Observatory for Mathematical Education

Transition to university mathematics

Themed report 25/02

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Evidence Excellence Equity

Summary

This report considers how changes in curriculum and teaching at the transition to university mathematics are experienced by students and how this relates to their engagement and attitudes with respect to learning and to the subject. In September 2024, the Observatory for Mathematical Education surveyed students with firm offers to study mathematical sciences degrees at universities in the UK, with a follow-up survey conducted six months later after the first semester. The analysis herein is based on the responses from the 723 students who completed both surveys.

The results show that many students experience a drop in mathematical confidence during the first semester, with those starting universities with the highest entry requirements experiencing a bigger jump in curriculum and drop in confidence. There is also a dramatic rise in the use of AI, particularly among students who are expecting lower marks, during the first semester, while starting a degree with confidence in coding is correlated with expectation of higher first year marks. The results also show some student groups are more likely to have a negative transition phase than others. For example, female students seem to fare less well than their male peers. This report will help university mathematics departments and the wider system to identify areas that could be addressed to improve the transition process for students.

Key findings

- The first semester of university does not change students' overall perception of the nature of mathematics, with 69% perceiving the curriculum builds on prior qualifications.
- 26% of students are very confident in mathematics after the first semester, compared to 57% prior to starting.
- The first semester sees an increase in the proportion of students who find it easier to memorise techniques rather than understand them.
- 64% of first year students think they need to attend every teaching session in order to do well.
- During the first semester, the proportion of students using AI increases from 13% to 58%, while the proportion confident in coding increases from 30% to 39%.
- 42% of students reporting they expect a first-class average were confident in coding prior to starting, compared to 14% of those expecting a third-class average (or lower).
- Female students are more likely than male students to report a drop in confidence in mathematics, finding the pace of learning too fast and using memorisation over understanding.

Introduction

The long process of educating mathematicians - from the start of primary school to postgraduate degrees - includes several important transitions. Each of these thresholds presents challenges for learners and for those supporting them. Those starting undergraduate programmes in the mathematical sciences, for example, can experience fundamental shifts in curriculum and pedagogical experiences. This typically coincides with changes in living arrangements, greater financial independence and new support structures. These issues are epistemological, cognitive, socio-cultural and affective in nature[1].

It is important that teachers, lecturers, support services and education leaders have better understanding of how to support mathematical sciences students through this transition, especially those from under-represented groups or those at greater risk of not completing their degrees[2].

While England saw record numbers of students studying A level Mathematics in 2024, the number progressing to undergraduate degrees in the mathematical sciences has changed little in recent years, with some institutions experiencing a decline in cohort size[3]. The Campaign for the Mathematical Sciences, among others, has highlighted the need to attract a wider pool of students, including those from related fields and diverse backgrounds[4]. Supporting the successful transition and retention of these mathematical scientists is important for the UK workforce.

In September 2024, the Observatory for Mathematical Education surveyed students with firm offers to study mathematical sciences degrees at universities in the UK (survey 1). This included students on programmes with mathematics or statistics comprising at least 50% of the curriculum. A follow-up survey was conducted in February/March 2025 (survey 2). The surveys generated 1003 and 758 responses, respectively, from across 65 UK universities. The analysis herein is based on the responses from the 723 students who completed both surveys. Further details of the methodology are in the accompanying technical report[5].

This report presents findings from the analysis in nine themes:

1. Who is studying mathematical sciences degrees?
2. Student confidence in mathematics
3. Aids to learning mathematics
4. Student learning strategies
5. Curriculum and pedagogy
6. Attendance and feedback
7. Coding and programming
8. Nature of mathematics
9. Student plans and aspirations

1. Who is studying mathematical sciences degrees?

According to HESA[6] data, there were 10,580 new entrants to first degrees in the mathematical sciences in 2023/24. This is down by 2.9% from the preceding year. Three-quarters of undergraduate mathematicians in 2023/24 had their permanent residence in the UK (64.9% England, 6.6% Scotland, 3.0% Wales, 1.9% Northern Ireland), with the remainder international students from the EU (3.0%) or elsewhere (20.3%). There were 420 fewer international students compared to the previous year, with a more modest drop in the number of home students.

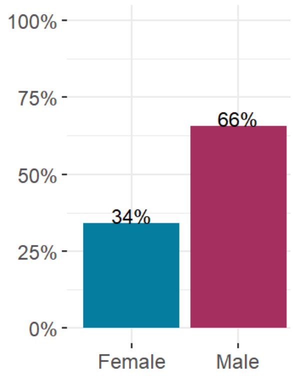

Figure 1: The proportion of first year female and male students studying mathematical sciences degrees at UK Universities in 2023-24 (HESA)

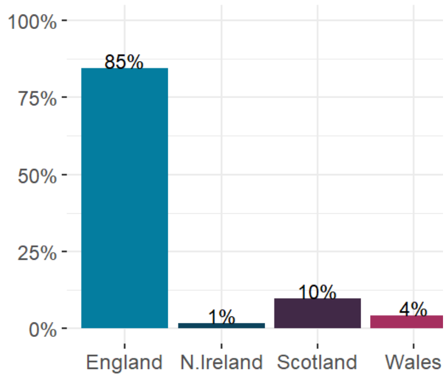

Figure 2: The proportion of first year students studying mathematical sciences degrees at UK Universities by country of university provider in 2023-24 (HESA)

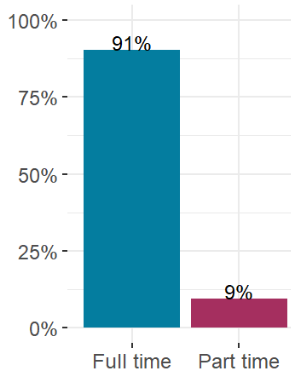

Figure 3: The proportion of first year full time and part time students studying mathematical sciences degrees at UK Universities in 2023-24 (HESA)

In undergraduate mathematical sciences, male students outnumber female students in a 2:1 ratio: female students comprised 34.3% of the cohort in 2023/24 (Figure 1) and 34.8% in 2022/23. Nearly all students study full-time, with the vast majority of part-time students studying at a single provider specialising in distance learning (Figure 3). This provider has the largest number of students registered on undergraduate mathematical sciences programmes. The distribution of mathematical sciences students between universities is highly skewed (Figure 4). The 13 largest institutions account for over half of all undergraduate mathematicians, with a third of institutions having fewer than 100 mathematical sciences students registered on undergraduate programmes (across all years combined). Only one of the largest 18 cohorts is outside England.

