VOCATIONAL STUDENTS IN A CDIO PROGRAMME – A LONGITUDINAL STUDY

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ABSTRACT

CDIO was born from a recognition that an entirely academic and scientific curriculum and approach does not necessarily deliver graduates able to cope with the much broader personal, interpersonal, problem solving, project and practical skills required by industry. CDIO developed a much more vocational learning model to help address this. Within the UK and elsewhere students joining University courses can often come from different backgrounds, both personally and educationally. Many students undertaking University degrees in engineering will join from conventional academic backgrounds but others will have more vocational qualifications and backgrounds. Data tends to show these students perform less well at University but does CDIO in itself, with its vocational emphasis address this issue in itself or is more required? This paper reports on a retrospective study of students on a particular CDIO programme, looks at outcomes and reports on some steps taken to help vocational students on their degrees.

KEYWORDS

Vocational, Academic, Outcomes, Progression, Standards: 3, 8, 12.

INTRODUCTION

The CDIO initiative was born out of a need to address concerns that “engineering education had evolved into the teaching of engineering science. Teaching engineering practice had become increasingly de-emphasized” (CDIO 2019). Commonly a research emphasis in engineering schools had focused education and faculty recruitment around a highly academic and sometimes narrow research science scope. The result of this was that the broader practical engineering and personal skills needed by industry lacked emphasis, with graduates sometimes being uneasy fits into the industrial workplace.

The CDIO standards and syllabus were drawn up as a means to help address this and emphasize an integrated and practical approach to developing new engineers for their careers. With a more practical and industrially applied approach that may be present in conventional programmes, it was decided to examine whether CDIO has the potential to attract, retain and develop students entering degrees from vocational as opposed to purely academic routes.

Within the English educational system, there are a number of qualification routes to access University which may involve traditional academic or more vocational routes. It is therefore of interest to see how students with academic or vocational entry qualifications perform once on a CDIO degree.

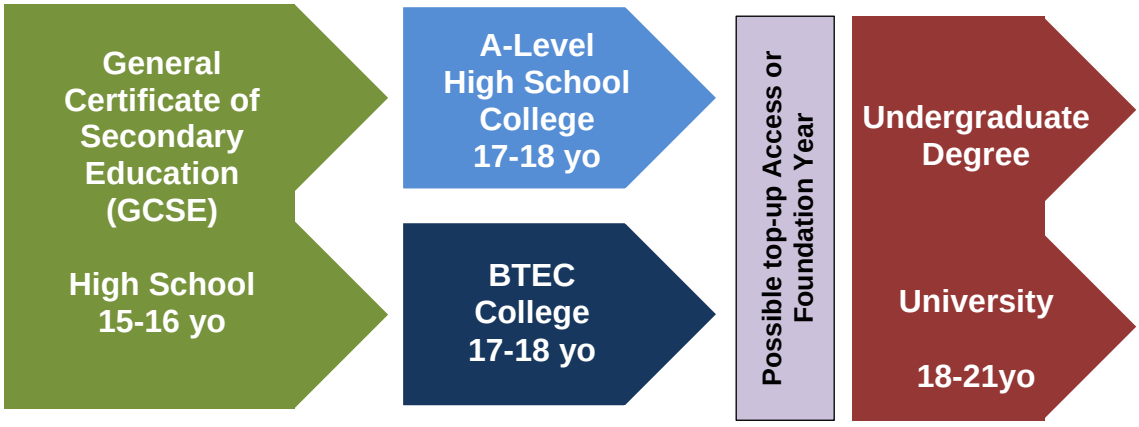

Figure 1. Typical Access Routes to Undergraduate Degrees at English Universities

Figure 1 shows typical access routes to Universities for students in the English educational system.

Most students will enter a High School at around age 11 and will do a broad-based curriculum for three years before selecting up to 11 subjects to be taken at 'General Certificate of Secondary Education' (GCSE) with these being assessed when the student is around 16. At this stage, students may embark on work-based apprenticeships but for those remaining in full-time formal education there tend to be two options, the academic A-level or the more vocational BTEC.

