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Engineering Student Belonging To Prevent Early Leavers Through Curriculum Decolonization, Academic Self-Concept, And Psychologically Safe Teamwork

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ENGINEERING STUDENT BELONGING TO PREVENT EARLY LEAVERS THROUGH CURRICULUM DECOLONIZATION, ACADEMIC SELF-CONCEPT, AND PSYCHOLOGICALLY SAFE TEAMWORK

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ABSTRACT

The proportion of early leavers from engineering degrees closely follows the higher education sector throughout Europe; around 10% leave before graduation. Students are more likely to drop-out if they do not feel that they belong in the learning community. While research shows that academic achievement is a primary factor contributing to student drop-out, other student-centric social factors, such as belonging are equally important to student drop-out rates within higher education. The aim of this paper is to present a model constructed on student belonging. The model consists of 3 pillars, namely academic self-concept & professional identity, psychologically safe teamwork, and decolonisation. The study was based on the development and continuous refinement of interventions that could assist students with feeling a sense of belonging. While the primary intention of this project is to present a body of work that highlights belonging as a contributing factor that may be pivotal to a student remaining in higher education or dropping out, readers will also learn about how best to support students in gaining a sense of belonging through self-concept, providing safe teamwork and by decolonising the curriculum.

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1 INTRODUCTION

A loss of human capital and talent for the engineering sector is a potential outcome of high student attrition in engineering degrees - the number of students who leave their programmes before completion. This exodus compounds the STEM skills shortage reported across many industry sectors. Around 8% of UK students leave university during their first year of study which is replicated elsewhere in Europe where 11.4% of men and 7.9% women in 2021 are early leavers (European Commission 2022). However, often, the situation in engineering faculties is reported higher than their university-wide averages (Andrews, Clark, and Phull 2020).

There are many factors identified in the literature since the 1970s as to why students leave early, and indeed many strategies suggested as to what universities might do to keep them. In (van den Bogaard 2012)'s review of this literature and its applicability to the engineering education context in the Netherlands, several frameworks are analysed identifying these factors. Broadly speaking, most factors are student-centric including background such as age, disposition e.g. motivation, and behaviour e.g. time commitment. Contrastingly, the education setting contributes to attrition through several factors including structures, pedagogies, and how students and staff interact. Although this review finds that the single most consistent and stable predictor of retention is students' ability, it makes the important observation that student abilities are influenced by the education experience we deliver.

So how do we change our educational settings to improve students' abilities and thus reduce the dropout rate? In this work we propose a model to improve students' sense of belonging. This choice is not casual, as belonging has long been established as a success factor which indeed might be inhibited by an over-representation of introverted students in engineering (Wilson, Spring, and Hansen 2008). Our work focuses on three pillars: academic self-concept, psychologically-safe teamwork, and decolonisation. We developed this work by integrating several ongoing studies across the University of Birmingham in the United Kingdom (UK). This is a research-focussed university with approximately 5000 engineering students across 6 faculties and a student cohort roughly split equally between international and home students. We recognise that different students and faculties may have different needs and challenges. Indeed, there will be other factors beyond our control that affect student success such as their personal circumstance, health, and finances. However, we believe that by focussing on these three pillars, we can enhance the education for all students.

2 THE MODEL

The primary factor for students leaving university may often be related to students' academic achievement (Greenland and Moore 2022). Decades of research have been dedicated to innovative pedagogies to improve student success. However, a

more holistic approach may be necessary as good academic results may not be the only factor contributing to the drop-out rates.

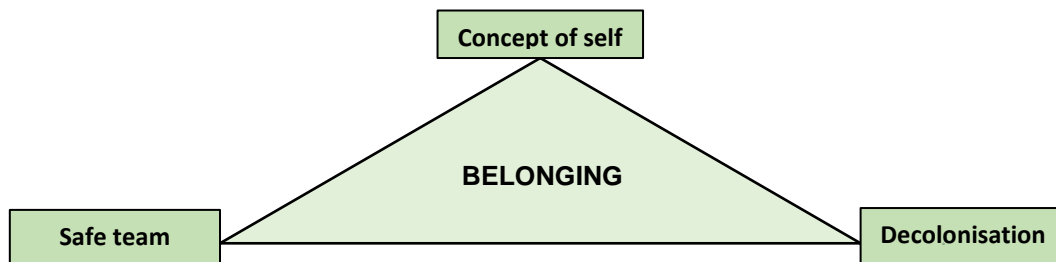


Fig. 1. Belonging model.