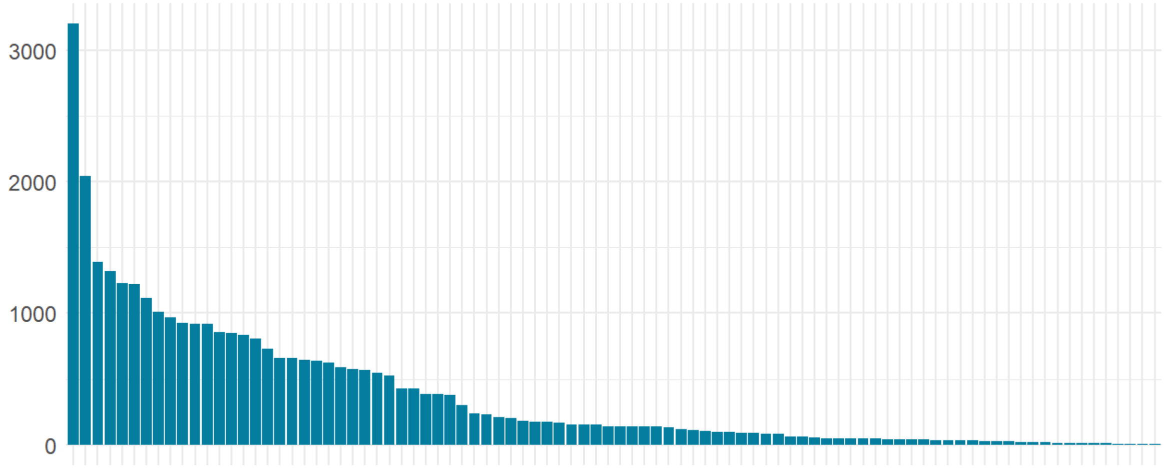

Figure 4: The total number of mathematical sciences students enrolled on first degrees at each UK university.

For students who came through the English education system, nearly a quarter start their mathematical sciences degree with an A* grade in both A level Mathematics and A level Further Mathematics (Table 1). Just over half of this cohort have taken A level Further Mathematics and nearly 70% of students have either grade A* or A in A level Mathematics. Around 8% of students have not taken A levels (possibly taking International Baccalaureate or other qualifications or enrolling on a course with no entry requirement).

A level	A level Further Mathematics grade						
Mathematics	A*	A	B	C	D or below	None	Total
A*	24.0	11.1	2.4	0.1		8.7	46.3
A	0.1	2.1	4.0	2.3	0.5	13.9	23.0
B			0.3	0.9	0.7	7.8	9.6
C			0.1	0.5		4.7	5.4
D or below			0.3			3.5	3.7
None	2.4	0.9	0.4	0.1	0.1	7.9	11.9
Total	26.5	14.2	7.5	4.0	1.3	46.5	100.0

Table 1 A level Mathematics and Further Mathematics grades of students starting mathematical sciences degrees in 2022/23 (students with KS5 record in England only; percentages).

Figures 5 to 8 show the students who progressed to a mathematical sciences degree programme as a percentage of those who took A level Mathematics in England in 2021. For example, 30.9% of students who also took A level Further Mathematics progressed compared to 4.0% of students without A level Further Mathematics (Figure 7). The progression rate is also higher among male students (Figure 5) and those with higher socio-economic status (Figure 8). Those of Chinese ethnicity are approximately 75% more likely to progress as those of Black ethnicity (Figure 6). There are also regional differences, with the highest progression rate in 2021 being 8.9% in the East of England compared to 6.8% in the West Midlands. Although the 2021 A level examinations were impacted by Covid, all these progression patterns are similar to the 2019 and 2020 cohorts (albeit with year-to-year variation in the regional rankings).

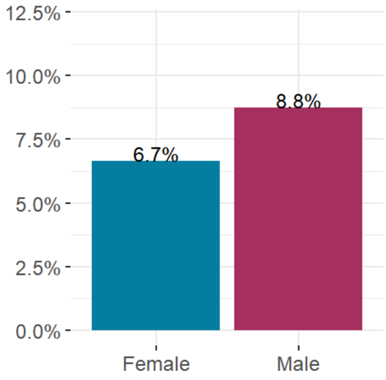

Figure 5: The proportion of A level Mathematics students, in 2021, that progress to a mathematical sciences degree, split by gender.

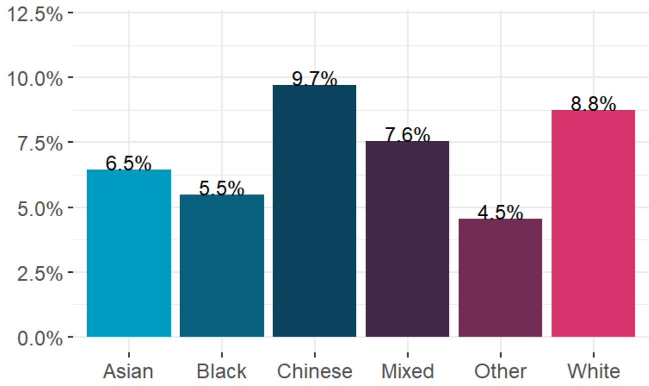

Figure 6: The proportion of A level Mathematics students, in 2021, that progress to a mathematical sciences degree, split by ethnicity.

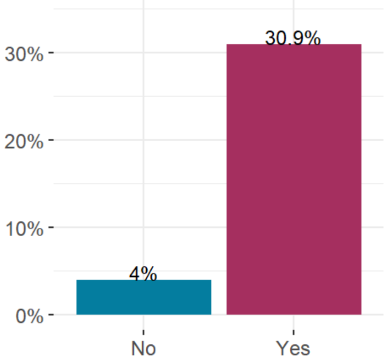

Figure 7 The proportion of A level Mathematics students, in 2021, that progress to a mathematical sciences degree, split by whether the student also did A level Further Mathematics.

