Developing a materials world: an analysis of UK higher education data

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Abstract

Despite being a catalyst for progress, Materials Science and Engineering is relatively unknown as an undergraduate discipline in the UK. By analysing UK data published by the Universities and Colleges Admissions System (UCAS) and the United Kingdom's Higher Education Statistics Agency (HESA), we explore how applications to study and uptake of Materials Science and Engineering differs from other related disciplines in the United Kingdom. We find Materials Science and Engineering lags significantly behind related disciplines in terms of applications, and this is likely to have ramifications on the diversity of our student population. We also find a significant number of students is likely to join a Materials Science and Engineering programme by an internal transfer process rather than by direct application. Our analysis suggests higher education institutions should ensure Materials Science and Engineering is defined well as a discipline, both in marketing materials and by consistently using the Higher Education Classification of Subjects (HECoS) coding system.

Keywords: Materials Science and Engineering, Higher Education, United Kingdom

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1. Introduction

This article is intended to accompany *Developing a materials world: why (not) us?*, an article published in the IOM3 magazine, Materials World (March 2021). Due to space limitation in the published article, a full explanation of how the data was analysed could not be included, and some data could not be presented. Also, some readers may benefit from a detailed description of how the Universities and Colleges Admissions System (UCAS) and the United Kingdom's Higher Education Statistics Agency (HESA) data is collected and published. We hope this may help UK Materials Departments to make informed choices when deciding how their data is reported to HESA, as well as assist them in developing equality, diversity and inclusion strategies.

In this article we will first briefly describe the UK University application process, for those readers that are unfamiliar with it (Section 2). We will then explain how disciplines are classified by nationwide bodies (Section 3) and how data on applications and students is collected and published (Section 4). We will then introduce

16 how MSE is represented (and affected) by the subject coding systems (Section 5).
17 Finally, we compare the overall number of home and overseas applications to MSE
18 courses with other STEM subjects (Section 6), the personal characteristics of the
19 applicants pool (Section 7) and then analyse the conversion from applicants to
20 students in Section 8.

21 **2. Applying to University in the United Kingdom**

22 In the United Kingdom, applications to undergraduate higher education are han-
23 dled by the University and Colleges Applications System (UCAS). The organisation
24 provides a single portal through which prospective students are allowed to make
25 up to five applications (for a £26 fee) to as many undergraduate programmes.
26 Generally, applications are made before high school qualifications are completed,
27 sometime between September and January of the final year of high school (Year
28 13). Upon reviewing the evidence provided in an application, Universities most com-
29 monly either reject applicants or make conditional offers to them. Conditional offers
30 promise to accept an applicant provided they meet a set of criteria in their final high
31 school qualifications. After outcomes are received from Universities, but before high
32 school results are announced, applicants have to select one of their offers as *firm*
33 (their top choice), and a second offer as *insurance* (second choice). Once results
34 are published, Universities decide whether to accept each *firm* applicant based on
35 whether they meet (or closely meet) their offer. Should an applicant be rejected by
36 their *firm* choice, they may be accepted by their *insurance* choice. In cases where
37 applicants do not match the offer criteria for either their *firm* or *insurance* choice,
38 they are released in *clearing*. Applicants can also release themselves into *clearing*
39 should they have changed their mind about attending their *firm* or *insurance* insti-
40 tution. Applicants in *clearing* can then search for available places at any University,
41 but this carries some risk as many Universities might then be at capacity.

42 In 2019 [1], there were a total of 706,435 applicants, and 541,240 of these
43 were accepted at an HE institution, the 2019 data is used due to 2020 being an
44 exceptional year because of the COVID-19 global pandemic and so the number of
45 applications and acceptances may not be comparable to previous years. Almost
46 69% of accepted candidates were accepted into their *firm* choice and close to 7%
47 of accepted candidates were accepted into their *insurance* choice. Nearly 14% of

48 accepted candidates were accepted through *clearing*, with about a quarter of these
49 applying directly during the *clearing* period. The only other large acceptance route
50 is the Records of Prior Acceptance (RPA), which accounts for 8% of all acceptances
51 in 2019. The remainder, roughly 2% of acceptances, happen via a variety of routes
52 (UCAS Extra, adjustment or other options).