For this study we have identified belonging as one of the key factors to students' wellbeing, contributing to whether student successfully completes their degree. We propose a model (see Fig. 1) that underpins student belonging to reduce or prevent early leavers. The model consists of 3 pillars, namely decolonization of the curriculum and of teaching and learning practices, academic self-concept, and psychologically safe teamwork which together provide a foundation on which a sense of belonging can be built. This study was designed and implemented to address the different pillars of the model.

We address academic self-concept & professional identity – a person's belief about their abilities, role, and purpose – since it is likely to be lower for under-represented student groups because of the reciprocal relationship with, and interpretations of, their environment. We discuss our development of teaching interventions to better develop metacognition and self-regulation to raise self-concept. Psychologically safe teamwork – where all members are comfortable and perform optimally - is an area that many students struggle with. Several suggestions explain the difficulties in group dynamics such as language differences, cultural incompatibility, social skills, and individualistic competition. We outline how cultural differences are being supported through early interactions within a group setting to offset many of these issues. Decolonisation – teaching engineering in a way that is fair and effective across ethnic, racial, social and cultural perspectives - is widely considered essential (Bhambra, Gebrial, and Nişancioğlu 2018) yet challenging for STEM, with a disproportionate effect on minority students which itself risks damaging the cohesion of entire cohorts. It is crucial to shift the conversation, through appropriate research, from "why decolonise?" to "why not?", and we describe how this research can be developed into educator trainings to help demystify the term.

3 SELF-CONCEPT

The first aspect of our model is to understand how students see themselves. We are undertaking 3 projects in this area focussing on academic self-concept, professional identity, and metacognition respectively.

3.1 Academic self-concept for foundation year students

Academic self-concept (ASC) refers to a student's own evaluation of their academic abilities. It is frequently indirectly referred to with other names such as self-reported

grades. In a recent study based on a longitudinal dataset of children in the UK born 1989/1990, the authors found that students with higher ASC were more likely to progress from compulsory, through to non-compulsory then higher education, and that these findings were applicable in all subjects including engineering (Marsh and O'Mara 2008). Although the study did not look directly at the relationship between ASC and retention once students reached higher education, based on ASCs correlation with positive trajectories in education, it is reasonable to assume that this continues during higher education.

To investigate ASC in our context, students enrolled on the foundation year programme were invited to complete a survey of ASC in their first month on the programme. The survey tool used was the Academic Self Concept Scale (ASCS) (Reynolds 1988), a 40-item Likert-scale survey with questions such as “Being a student is a very rewarding experience”, “No matter how hard I try I do not do well in school” and “Others view me as intelligent”. Items are scored between 1 and 4, so the metric mean is 2.5. 149 students were invited to complete an online ASCS survey. 33 responded demonstrating a range in ASC between 2.05 and 3.50 with a cohort mean of 2.71 for respondents.

To improve ASC scores, we have introduced a ‘Guided Study’ in the academic year 2021-22 with the aim of developing student belonging by providing opportunities for peer supported learning and structured yet informal contact sessions with at least two academic staff. The goal is to create the opportunities described above to facilitate informal interaction between students and academics, and to support students in developing peer relationships and their own ASC building on the principal that transition to university activities ought to be student-centred and provide informal opportunities for relationship building (Briggs, Clark, and Hall 2012).

Informal feedback from students indicated improved scores, and in future we hope to demonstrate more improvement as a result of engagement with interventions building on Guided Study.

3.2 Professional identity framework for student years 1-5

Complementing the ASC for the foundation year students is concept of Professional identity which we consider for all subsequent years of study. The Cambridge dictionary defines identity as “who a person is, or the qualities of a person or group that make them different from others”. In engineering education, students' engineering identity affects their performance and career choices. Engineering schools can use this concept to understand their students, widen participation, and improve career outcomes (Hansen, Henderson, and Shure 2023).

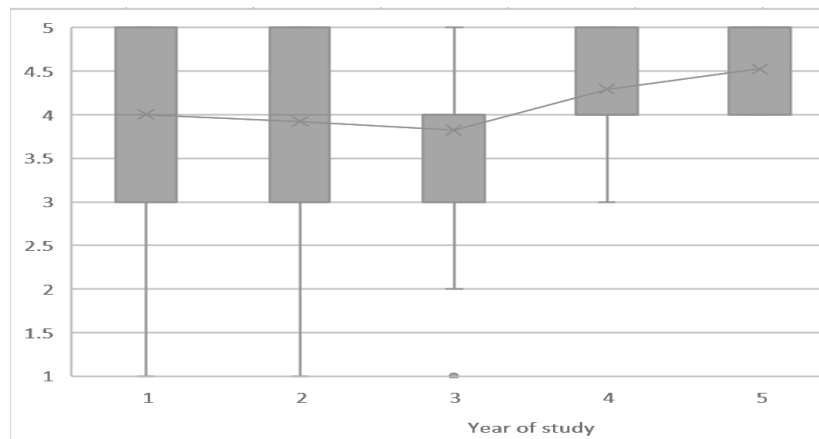


Fig. 2. Distribution of students (n=506) self-concept of identifying as an engineer