The A-level is a long-established qualification dating back nearly 70 years. It has an academic basis and is typically taught in sixth-form colleges which are often offshoots of high schools. Students would normally study 3 A-levels over two years with the subjects chosen by students often classic topics such as English, Physics, Mathematics or a modern language though it is also possible to do A-levels in more applied areas such as Music Technology or Food Studies. Assessment patterns vary by subject but, particularly for classic subjects, will tend to be dominated by formal written examinations. Access to A-level programmes and providers is often predicated on adequate GCSE performance.

An alternative for students is the more vocational based BTEC (Business and Technology Education Council) diploma which date back to the mid 1980s. These qualifications tend to be focused on vocational pathways with students taking a single course in topics including engineering, public services or travel and tourism. In the words of the awarding body "BTECs are all about learning by doing and that means BTEC students put what they learn into practice straight away. Throughout the course, they work on a series of assignments set in real-life scenarios, developing the practical knowledge and skills employers and universities are looking for." (Pearson 2018).

Each BTEC consists of a range of compulsory and optional units which for the engineering BTEC would include mandatory units in mechanical principles and applications, mathematics for engineering technicians and an engineering project. BTECs have often been assessed purely by coursework however examinations are starting to find their way into these qualifications. BTECs are sometimes augmented by an A-level in a supporting subject.

A relevant BTEC with distinctions would be considered as an equivalence to 3 good (B grade) A-levels with most Universities offering access to degree courses for both types of students based around these equivalences. For students missing out on grades at either BTEC or A-level, the opportunity to access University is often possible via a top-up up foundation year or a third party access course.

While A-level students are still the dominant single category of students entering University, students with BTECs or a BTEC combined with an A-level are becoming increasingly common and make up a significant part of entry cohorts in many institutions particularly those with low to middle level entry tariffs. The uptake of students taking BTECs has grown dramatically over the last decade growing from 50,000 to 150,000 between 2006 and 2014 though some tailing off has been observed more recently (Richards 2016).

For the 2016 application cycle, 54% of students accepted onto a University course nationally held only A-levels with 18% holding only BTECs and a further 8% holding a combination of the two. (Gicheva N, Petrie K, (2018), Havergal, C., (2016))

It should also be noted that there are notable socio-economic differences in the characteristics of many students taking vocational over academic qualifications with factors such as parental occupations and historic participation of the community in University education linked to a choice of qualification taken.

This can be seen in Figure 2 which shows that students being offered places at University nationally are more likely to have done so via vocational qualifications where they have come from low participation areas or their parents have manual rather than professional occupations. (Gicheva N, Petrie K, 2018). Similar indicators can also be found for the greater likelihood of vocational qualifications among students receiving free school meals, a common proxy for low income family background (Richards (2016)).

Related to this are concerns that students entering University with vocational qualifications, even if nominally equivalent in tariff to their academic counterparts, do not perform so well once on their degree, whether due to syllabus mismatch, learning and assessment modes, preparation, perception of self, or socio-economic factors. (Shields, R & Masardo, A, (2018), HEFCE (2018), Gartland C.E., & Smith C., (2018), Gill T., (2018)).