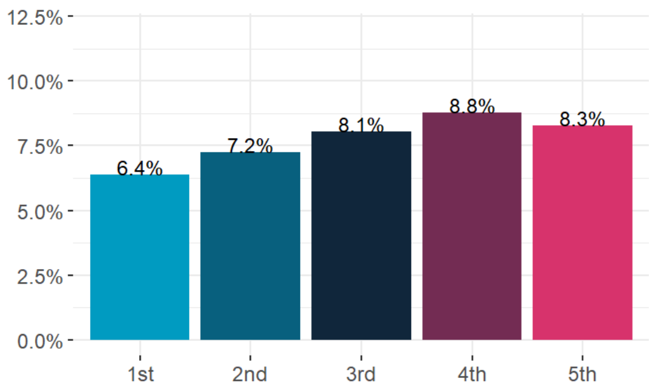

Figure 8 The proportion of A level Mathematics students, in 2021, that progress to a mathematical sciences degree, split by IDACI quintiles (1st indicates most disadvantaged).

The above analysis demonstrates that the undergraduate cohort is diverse in terms of its demographics, prior attainment and types of institutions attended. While male students, with high A level grades, studying at large universities in England is the largest group, it is important to note that there are many students who do not conform to that stereotype, and this impacts their expectations and lived experience of the transition to university.

2. Student confidence in mathematics

Nearly all students start their university mathematics degree confident in their mathematical ability, reporting that the discipline comes naturally to them with fewer of them feeling they needed to work hard to do well in mathematics at school (Figure 9, left). Having enjoyed the privileged position of being one of the best at mathematics in their school or college, only a minority of them think they will be among the best at university, recognising that the peer group against which they compare themselves will change dramatically.

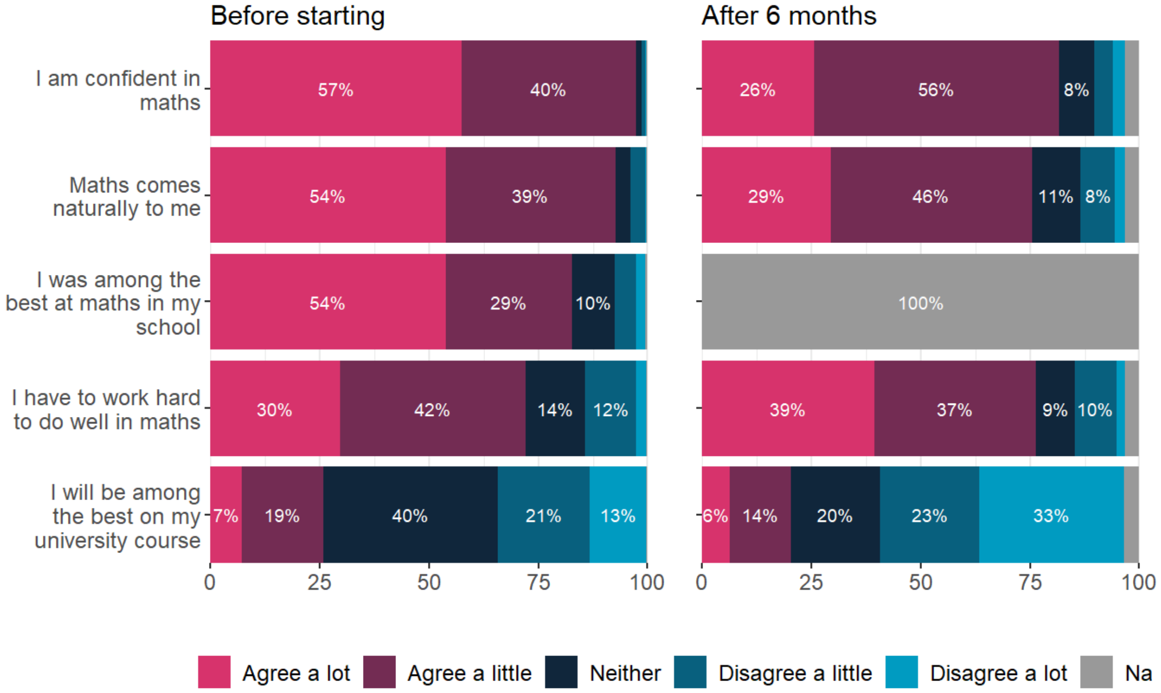

Figure 9: The agreement ratings across multiple statements measuring confidence in mathematics for survey 1 (left) and survey 2 (right) (N=723).

After six months at university, the levels of confidence in the student cohort have decreased, with a corresponding increase in the number reporting they have to work hard to do well (Figure 9, right). This adjustment is to be expected given the more challenging mathematical curriculum at university and is accompanied by an increase in the number of students recognising they are not among the best. For some students, the start of university is a test of their academic resilience as they struggle with mathematics for the first time.

These changes in mathematical confidence, though, are not experienced uniformly. The data shows that female students are more likely than male students to report a drop in confidence (Figure 10). Female students are also more likely to report having to work hard to do well in mathematics, both in school and university, even though there is no difference between the sexes in the proportion who report that mathematics comes naturally.

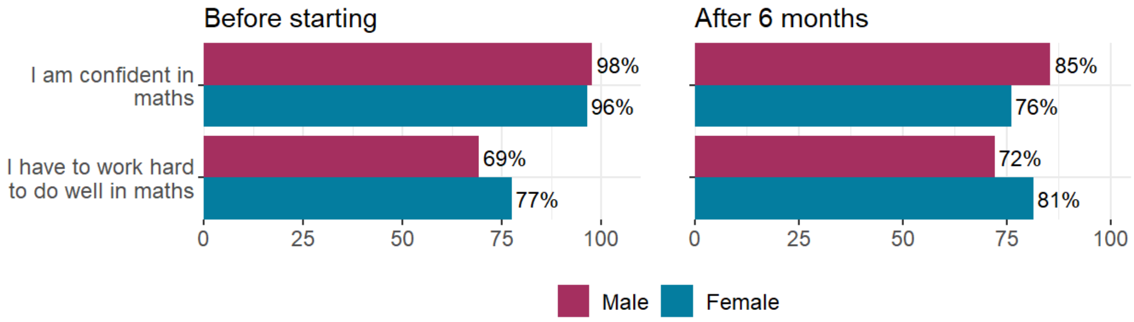

Figure 10: The percentage agreement (agree a lot or little) across two statements measuring confidence in mathematics for survey 1 (left) and survey 2 (right), split by gender[7] (N=284 females and 397 males).

