in employment after graduation. The skills in the questionnaire were evaluated by a scoring scale of 1-to-5 in two different aspects; a) importance of the skill, and b) level of skill development (acquisition) (Table 1). The first 10 skill set is clustered into a general category, where the second and third clusters included discipline-specific and competence categories respectively. The Quantitative data were sampled to assess the number (percentage) of students attaining certain skills in the given category. The qualitative data were collected to assess the level of attainment of the skills and their importance (to the participants) to the ultimate graduate/employability attributes.

1=very low	*2=low*	*3=moderate*	*4=high*	*5=very high*
General Skills				
skills, ability and competence		***Importance***	***Acquisition***	
Ability to apply engineering principles to design, development and research activities		*1 – 2 – 3 – 4 – 5*	*1 – 2 – 3 – 4 – 5*	

Table 1 Example of questionnaire scoring form

2.1 Participants

Two student groups of participants were invited to take part in the survey. They comprise of undergraduate students studying aircraft engineering at level 9 (year 3, L9) and level 10 (year 4,

L10) at UWS. Level 9 students are at the stage of completing their BEng degree course, where level 10 students are at their BEng Honour completion stage. The time of survey was chosen to be at the end of trimester two where all teachings were ended, so students could elaborate upon their skill development more conclusively. There was a total number of 67 students at both levels, of which 31 participants at level 9, and 36 at level 10.

3. FINDINGS AND DATA ANALYSIS

The aim of the current study is to assess and evaluate students' perception on skills and knowledge gained by aircraft engineering students at UWS. It will help identify existing gaps between graduates' attributes gained from the course/programme of study and what is actually needed for workplace. In many instances such gaps are reported by employers (Sarkar et al., 2016). Respondents' score to each skill (within each category) is a reflection to the level of how well a skill is developed/acquired as a result of teaching and learning, and other extracurricular activities. Industry placements and project collaborations, academic and career advice are examples of the extracurricular activities provided by the aircraft engineering programme at UWS.

The survey in the current study has indicated that there is a relative gap between skills that students developed from aircraft engineering degree programme and what they perceived as important to them. The responses of L10 students to skill sets at score scale 5 for both importance and acquisition aspects – for each given category (general, competence, subject-specific) – were averaged, and the overall percentage of each category is presented in Figure 1. It is evident that the majority of students agree on the level of importance of the required skills at scale level 5 (very important).

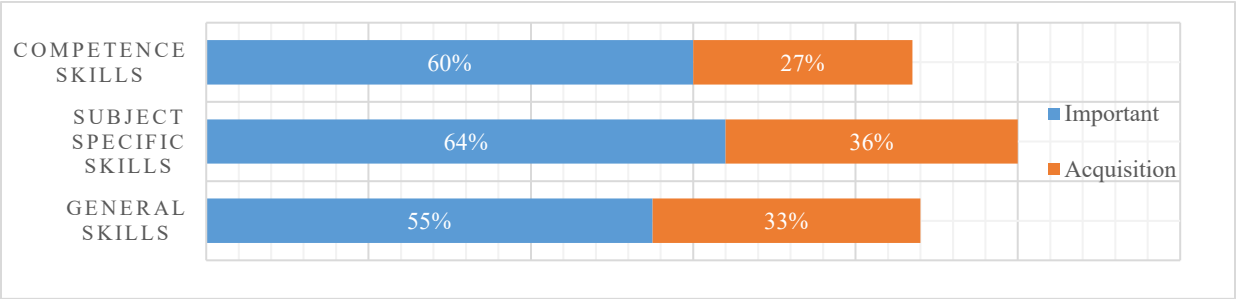


Figure 1 Comparison of averaged skill scores by L10 students: important vs acquisition

The results presented in Figure 1 represent a gap between what students saw as an important set of skills for their career development and what actually they believe they have achieved. Note that the embedded skills in the curriculum by no means are comprehensive and may not always satisfy the criteria required by students and/or employers. Similarly, in a survey, science degree undergraduate students from a number of Australian universities have reported a significant disagreement between skills/attributes they saw important to their employment and those that they have gained through their course (O'Byrne et al., 2008; O'Byrne and Mendez, 2012). Such gaps often occur when there is a mismatch between skills offered in education and those required by employers (ISC, 2019).