53 **3. Classification of subjects**

54 In order to classify academic subjects, and allow for in-depth data analysis, UCAS
55 and the Higher Education Statistics Agency (HESA) introduced the Joint Academic
56 Coding System (JACS) in 2002. Prior to 2002, UCAS and HESA each had a distinct
57 coding system to serve a similar purpose. JACS is an hierarchical system by design.
58 Academic subjects are split into several subject areas, which are themselves split
59 into principal subjects. These are then split further. JACS codes are made up of a
60 letter followed by three digits. Loosely speaking, the letter represents the subject
61 area, the second digit specifies the principal subject, and the subsequent two digits
62 refine this even further. For example,

F – Physical Sciences

F3 – Physics

F34 – Mathematical & theoretical physics

F342 – Quantum mechanics

64 It is not required for academic subjects to be specified below the level of principal
65 subject. For example, physics courses can be assigned the code F300. It is also
66 possible to assign multiple JACS codes to academic subjects and programmes, with
67 a weight. For example, a programme titled Mathematics and Computer Science
68 may be coded as 50% G100 (Mathematics) and 50% I100 (Computer Science).

69 It is important to note that UCAS course codes (the codes used by UCAS to
70 identify each programme at a given HE institution) are often similar to JACS codes,
71 but are not necessarily linked. Institutions try to pick UCAS course codes that are
72 evocative of the JACS codes for the course content, but will necessarily need to have
73 a distinct UCAS code for each of the programmes they offer in a specific area (e.g.
74 BEng, MEng, programmes with a specialisation or intercalated years, etc.). As a
75 result, the JACS code assigned to a specific course can be assigned independently.
76 For example, an undergraduate programme in Theoretical Physics may be identified

77 with the F342 UCAS code at one institution, but it may be classified as a simple
78 physics course (F300) or as a Mathematical & Theoretical Physics course (F340).
79 It is probably unlikely for it to be classified as Quantum Mechanics (F342), as that
80 would likely be too specific for an undergraduate course.

81 One of the problems with the JACS approach is that its rigid hierarchical nature
82 results in a limit to the number of subjects that can fit within a principal subject or
83 subject area. Indeed, there can only be 9 principal subjects within a subject area,
84 and the principal subjects themselves can only be broken down into 9 subjects.
85 It is therefore easy to run out of space in the coding frame in some instances.
86 For this reason, UCAS and HESA designed a new system, the Higher Education
87 Classification of Subjects (HECoS). This is a flat structure where each subject is
88 assigned a 6 digits code. There is no structure to these codes. Codes were initially
89 randomly generated for the list of subjects, and new subjects are simply given a new
90 code. For example, Physics is 100425 and Chemistry is 100417. As the HECoS
91 codes are new, they are not necessarily linked and mapped to JACS: there may be
92 multiple suitable HECoS codes for a course previously sitting against a JACS code,
93 or there may be a single suitable HECoS code for something that used to be defined
94 by a combination of JACS codes. UCAS and HESA produced mapping documents
95 to help institutions decide how to code their programmes using the HECoS system.
96 The HECoS system was used alongside the JACS system in 2019 and 2020, and is
97 expected to fully replace the JACS system in 2021.

98 In order to maintain a hierarchical approach to the classification of subjects,
99 UCAS and HESA created the Common Aggregation Hierarchy (CAH). The CAH
100 system categorises HECoS subjects so that data on related programmes can be
101 aggregated appropriately. Within the CAH system, there are three levels of hierarchy,
102 each level defined by a 2 digit code. This approach does run into the same problem
103 as the hierarchical JACS system, but using 2 digits for each level allows for up to
104 99 items to be nested under the parent level. For example, using v1.3 of CAH,

CAH07 – Physical Sciences

105 CAH07-01 – Physics and Astronomy

CAH07-01-02 – Astronomy

106 There may then be multiple HECoS codes mapped to the CAH level 3 code. CAH
107 v1.3 is expected to come into use in July 2021.

