

Research Space

Journal article

How are do you create an inclusive engineering graduate pipeline?

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How are do you create an inclusive engineering graduate pipeline?

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STEM Diversity Problem

UK industry is facing 173,000 STEM skills shortfall¹, increasingly these roles demand higher and degree skills to support industry 4/5², typically in 2020 approximately 117,000 STEM students graduated³. However, the challenge is further up the STEM pipeline, students in UK are limited by geography access to prerequisite STEM education⁴, for example school students in the West of South Yorkshire have access to STEM A'level education oppose to those in East of South Yorkshire.

Only 14% Black Asian Minority Ethnic (BMAE) students secured graduate employment, compared to over 70% their white counterparts⁵. Placement attainment gap is similar between BAME and White engineering students⁶. BAME and female graduates are typically employed in non-engineering roles, as well female engineers are paid less than their male peers⁷. Only a third of employers had taken have taken positive action to address inclusiveness⁸.

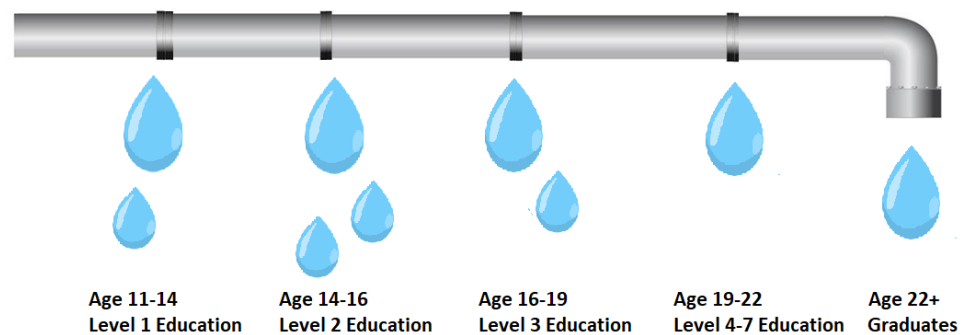


Figure 1: STEM Leaky pipeline

In conclusion, that in the UK everyone on the STEM pipeline, figure 1, need to take ownership to address the inclusive and diversity leaks:

- Schools ensuring students have access to the right STEM education, and advice.
- Higher Education (HE) needs to support Schools to ensure an inclusive and diverse STEM pipeline into HE
- HE needs to recruit, nurture and retain students to graduation into industry.
- Industry needs to reflect on how inclusive are their recruitment processes
- Industry evaluate the day to day operations and practices support inclusive and diverse workforce.

Addressing Leaky Pipeline

In Kent and Medway historically the access to HE engineering has been limited. Aspiring engineering and technology students have had to leave the area to study, and feedback from regional employers

the students don't typically return to the region. To address the regional engineering skills gap Office for Students and South East Local Enterprise Partnership, Charity Donations have invested £14.8M in the creation of the Kent and Medway Engineering, Development Growth Enterprise Hub (EDGE Hub) at Canterbury Christ Church University (CCCU). Kent and Medway EDGE Hub vision is to create inclusive 'industry ready engineering and technology graduate' pipeline to the region, national and enterprises to support economic growth.

The new School of Engineering, Technology and Design at Canterbury Christ Church University (CCCU) has been designed to be truly inclusive practice STEM approach to recruit and retain STEM pipeline (see figure 2). The approach has lessons learnt for industry and education on how to address STEM pipeline and leaks through inclusive:

- Student recruitment activities
 - Schools and Colleges outreach activities
 - Student marketing activities
- Higher Education Facilities and Resources
 - Human resources inclusive and diverse team
 - Estates Facilities and equipment
- Industrial engagement and learning opportunities
 - Commercial awareness learning
 - Employer Inclusive Engagement
- Higher Education Curriculum
 - Curriculum content
 - Learning and teaching facilitation

Student recruitment activities

Schools and Colleges Outreach

In 2021, ratio of male to female studying Maths A'level is 2:1, and 4:1 for Physics A'level and Further Maths A'level. In fact only 2% female A'level population study Further Maths A'level. Consequently a very small pool of potential applicants fulfil the typical STEM A'levels pre-requisites (Maths, Further Maths, and Physics) for engineering and technology degrees. Engineering needs to learn from Allied Health and Life Sciences degree subjects (no-longer requiring A' level Maths), whose "pipeline" is four times greater than engineering⁹. At CCCU the entry requirements is 3 A'levels or more or equivalent (including an A'level or equivalent in maths, physics, applied science or engineering) for engineering courses. The curriculum is designed to develop students' required mathematical and engineering science learning throughout the degree course.