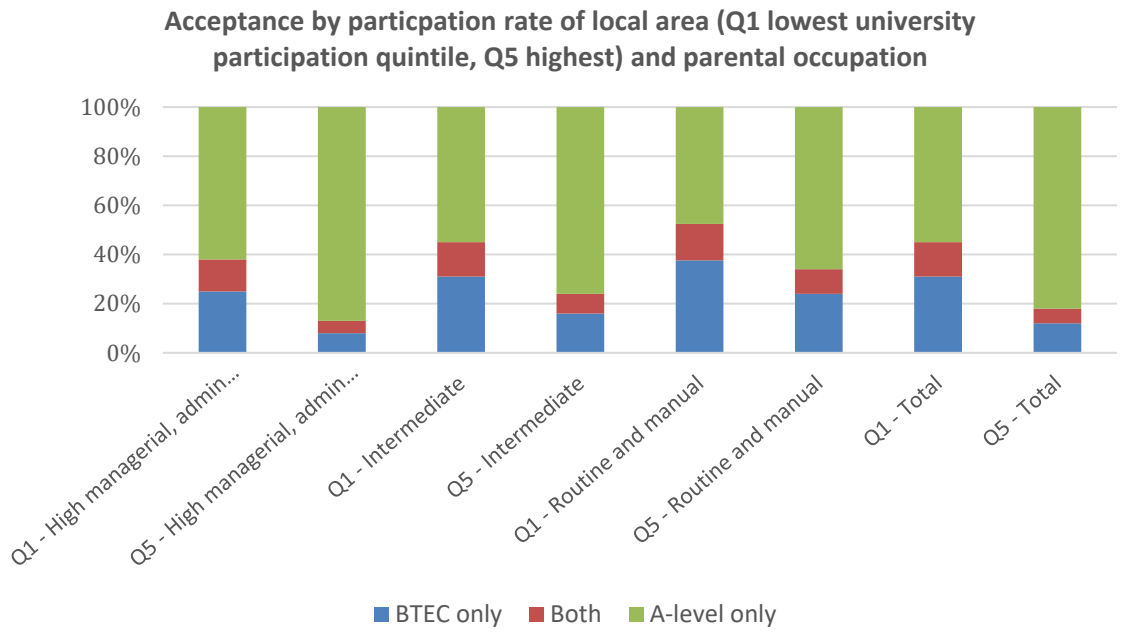

Figure 2: Acceptance by participation rate of the local area (Q1 lowest university participation quintile, Q5 highest) and parental occupation, (Gicheva N, Petrie K, 2018)

As an academic at a University with around 8 years of operating CDIO programmes, I decided to look to see if our adoption of CDIO had made a difference in terms of recruitment to our programmes, how this was reflected in different access routes and the outcomes for students from these different routes.

INVESTIGATION

Two cohorts were examined in detail. The entry year 2010-11 was our last pre-CDIO cohort and entry year 2014-15, the most recent graduating cohort. These latter students experienced a moderately mature iteration of our CDIO approach; however the 2017-18 entry cohort was also examined to see if some more recent changes to our approach had altered outcomes in the crucial first year of their degree.

Data on entry qualifications, outcomes over the course of the programme and performance of the type of student on different module types are also examined.

RESULTS AND DISCUSSION

Figure 3 shows the distribution of entry qualifications for our 2010, 2014 and 2017 intakes. Over the period our intake of students has increased significantly from 66 to over 130. During this time the number of A-level students joining us initially remained broadly static as did the numbers coming through our own foundation year (FY) though both have shown upturns in the most recent intakes. The initial rise in students since 2010 was however largely achieved through a large increase in BTEC applicants and students joining from access to HE courses

by third party providers. The pattern of intake between BTEC (rising numbers of students) and A-level (stable) is broadly consistent with the statistics of students taking these qualifications reported more generally (Richards 2016).

Anecdotally, experience at open days has shown that while potential students from a vocational background can feel a draw to our CDIO project-based approach, the bulk of the rise of BTEC entrants is likely to be largely through the national increase in numbers of these students and the increasing tendency for these to use this qualification as a route to HE rather than work.