108 In addition to being adopted by UCAS and HESA for data reporting pur-
109 poses, these subject classification systems are also used by other government agen-
110 cies. For example, the Foreign, Commonwealth and Development Office uses the
111 CAH/HECoS system to identify the subject area of programmes for visa purposes
112 in their Academic Technology Approval Scheme (ATAS).

113 **4. UCAS and HESA data**

114 UCAS and HESA both publish some of their data free of charge. In the fall of
115 each year, UCAS publishes an end-of-cycle report that includes data for applicants of
116 that year. The latest UCAS data available was published in the fall of 2020 [2], and
117 includes data about applicants that applied between September 2019 and clearing
118 in 2020. HESA publishes data on the student population in January/February of
119 each year, for the prior academic year. The latest HESA data available at the
120 time of writing was published in February 2021 [3], and includes data on students
121 for the 2019-2020 academic year. Both organisations publish data disaggregated by
122 principal subject, rounding numbers to multiples of 5 so that no individual applicant
123 or student can be identified. In the case of HESA some data is aggregated at the
124 level of subject area.

125 There are some key differences in terms of how UCAS and HESA publish their
126 data, and one of these differences is rather important, affecting how data on com-
127 bined subjects are reported. This is when a programme of study is linked to more
128 than one JACS or HECOS code, with a weighting to represent the relative impor-
129 tance of each subject in that programme. In the case of UCAS, data on programmes
130 where linked principal subjects are all weighted 50% or less are all aggregated in
131 a separate category of combined subjects in a way that it would be impossible to
132 separate data for a specific principal subject. Data on programmes where there is
133 a linked principal subject weighted more than 50% (a major) are reported wholly
134 within that major principal subject.

135 HESA takes a different approach. For programmes linked to multiple principal
136 subjects, a Full Person Equivalent (FPE) rate is assigned to each principal subject, in
137 accordance with the weightings specified by the institution offering that programme.
138 For example, in an hypothetical world where 100 students apply to study a joint-
139 honours programme in Theoretical Physics and Applied Mathematics (coded as

140 50% Physics and 50% Mathematics) and then join that programme, UCAS would
141 not show any data about those applicants under either Physics or Mathematics,
142 whereas HESA would attribute 50 FPE to Physics and 50 FPE to Mathematics.
143 This is particularly important for MSE, as we will see in the next section.

144 In addition to the openly available data, UCAS and HESA sell a range of data
145 services to Universities and other institution. The analysis in this report is entirely
146 based on the openly available data.

147 **5. Coding of Materials Science and Engineering**

148 One of the problems MSE faces as a discipline is highlighted by how it is rep-
149 resented within the JACS, HECoS and CAH. Within JACS, a number of principal
150 subject codes are relevant to MSE. These are

F – Physical Sciences

F2 – Materials Science

H – Engineering

H1 – General Engineering

H16 – Bioengineering, biomedical engineering & clinical engineering

151 H161 – Biomaterials

J – Technologies

J2 – Metallurgy

J3 – Ceramics & Glass

J4 – Polymers & Textiles

J5 – Materials Technology not otherwise specified

152 The first problem is that no single code captures the essence of MSE. Secondly,
153 the most relevant codes, Materials Science (F2) and Materials Technology (J5), are
154 are in two distinct subject areas. Thirdly, some of these principal subjects include
155 subjects that are generally not relevant for our discipline. For example, J4 (Polymers
156 & Textiles) includes Machine Knitting (J441) and Commercial Tailoring (J442).