There is very little difference in confidence levels between respondents of different socio-economic status. However, those with the lowest socio-economic status had the most unrealistic expectations, prior to starting, of their ranking at university but this difference is not present after six months (Figure 11).

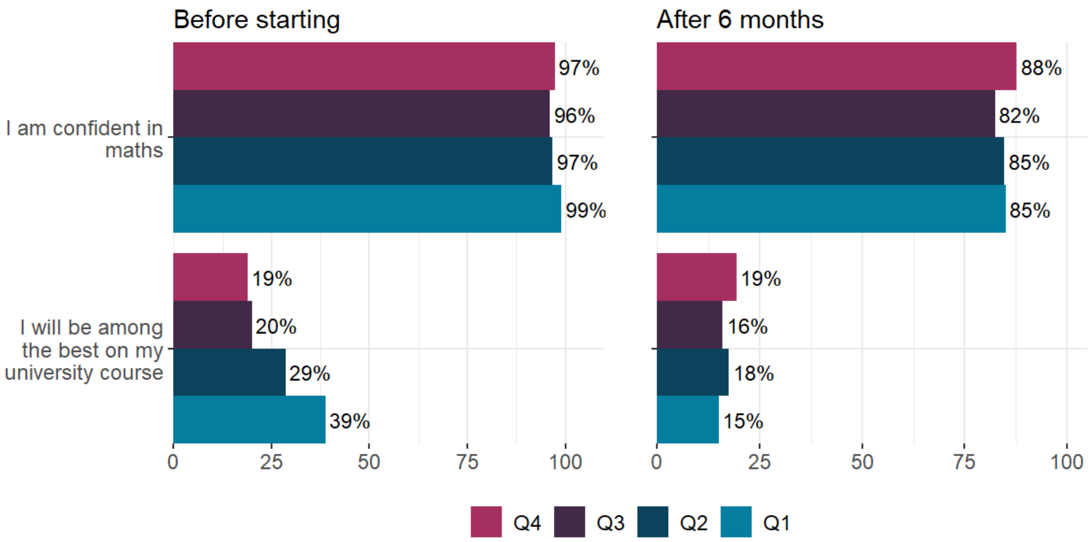

Figure 11: The percentage agreement (agree a lot or little) across two statements measuring confidence in mathematics for survey 1 (left) and survey 2 (right), split by IMD[8] quartile; Q1 is most disadvantaged (N=93 in Q1, 91 in Q2, 125 in Q3 and 186 in Q4).

Students at the universities with the highest entry requirements report a greater drop in confidence than those attending universities with lower entry requirements (Figure 12). Furthermore, students at universities with high entry requirements are more likely to experience not being the best at mathematics among their peers for the first time.

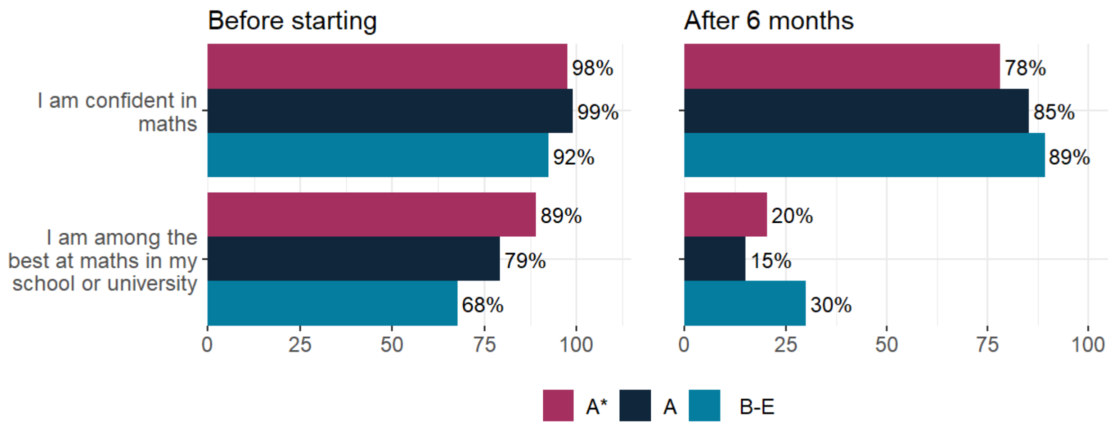

Figure 12: The percentage agreement ratings (agree a lot or little) across two statements measuring confidence in mathematics for survey 1 (left) and survey 2 (right), split by the typical A level Mathematics entry requirement[9] at the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

Unsurprisingly, after six months at university, students' reported confidence in mathematics and sense of whether mathematics comes naturally are both correlated with their expectation of their first-year mark. Those who think they are on track for a first-class average are twice as likely to report confidence in mathematics compared to those on track for less than 50% (Figure 13). However, these expected first-year outcomes cannot be predicted by confidence levels, or whether mathematics comes naturally, prior to starting. Students with lower expected outcomes were marginally more likely to report having to work hard, but generally there is a disconnect between self-reported effort and expected first-year mark.