3.1 Skill categories scoring analysis

Figures 2 – 4 present the scores to skills at given categories. Note that these scores are at scale 5 and for the acquisition aspect comparing the responses between L10 and L9 students. It is evident that the acquisition of all sets of skills at scale 5 was better performed by L10 as a group. This confirms that there has been a consistent skill development pattern across degree levels, i.e. students at higher level are more confident with their skill development. Such higher percentages of responses by L10 students may well be due to two facts; a) they are more mature and, b) the level 10 of the course/programme has provided more advanced opportunities to develop the skills in question.

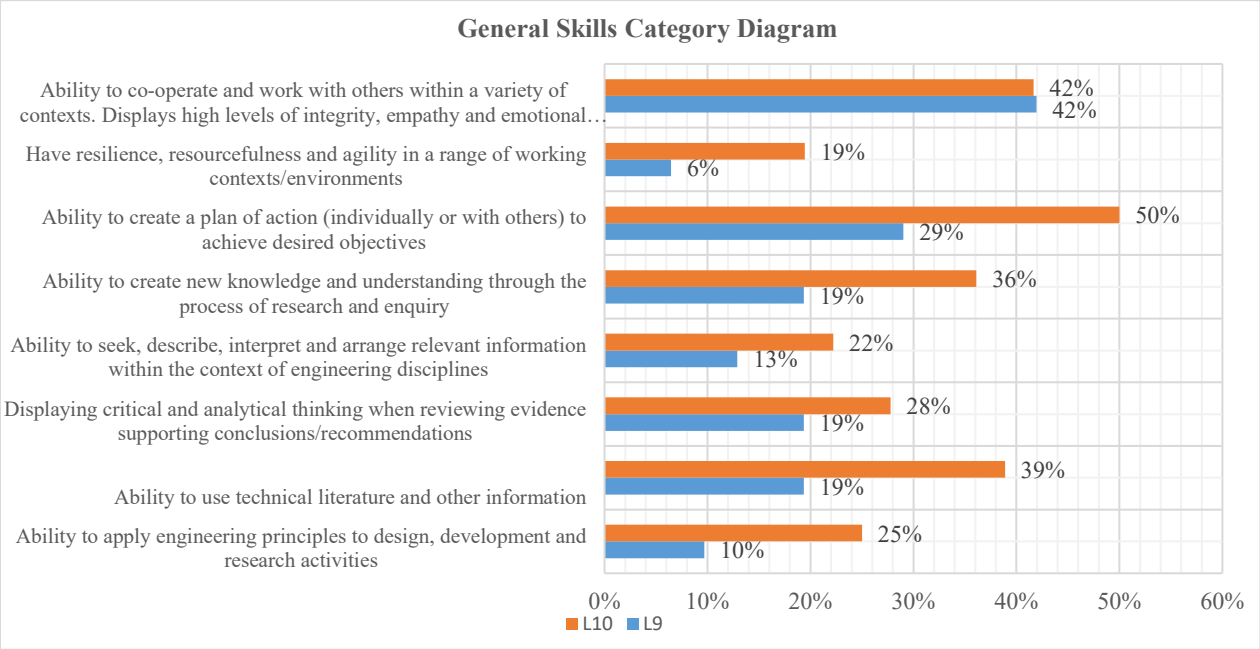


Figure 2 Percentage of skills acquisition scores at scale 5 – general skills

The responses of L10 students consistently overcome L9 across all skill sets/categories by a significant margin in some cases. Factors that may have contributed to such scores are; level 10 students have benefited from industrial placement compared to those from level 9 who haven't had any placement undertaken; level 10 final year engineering project has provided additional opportunities – especially in the case of general skills, where 50% of responses were recorded for item " Ability to create a plan of action (individually or with others) to achieve desired objectives" – pointing to relevance of skills developed during completing a project; level 10 study modules/subjects provided more in-depth discipline-focused knowledge and information with the embedded skills (50% responded to item "Ability to apply aerodynamic theories to conduct aircraft design computations and analysis").