157 The fact that no single code captures MSE is particularly problematic, as some
158 institutions may be tempted to code their MSE programmes as 50% Materials Sci-
159 ence and 50% Materials Technology not otherwise specified. UCAS would aggregate
160 data from these programmes to data from all combined programmes of science and
161 engineering/technologies. HESA would do marginally better, and report data using

162 FPEs. However this can have dramatic ramifications when thresholds need to be
163 met in order for data to be published. For example, lets assume that there are 40
164 students on such a combined programme, and that HESA requires a threshold of
165 30 FPEs in order to publish data, employment statistics or National Student Survey
166 (NSS) output for that programme may not be available.

167 Similar issues are encountered when looking at the representation of MSE within
168 CAH and HECoS. The relevant codes are (CAH version 1.3):

CAH10 – Engineering and Technology

CAH10-01 – Engineering

CAH10-01-06 – Bioengineering, Medical and Biomedical Engineering

101210 – Biomaterials

CAH10-03 – Materials and Technology

CAH10-03-02 – Materials Technology

100033 – Metallurgy

169 100203 – Materials Engineering

100545 – Corrosion Technology

101217 – Composite Materials

CAH10-03-03 – Polymers and Textiles

100145 – Polymer Science and Technology

CAH10-03-07 – Materials Science

100225 – Materials Science

170 Since CAH version 1.3, which will be implemented in July 2021, MSE-related
171 subjects have been grouped under a single level 1 area (Engineering and Technol-
172 ogy). This has been a welcome change relative to CAH version 1.2, which placed
173 Materials Science amongst the level 1 Physical Sciences area. The two most rel-
174 evant HECoS codes (Materials Science and Materials Engineering) are in a single
175 level 2 subject group, Materials and Technology (CAH10-03). However, that level
176 2 subject group includes many other subjects such as maritime technology and
177 biotechnology. If we drop down to the level 3 groupings, the two most relevant
178 HECoS codes are split in two subject groups, Materials Technology (CAH10-03-
179 02) and Materials Science (CAH10-03-07), which leads to the same issues we have
180 encountered when exploring the JACS system. In addition, similar to JACS, rele-
181 vant level 3 groupings include other subjects that may not be classified as MSE:

182 Polymers and Textiles (CAH10-03-03) includes Leather Technology (100210) and
183 Textiles Technology (100214).

184 It can be seen that, both within JACS and in HECoS/CAH, Biomaterials ap-
185 pears somewhere else entirely. This could also be a concern. If an institution
186 decides to map an MSE programme with a specialisation in Biomaterials to the
187 Biomaterials subject with a weighting $>50\%$, data pertaining to that programme
188 will be aggregated with Bioengineering or General Engineering rather than any of
189 the MSE-related subject groups. Even though this is unlikely, and it would be more
190 common for an undergraduate programme in MSE to be mapped to Biomaterials
191 with a weighting of $\leq 50\%$, there are still issues with meeting reporting thresholds
192 for smaller student populations.

193 **6. Applications to study Materials Science and Engineering**

194 Having covered how the undergraduate application process works in the UK in
195 Section 2 and how UCAS and HESA classify subjects in Section 3, we can now
196 start looking at the available data on UCAS applications. Using JACS codes, we
197 can look at data for every single UCAS cycle since 2007, as HECoS/CAH data has
198 only been published in 2019 and 2020. Due to the issues presented in Section 5, we
199 decided to isolate MSE applications and acceptances by summing data for Materials
200 Science (F2) and Materials Technology (J5). We have to ignore both J4, which
201 contains Polymer Technology, and H1, which contains Biomaterials, as both of these
202 principal subjects include many irrelevant detailed subjects. We also opt to ignore
203 Metallurgy (J2) and Ceramics & Glass (J3). Applications in the Ceramics & Glass
204 principal subject can be attributed to art programmes, while there have been very
205 few applications in Metallurgy in recent years. With the withdrawal of Metallurgy
206 programmes at the University of Sheffield and the University of Birmingham, we
207 infer from the data that no programmes in the UK are mapped to Metallurgy with
208 a weighting $>50\%$.