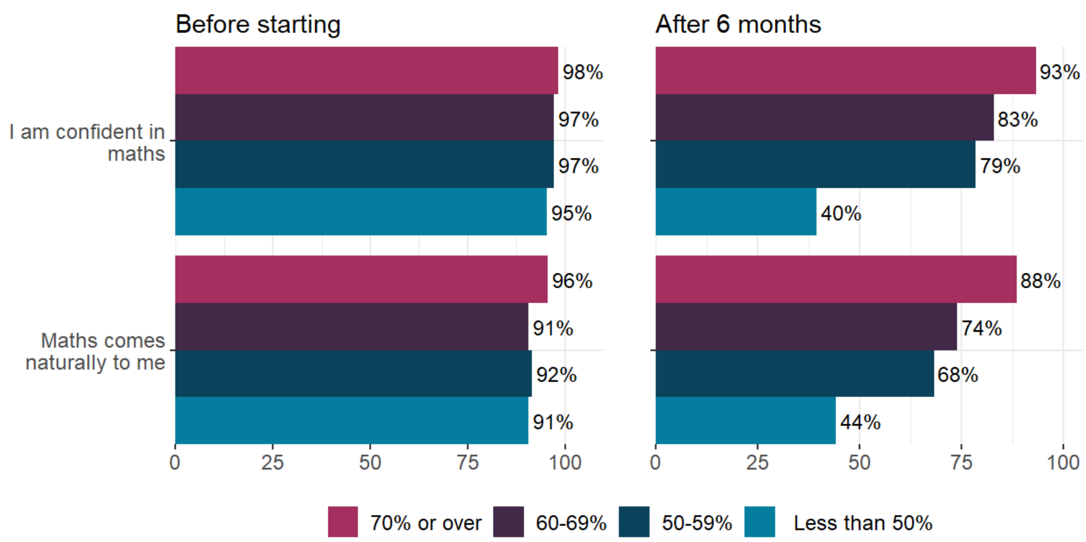

Figure 13: The percentage agreement ratings (agree a lot or little) across two statements measuring confidence in mathematics for survey 1 (left) and survey 2 (right), split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

3. Aids to learning mathematics

At first glance there is little difference in how students report their experiences of learning mathematics at university compared to school or college (Figure 14). *'Working through problems or exercises'* and *'working through past paper questions'* are almost universally seen as the most helpful ways to learn mathematics. With most of the undergraduate cohort embarking on their mathematical degree following high-stakes qualifications such as GCSE Mathematics and A level Mathematics in England, this is perhaps to be expected. While many educators may advocate that wrestling with mathematical problems aids learning, not all universities publish a bank of past papers. As a result, some school-acquired exam preparation strategies (e.g. question spotting) may be less fruitful at university. After six months, there is nothing to suggest students are less assessment-driven than prior to arrival.

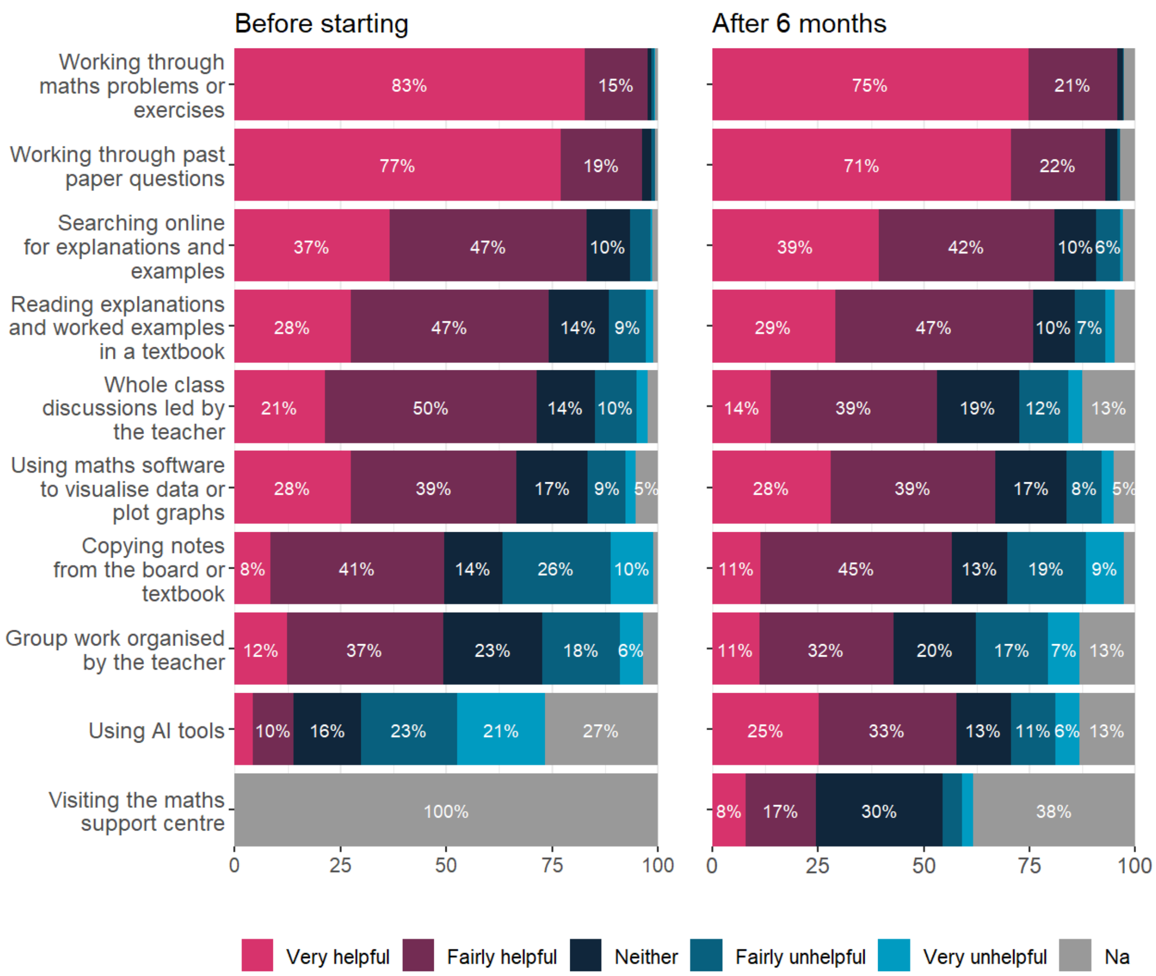

Figure 14: The ratings of how helpful students found different resources when learning mathematics for survey 1 (left) and survey 2 (right) (N=723).

The biggest change in the first six months of university is the use of artificial intelligence (Figure 14). Prior to starting, less than a fifth of students reported *'using AI tools'* as useful in their learning of mathematics. Around two-thirds of students reported AI as either unhelpful or did not respond to the question, probably indicating that they had not used AI. After six months of university, 58% of students report that AI tools are helpful to learning mathematics. More collaborative forms of learning, such as *'whole class discussions'* or *'group work organised by the teacher'*, are reportedly less helpful.