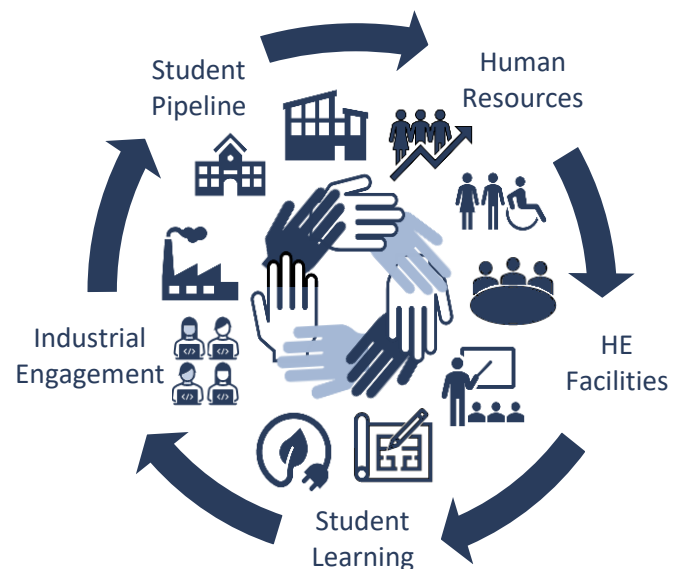


Figure 2: How to create inclusive and diverse STEM pipeline

The real key is inclusive outreach activities in schools¹⁰, which has a positive impact and on the short, mid, and long term unbiased pipeline to STEM. The ASPIRE Programmes demonstrated that

meaningful STEM outreach learning activities at each key stage of national curriculum leads to students progressing to a STEM career¹¹.

In 2021, there was 79,473 fewer A'level students than in 2017. The pandemic has widened the education attainment gap between high and low social economic students¹². However, in Kent and Medway in real student numbers terms more students studied STEM A'levels than in 2017¹³. The real success story is the female uptake of A'level Computer Science (5 fold increase) and Physics (1.8 fold increase) positive impact on STEM pipeline.

Student Marketing

Student marketing materials, resources and activities all need to be inclusive and without bias. The School of Engineering, Technology and Design at CCCU has adopted lessons learnt from inclusive recruitment processes used by industry¹⁴. Marketing materials are gender decoded to preventing perpetuating gender bias¹⁵, the key is to feminise word encode course advertisement materials. Visual stills and reels reflect an inclusive and diverse engineering and technology community, as female¹⁶ and BAME¹⁷ students seek-out affirmation of 'people like me'.

The current student population at the new School of Engineering, Technology and Design at CCCU is 16% female, 36% students from low social economic household, 21% are declared disabled and 23% describe themselves as BAME. The School is working towards 30-35% widening participation of lower socio-economic, females and BAME students by 2024/25

Higher Education Facilities and Resources

Human Resource Activities

Female role models matter to female students as inspire achievement and progression¹⁸. Equally visibility of BAME staff promotes BAME student engagement and the opportunity for authentic conversations between student and staff on how to address and overcome employment challenges¹⁹.

Leader's influence is key to inclusive and diverse staff recruitment in reducing unconscious bias²⁰;

- inclusive recruitment adverts¹⁵, promoting flexible working and returning to work career opportunities.
- educate the recruitment team on gender/cultural applicant complexities and unconscious bias²⁰
- address short-listing biases²⁰⁻²¹
- good practice inclusive applicant assessment job related exercises and interview practice (gender balanced panel and batch interviews)²²

Currently the new School of Engineering, Technology and Design at CCCU, the learning and teaching team (academic, PhD Scholars/University Instructors and technician) team is 41% female and 49% BAME.