We developed a professional identity framework to help engineering faculty to improve their programme development, module designs, and motivate students' skill development and inform their career choices (Cooke and Hawwash 2020). The framework has a survey instrument embedded into the yearly academic review process that measures ASC by getting students to evaluate themselves against the full skill inventory. As a broad measure of identity, one survey question asks how much they agree with the statement "I identify as an engineer" on a 5-pt likert scale. We analysed this response for 536 students in electrical, civil, and mechanical disciplines against their year of study in 2022/23. We found a slight decrease in the average score between from year 1 (4.0) to year 3 (3.8), but then an increase for year 4 (4.3) and year 5 (4.5) (Fig. 2). This trend might be explained by the fact that a proportion of students leave at the end of year 3 with Bachelors degrees, while those who continue in years 4 and 5 are studying for at Masters level, which leads to them developing a stronger identity as engineers. We are further analysing whether this trend can help identify students who might be prematurely leaving with Bachelors degrees with lower than average ASC, despite having the capabilities to complete engineering study as Masters level.

3.3 Metacognition to improve self-concept

ASC requires students to reflect on their experiences and be effective learners. These skills are more formally referred metacognition and self-regulation. Developing metacognition and self-regulation are optimal skills that students should acquire to mature academically because students who can reflect on their thinking perform better academically. Being able to critically think about one's own learning process is vital for students to develop their own ASC and professional identity, especially in an environment where they may not have the experience or support that more established students might have. Acquiring such skills means that students can analyse their learning; determine whether their understanding of it is true; and develop a feedback mechanism with which to constantly evaluate the quality of their learning. This may lead to a more positive academic experience overall.

Furthermore, metacognition is a crucial part of developing an academic concept of self. Over the past 3 years (2020/21 to 2022/23) a project is underway within the School of Computer Science (SoCS) to evaluate the effects of applying metacognitive skills in an undergraduate and post-graduate curriculum. From 2020/21 academic year programming modules taught to both cohorts, included several tools to assist them with acquiring metacognitive skills and therefore being able to reflect on their learning. This was particularly important during Covid when students' learning was fully online. Although a blended learning approach has been adopted post-Covid, the use of these tools has been maintained. For example, the use of Kahoot is an effective tool for both educators and students to reflect on their teaching and learning (Altawalbeh and Irwanto 2023). Within a classroom environment, regardless of class size, educators can instantly be provided with feedback on how students are performing. Conversely, students can measure their own learning.

Currently, students complete a weekly reflective online survey that prompts them to think about their understanding of the content; lab work and tutorials completed; other formative assessments; and their level of engagement with the content. The survey provides students with a score, then if their score is below a particular number, further suggestions on how to improve their learning are offered. Current data collection for 2020/21 to 2022/23 shows that although students initially engage with metacognition thinking tools, they very quickly then disengage. For example, engagement dropped steadily from 349 students in the first week of class to a mere 7 in the last week of class and averaged only 75 students per week.

However, research shows that when a tool is fun students tend to continue using it (Licorish and Lötter 2022). For example, Kahoot quizzes were also presented to students weekly (throughout the same academic periods), and while engagement fluctuated more, it remained high every week with an average of 244 students applying the tool. One further difference between the implementation of the two tools mentioned above is that the Kahoot quizzes were run during class time, while the Canvas quizzes were available to the students at any point during the week.

From these results the following points of interest become apparent: metacognition, while intrinsically a solitary activity, is enhanced by the support of academics and peers; secondly making the process of metacognition more fun results in higher engagement. By making the tools for metacognition, and the skills to use them, more easily available to all students, those students who might not have a well-defined academic concept of self, have an opportunity to improve this concept of self.

4 PSYCHOLOGICALLY SAFE TEAMWORK

Whereas the self-concept pillar of our belonging model helps students to develop individually, the safe teamwork pillar focuses on their relationships; we want all students to feel secure and confident when collaborating. In many engineering programmes including ours, home students perform better than international students. This is not just because of language skills, as our data from our

postgraduate Master's courses shows; the attainment gap exists even when international students studied in English for their first degree. We aim to identify and close this gap.