Qualitatively, the data in Figures 2 – 4 indicate the extend of which students recognise and prioritise the importance and development of the skills given in the survey. The ability to rate the skills is an opportunity for students to self-reflect and audit their employability preparedness. Hence, integrating skills in university degree programmes can be seen as a way of addressing the types of skills required by industry (Smith et al., 2018; European Commission, 2016).

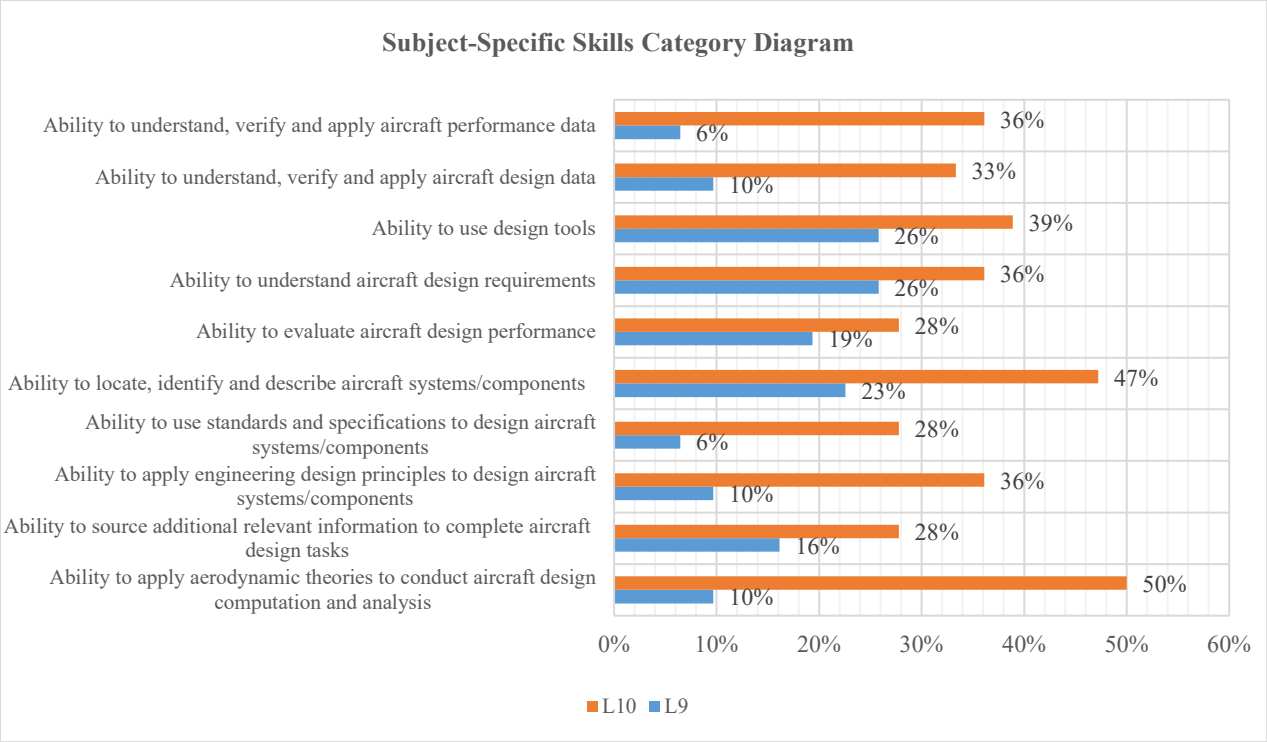


Figure 3 Percentage of skills acquisition scores at scale 5 – subject specific skills