Higher Education Facilities

The School's new facilities are in the new Verena Holmes Building, the building has been researched and designed to be inclusive²³. Verena Holmes was local trailblazing woman first female; member of Institute of Mechanical Engineers (IMechE) in 1924; to have a full-time career as a professional mechanical engineer, innovator and engineering entrepreneur of inclusive engineering products. The school has procured inclusive equipment, CE Kite Marked²⁴, inclusive PPE²⁵ to support sense of

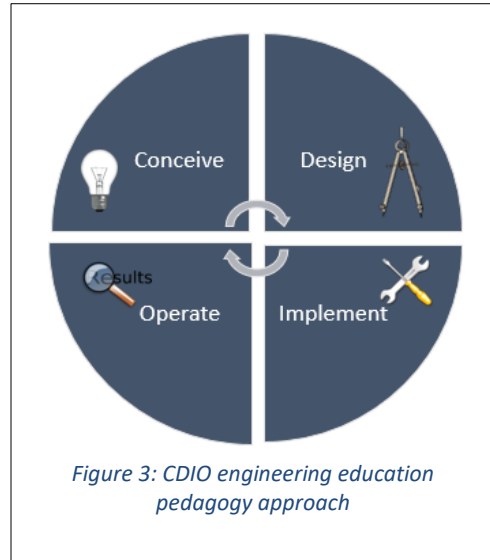
belonging for all students and staff. This has extended to the classroom furniture through the use of round and reuleaux tables in the active learning spaces to promote inclusive and successful student collaborations²⁷.

Industrial engagement and learning opportunities

Commercial awareness learning

In keeping with Verena Holmes spirit of creating inclusive and entrepreneurial engineering graduates, the School has adopted the Conceive, Design, Implement and Operate (CDIO) engineering education practice developed by Massachusetts Institute of Technology (MIT)²⁸, see figure 3. The commercial CDIO group projects are typically sourced from industry and embedded into the foundation to final year curriculum.

Creating flexible internship opportunities (one day a week/sandwich/summer/vacation) with industry and open to all students at any academic level is a more inclusive solution. Flexible internship accommodates mature students and students with caring responsibilities and still has the potential have a positive impact on student grades and long term graduate employment prospects as traditional sandwich placement²⁹.



Employer Inclusive Engagement

The industry and academic collaborations through CDIO/Research/IP/Consultancy projects and student placements have the potential to promote³⁰ and cross-fertilise inclusive engineering working practices³¹.

“Working with CCCU was a fantastic experience. The university gave us access to the skills and knowledge of their students and academics, which added real commercial value to our projects and aided in our product development. Our [local first year] intern was exceptional and his eagerness to learn and apply his skillset made the project a great success.” -
Jack Sherrin, Managing Director at Aptus Outdoor Limited



Higher Education Curriculum

Curriculum content

The engineering courses at CCCU embrace spiral curriculum and the multi-disciplinary nature of engineering subjects; materials, manufacture, design, engineering science, maths, engineering dynamics, electromechanical, instrumentation and control to derive inclusive solutions³². Adopting inclusive, decolonised curriculum, with a world-centric view, language and culture³³, promotes academic reflective practice continuous improvement and critical analytical skills of students.

Learning and teaching facilitation

The industry sourced CDIO projects facilitate student learning in a social context³² and in engineering inclusive solutions to problems³⁴. Active learning sessions develop students ability to work collaborative in teams, a key skill for engineering career. The TARGIT Toolkit has been adopted as a useful resource that enables engineering educators to facilitate good gender inclusive teamworking practices.³⁰

Conclusion

Schools, colleges, higher education and industry need to work collaboratively to address the leaks in the STEM pipeline. One party needs to take ownership and leadership to initiate the collaboration. In the South East Canterbury Christ Church University has acted as the regional kingpin in steering and leading regional education and industry collaboration. The collaboration has the potential to create a resilient inclusive engineering workforce to address regional, national and international economic growth and capable of solving problems for all of society. To learn more colleagues from industry and academia are welcome to get in touch with School of Engineering, Technology and Design at CCCU.

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