For pedagogical benefits, increasing amounts of study time are spent in groupwork. International students frequently achieve a higher grade in group assignments when compared to their individual work demonstrating the power of diversity (Channon et al. 2017). However, they also face challenges, particularly when groups are mixed between home and international students (Baker and Clark 2010). These challenges include communication, lack of group work experience, different expectations and cultural norms. This pillar aims to improve students' performance by modifying group structures, assignments, and staff and student training on group work skills. The first stage of this is to observe groups working together and identify if any of the issues highlighted in academic literature are present. A group of 58 students (32 international) were observed working on a series of challenges relating to systems engineering and ergonomics during an intensive module week. Groups of 6 or 7 were allocated randomly and students were expected to organise team roles themselves.

We observed that in all groups a home student became the leader and allocated duties. The exercise briefs allowed for solutions geared to international audience, yet groups usually focussed on the home student preference; home students often gave opinions first and led the group in their preferred direction. Home students took on a parent/teacher role, with international students asking questions. After the first day a number of international students did not return to the group sessions. These observations have led to our questioning the structure and content of all groupwork that is completed by students; group dynamics will be affected by the exercises students are asked to complete e.g. if an exercise can be completed by one or two students then home students have less incentive to involve international students, particularly if there are perceived communication barriers. Moreover, a project based in UK industry puts international students at an immediate disadvantage and are less likely to lead.

The next step in this work is to change these group dynamics and make group work psychologically safer. We are encouraging staff to consider cultural differences to make group exercises more inclusive, better contextualising tasks to several countries. This way, international student's knowledge becomes valuable to the group. Furthermore, we are improving teaching of interpersonal skills and how other cultures communicate.

5 DECOLONISATION

This pillar focuses on decolonisation's contribution to students' self-concept, attainment gaps, and their interaction. Evidence shows persistent gaps in attainment for underrepresented groups. Widening participation processes have been broadly speaking successful in the UK Higher education systems, but gaps persist at the award level especially between BAME and white students.

To address persistent gaps in attainment for underrepresented groups, decolonising the curriculum is necessary. This involves recognising and addressing the legacy of

disadvantage, injustice, and racism. Curriculum decolonisation covers all aspects of learning, but focusing on student perceptions and relationships is especially fitting in our model. We commissioned a study in 2020 to explore academic disparity, also known as the "ethnicity attainment gap" (Rana et al. 2022). The study aims to investigate student perspectives and perceptions on this topic and offer strategies to tackle them. The results indicate that it is crucial to cultivate a stronger sense of belonging among students, both with their peers and with staff members. We found that fostering a sense of belonging is an important first step towards achieving the necessary cultural and behavioural changes to close this gap. Other researchers also consistently find a sense of belonging is linked to success e.g. (Pedler, Willis, and Nieuwoudt 2022).

While acknowledging that the causes behind the academic disparity are highly complex (Stevenson 2012), our study's key finding highlighted that only 37% of BAME students surveyed felt a sense of belonging, compared to 83% of white students. Despite accounting for multiple socio-economic factors and previous academic achievement, questions remain that can be effectively addressed by exploring students' beliefs about their potential. Stevenson's research revealed that many minority ethnic students have internalized negative stereotypes associated with their ethnic group, which may lead to self-doubt, underachievement, and a mismatch between their perceived and possible future selves. One notable difference between the attitudes of BAME and white students in both studies was their intentionality in contacting academics for support. Interestingly, this is not due to fear of discrimination, but the students' perception of their own self-worth and the likelihood of establishing meaningful dialogue with staff members. This is clearly represented by the fact that a minority of BAME students find their lecturers approachable, compared to the majority of white students surveyed.

Despite the complexity of the problem and potential solutions, it is crucial to openly address race and ethnicity, particularly in STEM subjects, where the debate is lagging behind. Decolonizing education involves bringing these issues to the forefront of student experience design and evaluation, ultimately promoting a greater sense of belonging and improving educational and social outcomes. In this context, there are three areas of focus for intervention: promoting a sense of belonging, improving staff/student relationships, and increasing staff diversity, especially in leadership roles. We plan to investigate student belonging within their academic community, considering the impact of Covid since our 2020 study. Additionally, we will examine staff perceptions and attitudes.

6 SUMMARY

"Engineering student belonging" aims to improve student success through integrating and developing measures and interventions that focus on self concept, safe teamwork, and curriculum decolonisation. In this paper we have raised awareness of several of its foundation projects to inform training of educators and the development of teaching interventions.

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