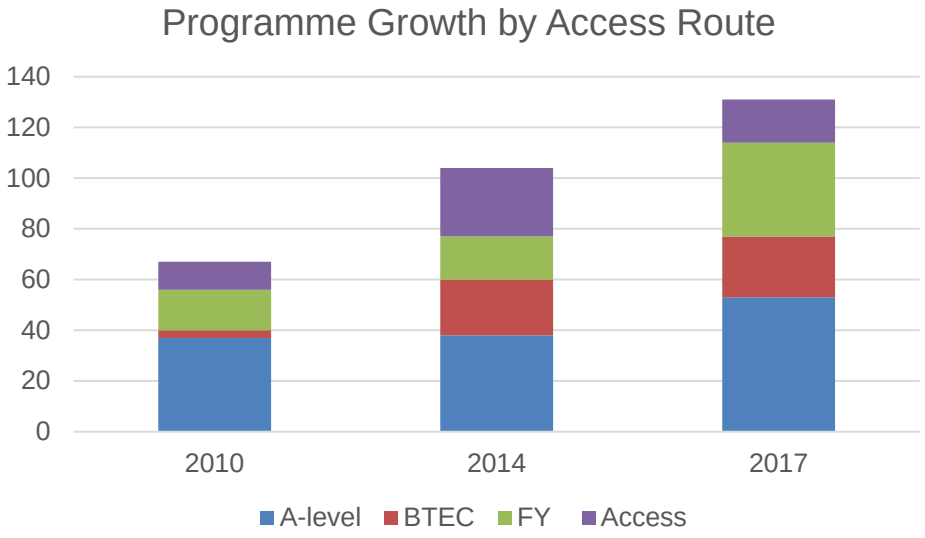

Figure 3: Entry qualification types for the entry year 2010 (pre-CDIO), 2014 (CDIO programme and most recent graduating cohort) and 2017 (most recent 1st year on CDIO programme)

Figures 4 and 5 compare the outcomes of the two cohorts, pre and post-CDIO to see if the shift of programme culture from a traditional lecture and exam based academic approach to one with a much greater degree of applied and practical learning has had an impact on the outcomes for students on the whole and for particular entry types in particular.

For both pre and post-CDIO cohorts, students joining the programme with academic A-level qualifications have generally had very good outcomes with small numbers of students withdrawing and the majority of students leaving with good degrees (Integrated Masters, 1st class or upper second class degrees).

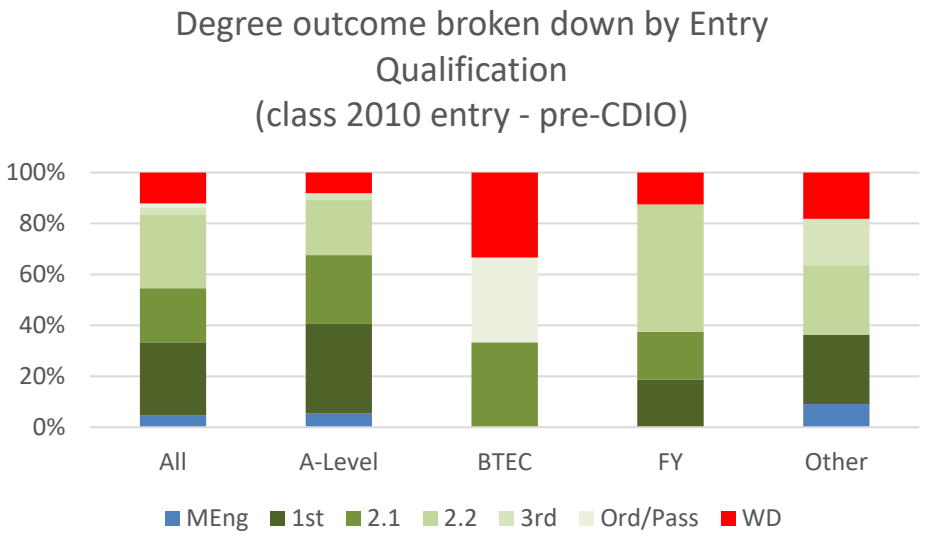

Figure 4: Degree outcome broken down by Entry Qualification (2010 entry – pre CDIO)