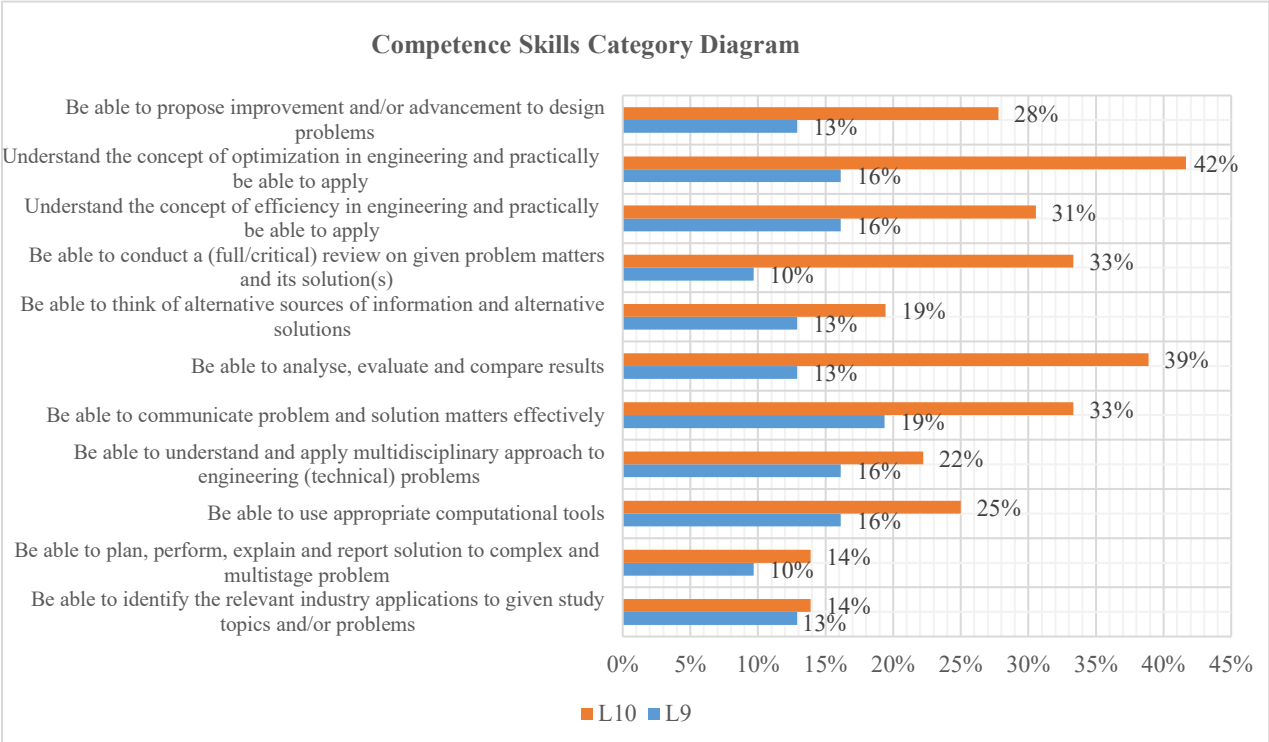
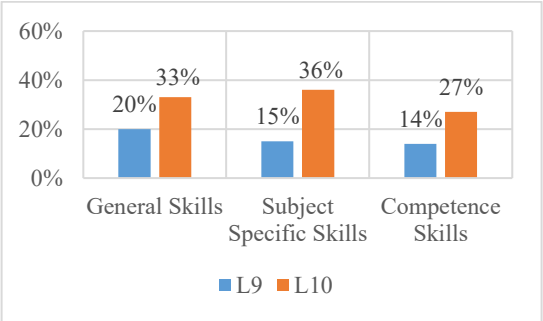