209 Using this approach, we can see that UCAS received 1815 applications to MSE
210 courses in 2020. Assuming each applicant applies to 4-5 MSE courses (the majority
211 of applicants opt to apply for the same subject at different institutions), we can
212 therefore estimate that at least 400 applicants have applied to MSE courses in
213 2020. This is an underestimation as the University of Birmingham alone received

Figure 1: Comparison of 2020 application numbers to MSE and related subjects using JACS and HECoS/CAH

214 applications from 300 individual applicants to MSE programmes, and it is one of 10
 215 institutions offering UG MSE programmes. The underestimation is most likely due to
 216 two reasons. Firstly, some MSE programmes may either have been miscoded, or may
 217 be mapped to a more general subject (e.g. H100, General Engineering). Secondly,
 218 some Universities possibly coded their MSE programmes as combined subjects,
 219 perhaps mapping 50% to Materials Technology and 50% to Metallurgy. With the
 220 advent of HECoS and CAH codes, the HECoS subjects of Materials Technology and
 221 Metallurgy sit within the same CAH level 3 subject group. Other Universities may
 222 have previously mapped MSE programmes to multiple JACS codes but may have
 223 opted for simplicity when transitioning to HECoS, perhaps due to the possibility
 224 of a subject-level Teaching Excellence Framework (TEF). If we sum applications
 225 in Materials Science and Materials Technology CAH level 3 subject groupings, we
 226 get 3405 applications in 2020. This number is much closer to an estimation of the
 227 number of applications received to Materials Science and Engineering programmes
 228 at the 10 institutions offering such programmes.

229 A comparison of applications numbers as obtained using JACS versus HECoS/CAH
 230 for various subjects can be seen in Figure 1. There appears to be always a differ-
 231 ence, although that difference is relatively larger in the case of MSE for reasons
 232 discussed previously. We note that the number of applications to Chemistry and

Figure 2: The total number of UCAS applications made to Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering from 2007 to 2020

Physics also increases when looking at the HECoS/CAH data, while a drop is observed for Mechanical Engineering. Without knowledge of how Universities map their programmes to JACS and HECoS codes, it is impossible to fully establish the reasons for these differences.

Even though the JACS data underestimates our number of applications, we believe it captures a representative sample of MSE applicants. Applicants that apply to MSE programmes that are coded as combined subjects or mapped to something else entirely will also apply to MSE programmes that are mapped against a single principal subject. The proportion of applications from women, overseas applicants, and other applicant characteristics are consistent whether one looks at JACS or HECoS data. It is probably more robust to use HECoS data, as larger application numbers mean it is easier to meet reporting thresholds when data is disaggregated into several categories (e.g. ethnic background). On the other hand, JACS data provides a precious historical perspective as the data stretches back to 2007.

The total number of applications to MSE compared to applications to Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering is shown in Figure 2. Roughly speaking, the number of applications to MSE are an order of magnitude lower than other disciplines we compare to. We have observed significant growth in application numbers, but this is matched to the growth observed in applications to Mechanical Engineering, Aerospace Engineering, and Physics. Chemical Engineering and Chemistry appear to have had sustained growth in the number of applications up until 2015, followed by a significant drop in the

Figure 3: The percentage of applications from overseas applicants made to Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering from 2007 to 2020

last 5 years.

We would not expect MSE to be as popular as Mechanical Engineering, and it is natural to ask ourselves what an appropriate number of applications should be. To do this, we can look at the proportion of applications that are made from overseas applicants, which we define as anyone not domiciled in the UK. This is shown in the left panel of Figure 3. It can be seen that applications to MSE from overseas applicants have increased significantly, from 30% to 50%. At 50%, the rate of applications from overseas applicants is considerably higher than all other disciplines we compare our data to. Chemical Engineering, the second most popular discipline, received 35% of its applications for overseas, and it appears this proportion has steadily declined since 2007. Applications from overseas to other engineering disciplines have largely remained unchanged, while Physics and Chemistry have observed significant increases, but the proportion of applications from overseas applicants remains low.