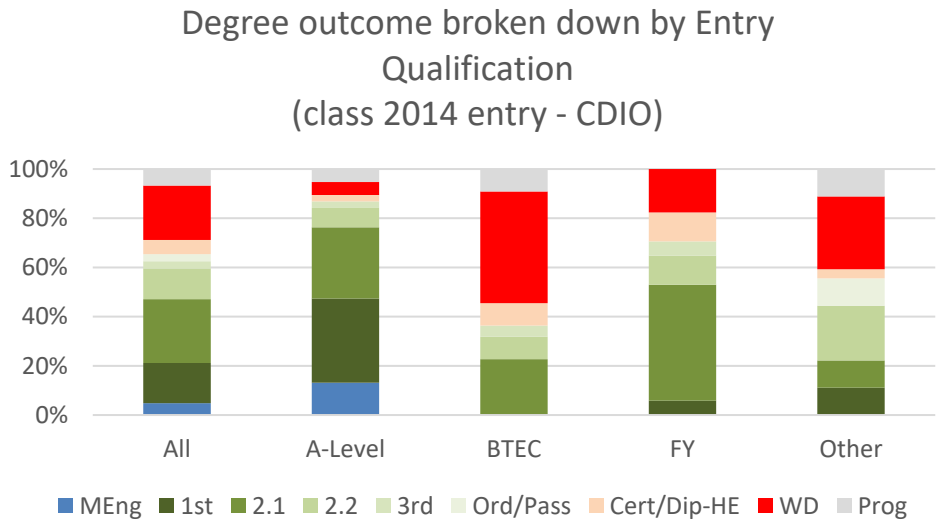

Figure 5: Degree outcome broken down by Entry Qualification (2014 entry – CDIO and most recent graduating cohort)

Unfortunately, for the purposes of the study, the number of students joining us with a BTEC in 2010, pre-CDIO, was very small (n=3, see also figure 3) and it, therefore, makes it impossible to use this as a baseline metric to evaluate how CDIO methodologies have impacted our vocational students.

Nonetheless looking at figure 5 for the most recent graduating cohort it is also clear that the outcomes for students joining with primarily vocational BTEC qualifications are significantly poorer than their A-level classmates with lower overall grades and a much higher degree of withdrawal despite the practical bias of our degrees,

While this is much in line with data reported elsewhere it is not ideal for the students involved or the University itself. To examine why this might be I looked at the first year of our degrees and the performance of students on this. For us, this year is made up of two 15 ECTS project modules very much directly built around the CDIO philosophy coupled to 20 ECTS of hybrid practical/lecture/tutorial engineering science modules and 10 ECTS of mathematics taught quite traditionally.

Figure 6 shows the mean performance of our most recent graduating year when in the first year (2014-15) split by module type and entry qualification.

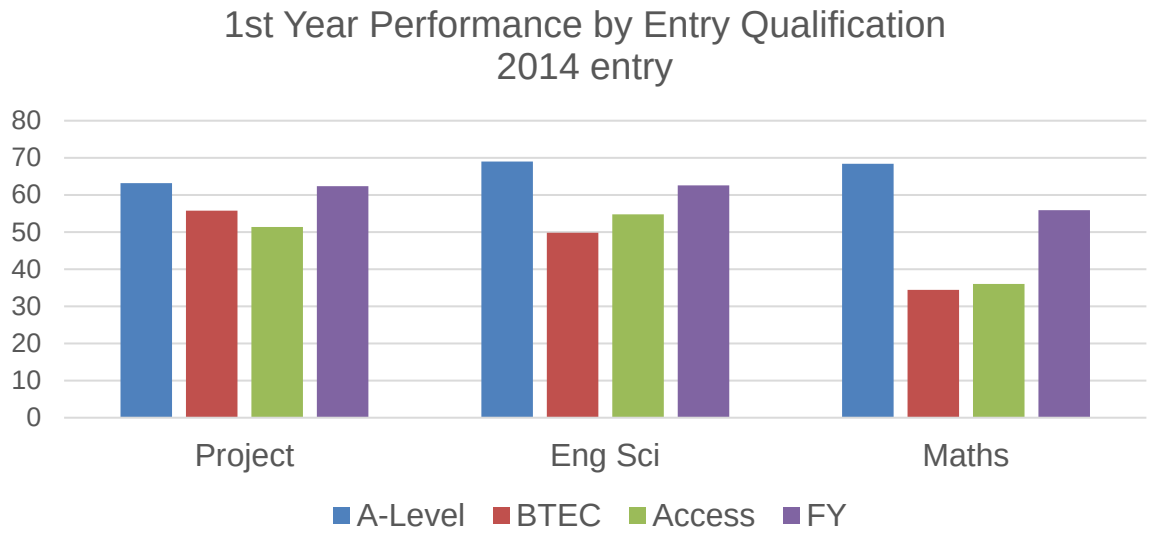

Figure 6: 1st year performance – entry year 2014-15

It can be seen that in the project modules the difference in outcome between the academic A-level students and vocational BTEC students is relatively modest. For the conventionally taught and assessed Mathematics however the A-level students very notably out-performed their BTEC peers with the result the latter were vulnerable to dropping out, unable to clear the Maths modules even after retakes.