Some students report mathematics support centres as helpful, but these are not available at all universities. Female students are more likely to find visiting the mathematics support centre helpful (33% of females compared to 19% of males). They are also more likely than male students to find copying notes from the board or textbook helpful (Figure 15). Although female students were less inclined to find AI tools useful before starting university, there was no difference between the sexes after the first semester.

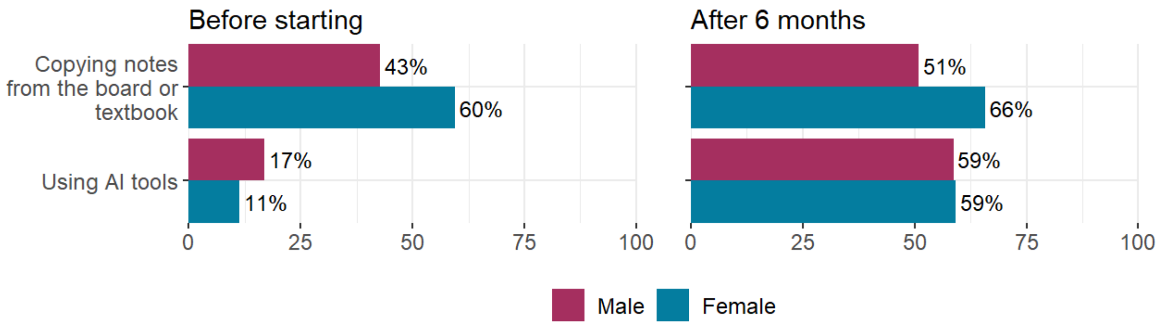

Figure 15: The percentage of students who found each tool very or fairly helpful in survey 1 (left) and survey 2 (right), split by gender (N=284 females and 397 males).

One concern about the introduction of AI into higher education is that the cost is discriminatory to students from low-income families. The data shows that students from all socio-economic backgrounds find AI equally helpful which may suggest cost is not driving study habits (Figure 16).

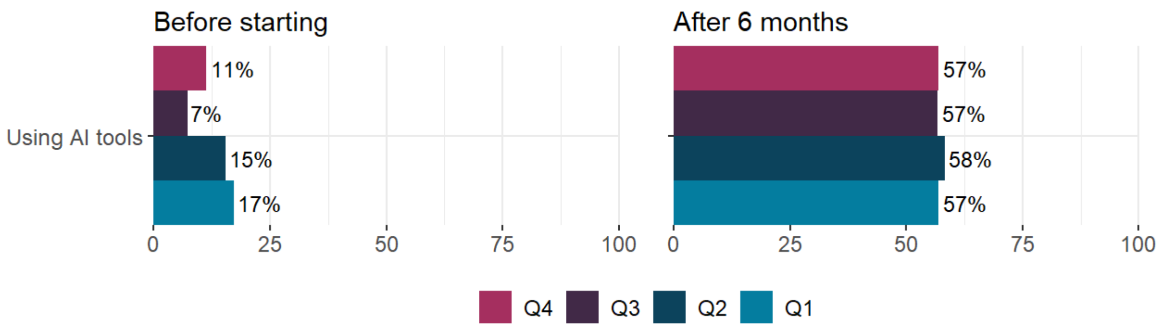

Figure 16: The percentage of students who found each tool very or fairly helpful in survey 1 (left) and survey 2 (right), split by the respondent's IMD quartile (Q1 is most disadvantaged) (N=93 in Q1, 91 in Q2, 125 in Q3 and 186 in Q4).

Students who are anticipating both higher and lower grades at the end of year 1 use computers to support their studies, but they appear to do this is different ways. Students who consider themselves to be on track for a first-class average are much more likely to find it helpful to use mathematics software to visualise data or plot graphs, whereas students on track for less than 50% are more likely to find AI tools helpful (Figure 17). The correlation between reported use of AI and expected low attainment raises interesting questions regarding the possible underlying causal relationship. Students at universities with higher entry requirements place greater emphasis on traditional learning techniques, such as reading explanations and worked examples in textbooks, than AI (Figure 18).

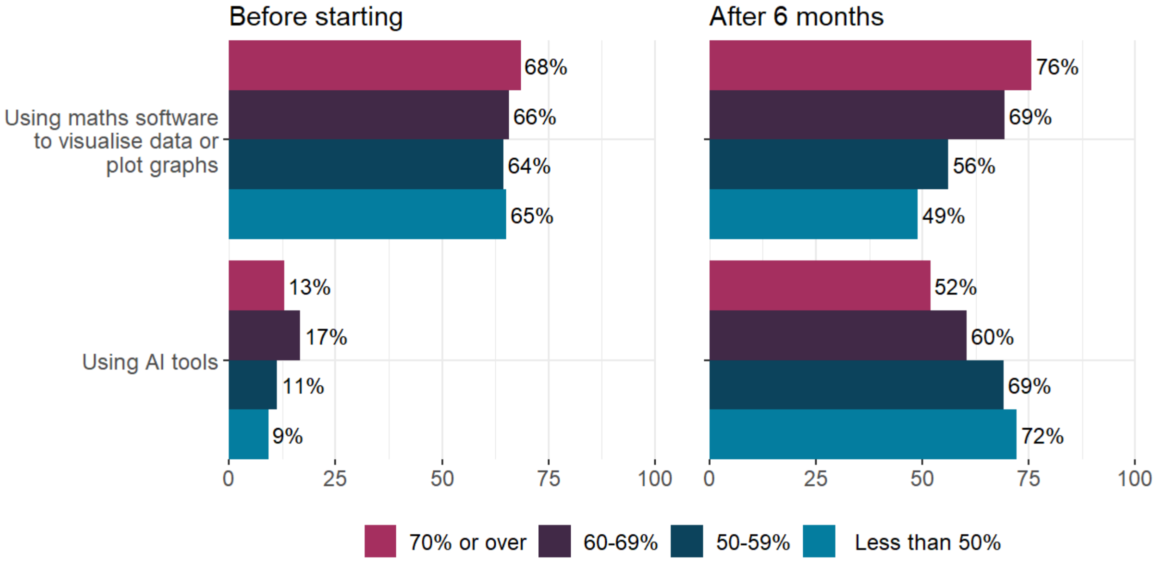

Figure 17: The percentage of students who found each tool very or fairly helpful in survey 1 (left) and survey 2 (right), split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