Two things could explain the relatively high proportion of applications from overseas applicants: either MSE is relatively more popular abroad than in the UK, or the UK is seen as a destination country where to study MSE.

Figure 4: The percentage of applications from women applicants made to Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering from 2007 to 2020

7. Characteristics of applicants pool

It is useful to study the characteristics of the applicants pool, in order to determine how accessible the discipline is to the wider public. Anecdotal evidence suggests that many MSE students stumble into the subject almost by mistake, while exploring opportunities in science and engineering through friends and family working in high-skilled jobs. Others are aware of the subject because a family member or a family friend has studied it or works in the sector. University tutors in schools are generally less aware of it, and may be inclined to direct their students to better-known disciplines such as Mechanical Engineering, Physics or Chemistry.

7.1. Women

UCAS publishes the data split by the stated gender of the applicant, which UCAS treats as a binary variable at this stage [4]. We can therefore use this data to study the proportion of applications coming from women, and compare this to similar disciplines. Using JACS, we can look at data from 2007 to 2020, and the fact that applications are divided in two relatively large groups (men and women) means we do not have to worry about issues caused by the data being rounded to a multiple of five.

The proportion of applications from women made to MSE, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering is shown in Figure 4. Although MSE does seem to attract a large proportion of applications

292 from women relative to other engineering disciplines (e.g. 12% for Mechanical
293 Engineering versus 32% for MSE in 2020), the historical data suggests some soul
294 searching is required. All disciplines that we have looked at show a steady increase
295 in the proportion of applications coming from women in the 13 years to 2020. The
296 only exception seems to be MSE, where the proportion of applications from women
297 has dropped from 45% to 33% in the last 13 years. This is surprising and it implies
298 efforts to reduce the gender gap are either insufficient or ineffective in MSE, while
299 progress seems to have been made in other disciplines. The current proportion of
300 applications coming from women is confirmed when looking at the HECoS/CAH
301 data, where we find 36% of applications to MSE came from women in 2020. This
302 suggests it is unlikely that the trend is a result of biases introduced by the subject
303 coding system.

304 Observation of the raw numbers reveals that while applications from women
305 have only grown by 25% since 2007, applications from men have more than doubled.
306 The reason for the relative growth in popularity of MSE amongst men is unclear.
307 Qualifications required to study the subject across the sector have not changed
308 considerably, and these are similar to other sciences and engineering disciplines. The
309 uptake of A-level subjects like physics and chemistry from girls relative to boys has
310 increased in recent years, while it has remained largely unchanged for mathematics.
311 We can only infer that the work done by the MSE community to promote the
312 discipline over the last two decades has been more successful at convincing men to
313 apply for the subject.

314 We would ideally like to be able to confirm whether this downward trend is
315 observable when looking at the proportion of women registered for MSE courses
316 as reported by HESA. Unfortunately, to the best knowledge of the authors, HESA
317 openly reports the number of registered students split by personal characteristics at
318 a higher level, by JACS subject area or CAH level 1 category. This would not give
319 us sufficient granularity to isolate MSE programmes.

320 *7.2. Ethnic background*

321 We can now look at the number of applications split by ethnic group. UCAS
322 reports data split in the following categories: asian, black, mixed, other, white, and
323 unknown (prefer not to say). Due to the higher number of groups, and the fact
324 that some of these groups represent a small proportion of the applicants, we are

Figure 5: The percentage of home applications from people of asian, black, mixed, other, unknown and white background made to Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering in 2020

restricted to use the HECoS/CAH data, and lose the historical perspective. There are simply not enough applications in the JACS data to meet the reporting threshold for all groups dating back to 2007.