As stated earlier such issues are not uncommon in many degrees enrolling BTEC students and support approaches to help these individuals or the class as a whole very often have to be implemented.

To address this issue in our case the BTEC students have for example been allocated to specific and experienced personal tutors to help provide specific targeted support.

In addition, some modifications have more been made to the Mathematics module to address some general issues which also impacted BTEC students in particular.

Previously Mathematics had been a very large cross-school – one size fits all - module with classes of approaching 500 taught to all engineers regardless of a specific discipline. This was more recently devolved down to individual programmes to create their own mathematics modules which not only gave smaller class sizes but also afforded more opportunity for a more relevant syllabus and teaching mode.

Figure 7 shows the outcomes at first year for the 2017-18 cohort taking the new model of mathematics module which was framed much more closely around the CDIO philosophy coupling project work with core maths principles. Further details on this work are reported elsewhere. (Peters & Prince, (2019))

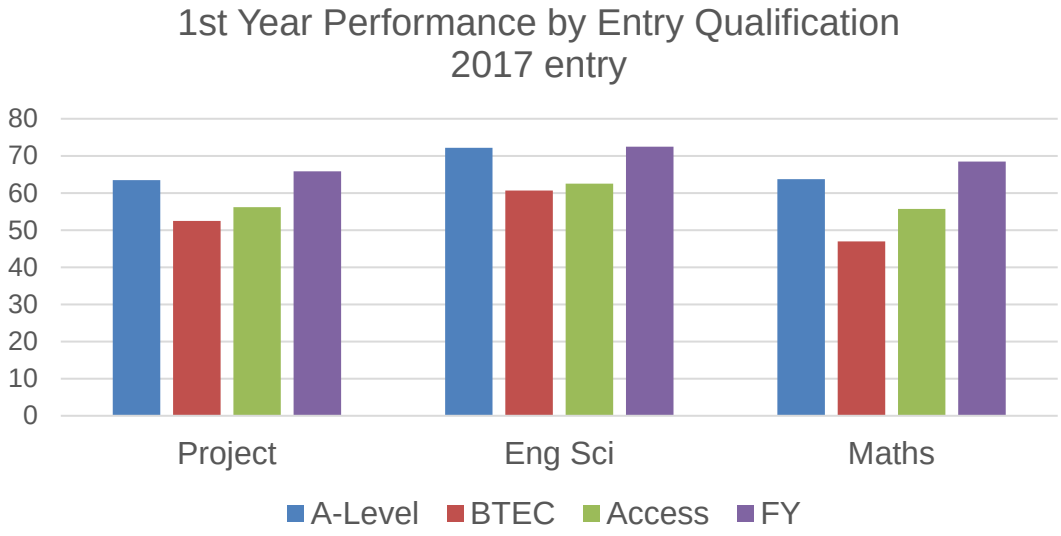

Figure 7 : 1st year performance – entry year 2017-18

It can be seen that while the BTEC students still lag their peers in Mathematics, the difference is much less marked than previously and is closer to the performance in other subject types. This approach will be followed up and evolved in due course to see if these changes impact overall degree outcomes.

CONCLUSIONS

Best practice in education is to recognize the fact that different students will enroll in programmes with different backgrounds, support networks, experiences, qualifications and learning style preferences. While recognizing each student as an individual, access qualifications at the pre-University level may cause a certain coalescence of some of these characteristics around certain qualifications. In the case of the English context, while most

students enter with academic A-level, access or foundation qualifications a significant proportion will enter degrees with vocational BTEC type qualifications. While other countries will have different pre-university education system it is likely that entries at all Universities are likely to either formally or informally have proportions of students with primarily vocational experiences or learning profiles.

While CDIO, with its practical applied focus, should be a good match for these students, the experience here as shown that this has not always been the case. While students may fare quite well on practical activities, more core academic content can sometimes, if taught conventionally or without extra support, be a block to progress. To address this a more fully integrated approach is being developed to support students with greater emphasis on integrated and practical learning together with a greater focus on the needs of these students to ensure they can meet their potential has been developed and is moving outcomes in a positive direction.

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BIOGRAPHICAL INFORMATION

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