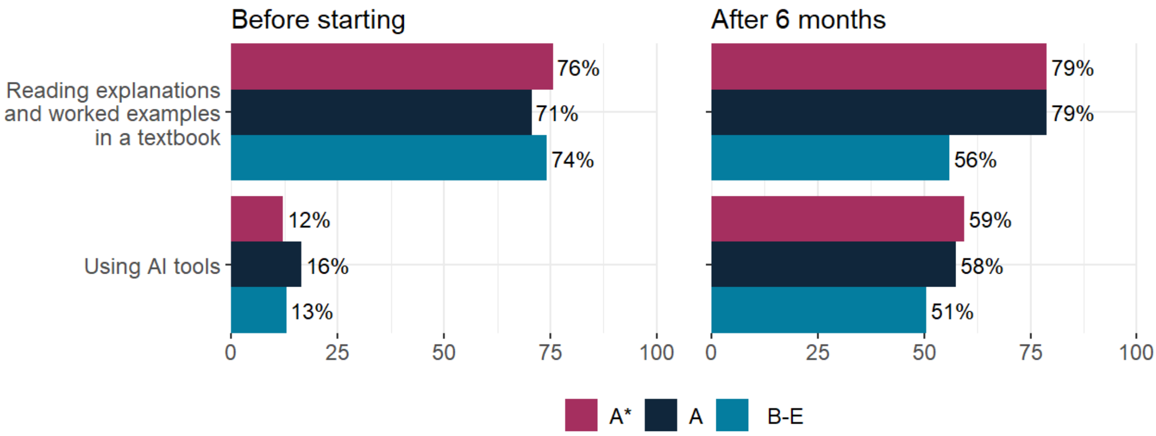

Figure 18: The percentage of students who found each tool very or fairly helpful in survey 1 (left) and survey 2 (right), split by the typical entry requirements at the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

4. Student learning strategies

The learning strategies that students reported using after the first six months at university are not very different from school or college (Figure 19). Students place great emphasis on problem solving to measure their understanding. Interestingly, a majority of students believe that they *'learn maths best when I work on my own'* even though they also believe they *'learn a lot from explaining maths to others'*.

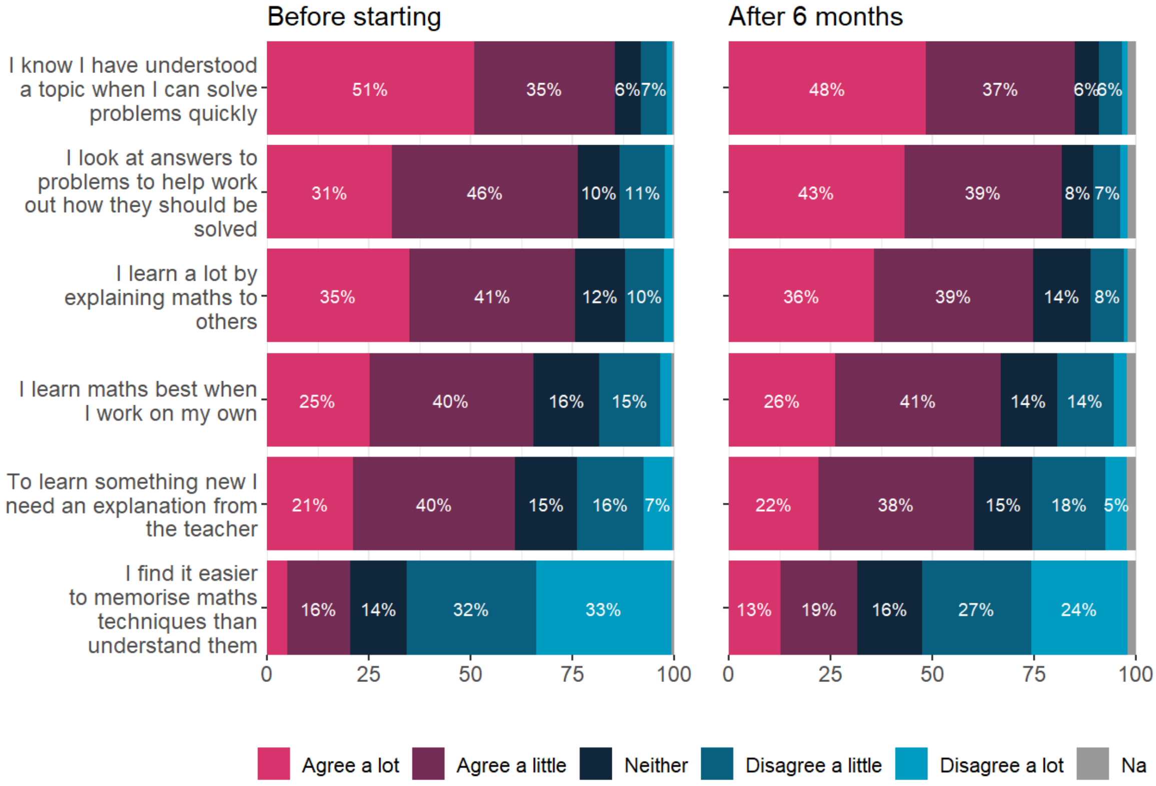

Figure 19: The agreement ratings across multiple statements investigating student learning strategies for survey 1 (left) and survey 2 (right) (N=723).

Of potential concern is a rise in the number of students reporting that the first semester of university has taught them it is *'easier to memorise techniques rather than understand them'*. This increase in memorisation is greater among female students compared to male students (Figure 20). Female students are also more likely to report needing an explanation from the teacher when learning something new. Similarly, female students are 10 percentage points less likely than male students to think they learn mathematics best when working on their own.