The percentage of total applications to MSE and comparator disciplines from the UCAS ethnic groups in 2020 is shown in Figure 5. We note this only includes home applicants, and excludes applications from overseas and the European Union. MSE appears to sit somewhere in between science and engineering disciplines. Engineering disciplines seem more successful at attracting applicants from asian, black and mixed backgrounds compared to MSE.

7.3. Socioeconomic background

UCAS data also reports on the applicants' socioeconomic background. In the UK, there are several methods to measure this. UCAS publishes data using two distinct methods. One is the Participation Of Local ARea (POLAR) classification, which classifies residential areas (i.e. postcodes) based on the proportion of young people progressing to and participating in higher education. The POLAR system splits UK postcodes into 5 groups, or quintiles. Postcodes in quintile 1 have the lowest rate of participation while postcodes in quintile 5 have the highest rate of participation. The other measure used by UCAS is the Index of Multiple Deprivation

Figure 6: The percentage of home applications classified by the POLAR4 category of the applicant made to Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering in 2020

(IMD). This approach also classifies UK postcodes into 5 quintiles, with quintile 1 being the most deprived and quintile 5 being the least deprived. The index combines data on income, employment, education, health, crime and housing to rank all postcodes in terms of deprivation. It is important to note that the social makeup within a given postcode may be diverse. As expected, the position of postcodes within these ranking tables may change, so new versions of these classifications are published periodically. For example, the most recent version of POLAR is version 4 (POLAR4).

We first can look at applications split by the POLAR4 classification of the applicant, as shown in Figure 6. Compared to other established science and engineering disciplines, we appear to have a low proportion of applications coming from postcodes with lower likelihood of participation in higher education. Close to 70% of applications to MSE programmes come from postcodes with a higher than average participation in higher education.

This is not surprising: the disciplines we compare to are well known amongst the public. Young people from low POLAR quintile postcodes will more likely know of others studying those disciplines, and may be completely unaware of MSE. Teachers and university advisors at their schools may focus on promoting the study of better known disciplines. In addition, MSE programmes are less widely available than more

362 established science and engineering disciplines, and may therefore be less accessible
363 to those less able to relocate to attend university.

364 **8. Conversion to students**

365 Within HE institutions, it is fairly common to monitor the conversion rates at
366 key stages in the admissions cycle. For the purpose of our study, three conversion
367 rates are particularly important:

- 368 • Offers to applications ratio – this is the number of conditional and uncondi-
369 tional offers made to study a subject relative to the number of applications
370 made to that subject
- 371 • Acceptances to offers ratio – this is the number of acceptances in a particular
372 subject relative to offers made to study that subject
- 373 • Registered students to acceptances ratio – this is the total number of year
374 1 registered students in a particular subject relative to the number of accep-
375 tances in that subject

376 It is worth pointing out that these conversion rates do not really tell us anything
377 about the experience of an individual applicant. Since published data is anonymous,
378 it is impossible to know, for example, how many offers an individual applicant has
379 received, or how clustered these offers are within the applicant pool. Also, students
380 might apply in one academic year, and defer their entry to the following academic
381 year, and there are a number of students that apply directly through clearing without
382 having made main scheme applications. The simplest thing we can do is to take
383 the ratio of the total numbers of applications, offers, acceptances and registered
384 students, and be careful not to attach additional unsupported meaning to these
385 figures.

386 The calculated conversion rates are shown in Figure 7. The data for the offers to
387 applications ratio and acceptances to offers ratio spans from 2007 to 2020 (available
388 through UCAS). For the ratio of registered students to acceptances, we have to use
389 HESA data, and this limits our time window. More recent HESA data is available,
390 but this is published using HECoS/CAH, and we cannot directly compare to the
391 JACS data used for all other years.

Figure 7: The offers to applicants ratio (top left), acceptances to offers ratio (top right) from 2007 to 2020, and registered students to acceptances ratio (bottom) from 2014 to 2018 for Materials Science and Engineering, Chemistry, Physics, Mechanical Engineering, Aerospace Engineering and Chemical Engineering

392 It can be seen that the ratio of the number of offers to the number of applications
393 generally fluctuates between 70% and just over 85%. Differences between subjects
394 are not significant. The situation is different for the other two conversion ratios.