Figure 4 Percentage of skills acquisition scores at scale 5 – competence skills

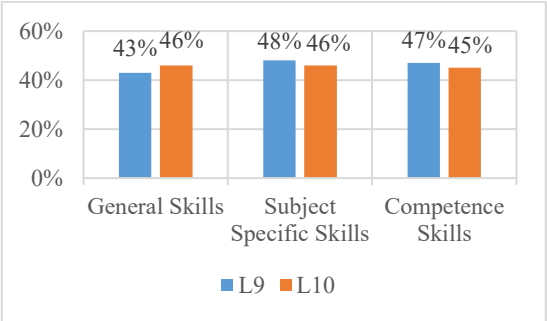
3.2 Skill categories scores analysis at scale levels 4 and 5

In order to gauge the level of skills attainment at different scales (4 and 5), the responses to all skills per given category are averaged and a mean value (in percentage) is obtained for each skill category at a given scale score (similar to the data processed for Figure 1). From the five scoring scales, only 4 and 5 were selected as the values for scales, 1, 2, and 3 are limited and in some cases are insignificant.

Figure 5 shows that almost half of the responses are recoded at scale 4, where subject-specific skills category at scale 4 (L9) attracted 48% of the responses overall. These results to an extent reflect the effort of the aircraft engineering programme at UWS to support experiential learning dynamic to cater for the development of not only discipline-specific knowledge but also other required skills. Universities are usually focused on the development of discipline-specific knowledge (Jones, 2014), where generic skills are left to the merit of students. At UWS however, the embedded skills in the programme have given students the opportunity to critically evaluate and make judgment on skills matters.



(a)



(b)

Figure 5. (a) scale 5 and (b) scale 4 averaged skills acquisition scores

4. DISCUSSION, REFLECTION, AND CONCLUSION

The findings of the survey suggest that students feel that they are developing skills required for progressing throughout the course and also, for employment. Exposure to transferable skill development is seen by the majority of students as a consequence of experiential learning – in particular involvement with industry-based course works, case studies and projects – a fact that is supported by Marsden, et al. (2018). Moreover, the first-hand experience of solving problems and making decision at industry level has been a unique opportunity for students taking projects with industry to develop critical skills in real-life situations. As a consequence, this will positively impact their employability (Rayner et al., 2013). The current study demonstrates to what extent the university in general and the undergraduate course of study (aircraft engineering) in particular could provide the opportunity for students to develop the skills needed for employment.

During the course of study, students weren't explicitly made aware of the transferable skills requirements and/or their embedment in certain or particular modules. But the results of current study have shown that they have been able to recognise and rate them. Teaching and learning methodologies that are used to support the development of such skills were generally found by the students (and tutors) as catalyst for producing skilled graduates. Especially, subject-specific skills

were highly regarded and rated by students. Although not all have agreed on the importance of such skills at the highest scoring scale 5, but where there is a direct and/or strong relevance to aircraft engineering subject matters the scores were relatively significant. For instance, higher percentage of responses were given to optimization, problem solving and data analysis skills (Figures 3, 5b). Moreover, there was a 64% response rate for the importance of subject-specific skills recoded by L10 students in Figure 1 (the highest amongst other skills categories). It should be noted that some of the core-subjects teaching in aircraft engineering is shared with mechanical engineering programme, and this has given students the opportunity to widen their competence-based skill development.

It should be recognised that the study could have benefited from a lager sample and multiple case-study institutions. It would be useful to advance the study with a larger sample size to determine any impact the sample size may have on the results of the survey. However, what is clearly evident is that students recognise the relevance to learning skills through the variety of activities available to them. Although, the focus of aircraft engineering programme at UWS is to enrich the curriculum with industry and practical-based learning, it seems there is still a need for improvement and modification of the traditional teaching and learning methodologies. Perhaps a skill-focused teaching may become an approach by which students can sufficiently and adequately imply the required skills for employment.

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