395 When looking at the ratio of acceptances to offers, MSE appears to behave
396 differently compared to other subjects. The ratio appears higher, on average, for
397 MSE relative to other disciplines. This either suggests MSE offer holders are more
398 likely to satisfy the acceptance criteria for their offers relative to other disciplines,
399 or that Universities are more flexible when making decisions on students that are
400 narrowly missing their conditional offers. The difference between MSE and other
401 disciplines appears to be reducing overtime, and reasons for this are unclear from
402 the data.

403 The difference between MSE and other disciplines is even more obvious when
404 looking at the ratio of the number of students to acceptances. It is important to
405 remember that the numerator here is obtained from HESA, which includes FPE
406 fractions for combined programmes, while UCAS does not do this (see Section
407 4). It is therefore expected that these ratios might be above 100%: there will be
408 additional fractions of students that are registered on combined programmes. MSE
409 here appears to be a clear outlier, with the number of registered students appearing
410 to be almost twice the number of accepted students.

411 This is partly due to the differences between how HESA and UCAS report their
412 data, but it is unlikely this is the only explanation. We can investigate this by looking
413 at the number of registered MSE year 1 students reported by HESA. According to
414 HESA there were 555 students (FPE) registered under F2 and J5 JACS codes in the
415 UK in the academic year 2018/2019. This is much higher than the 315 acceptances
416 in those same JACS codes in the UCAS cycle leading to that academic year. The
417 majority of the 555 registered year 1 students is in J5 (410) and the rest are in F2
418 (145). We would ideally like to identify the proportion of 'whole' students vs the
419 number of FPE that is a result of fractions coming from combined programmes.
420 This is unfortunately impossible to determine from the freely available data.

421 In order to estimate how many of these students are FPE fractions, we can
422 look at which institutions these students are registered in to study MSE. HESA
423 publishes this, but as a total of UG students (FPEs) so that it is not possible
424 to determine the number of first year students registered under a particular JACS

code at a specific institution. Nevertheless, the institution data may shed some light. In the academic year 2018/2019, a total of 1985 FPE UG students (all years) was registered on programmes mapped to F2 (520) or J5 (1465) across the UK. The first obvious thing to check is that no institution has students in both, which implies a combined programme mapped to both F2 and J5. This is indeed not the case, as all institutions either report registered students in F2 or report registered students in J5. The only exception is the University of Birmingham, reporting a very small number of students (5) in F2 due to a programme now withdrawn, and the University of Derby, reporting small numbers in both JACS codes (10 and 15 respectively).

Next, we can look at how these students are distributed. Only 9 institutions report 100 or more students in the relevant JACS codes. These are all institutions that have single-honours programmes in MSE that are probably wholly mapped against a single JACS code. These institutions may also offer major/minor combinations, but these would not be classified as combined subjects according to UCAS. The total number of FPE students registered at these 9 institutions is 1855. Unless one of these 9 institutions offers a combined programme with another discipline that is taken by a significant number of students, we can conclude that at least over 90% of FPE students registered for either F2 or J5 JACS codes are registered for programmes that are wholly mapped against one of those two JACS codes, or have a major/minor configuration where one of those two JACS code carries a weight higher than 50%.

Assuming this remains roughly constant, we can infer that roughly 500 of the year 1 students (FPE) registered to study on programmes mapped to either F2 or J5 is actually registered on programmes that are not considered combined according to UCAS. This would lower the students to acceptances conversion rate from 176% to 159%. We therefore conclude that differences in how UCAS and HESA report their numbers is not the cause for MSE behaving as an outlier.

Instead, we suggest that a significant proportion of the registered MSE students in year 1 is a result of internal transfer processes after the UCAS cycle is complete.

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