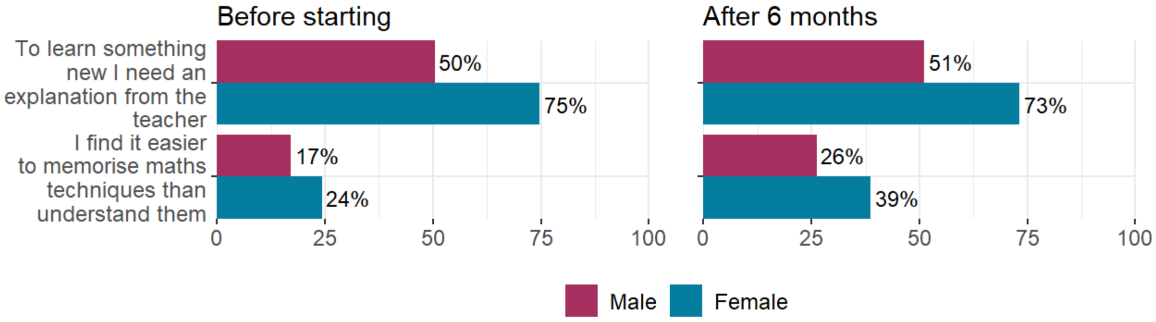

Figure 20: The percentage agreement (agree a lot or little) across two statements investigating student learning strategies for survey 1 (left) and survey 2 (right), split by gender (N=284 females and 397 males).

The trends associated with female students, a greater reliance on teacher explanations and memorisation over understanding, are also found among students with lower expected grades compared to students with higher expected grades (Figure 21). Potentially, because female students are less confident and therefore may report lower expected grades, these relationships are connected, but the differences between higher and lower attaining students is even greater than the differences between male and female students.

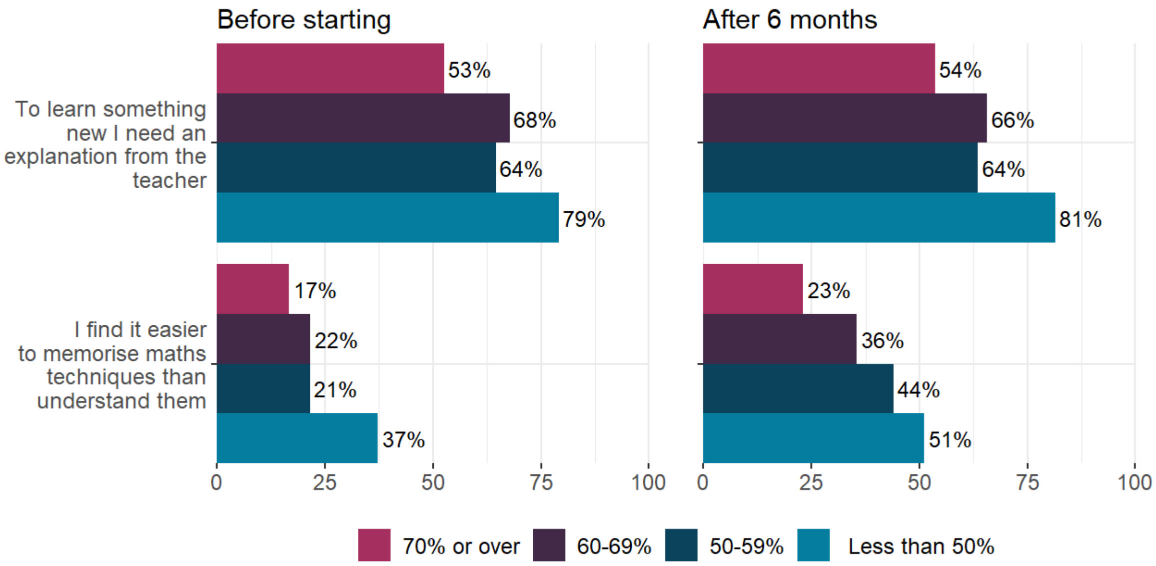

Figure 21: The percentage agreement (agree a lot or little) across two statements investigating student learning strategies for survey 1 (left) and survey 2 (right), split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

Less reliance on memorisation and teacher explanations is also a hallmark of students accepted for entry at universities with higher entry requirements (Figure 22). However, after the first semester of undergraduate study there is less difference between the types of university. This suggests that, regardless of an institution's entry requirements, a similar proportion of students think they are beginning to struggle. Indeed, the proportion of students reporting they are resorting to memorisation without understanding for the first time is greatest at the universities with higher and middle entry requirements, suggesting the transition phase is most challenging at these institutions. There is very little relationship between student learning strategy and socio-economic status (Figure 23).

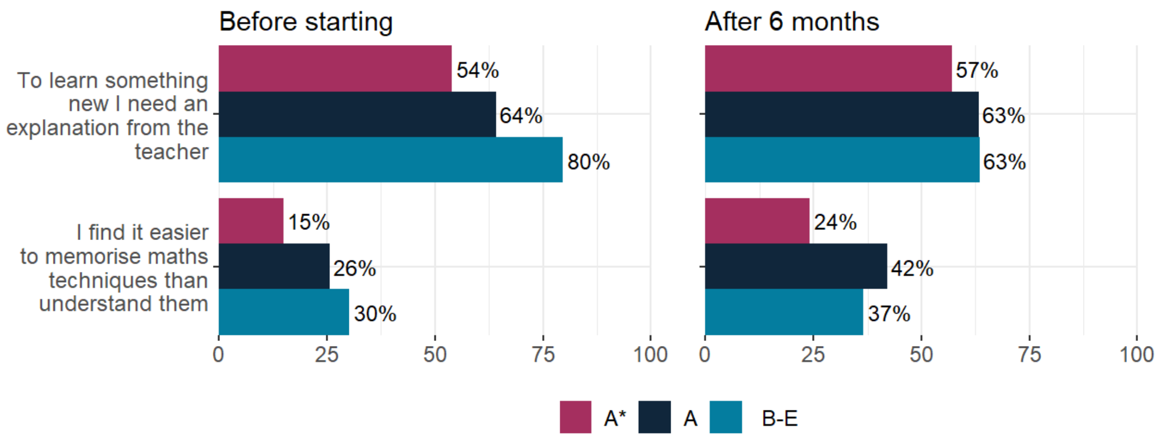

Figure 22: The percentage agreement across two statements investigating students' learning strategies for survey 1 (left) and survey 2 (right), split by the typical entry requirements at the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

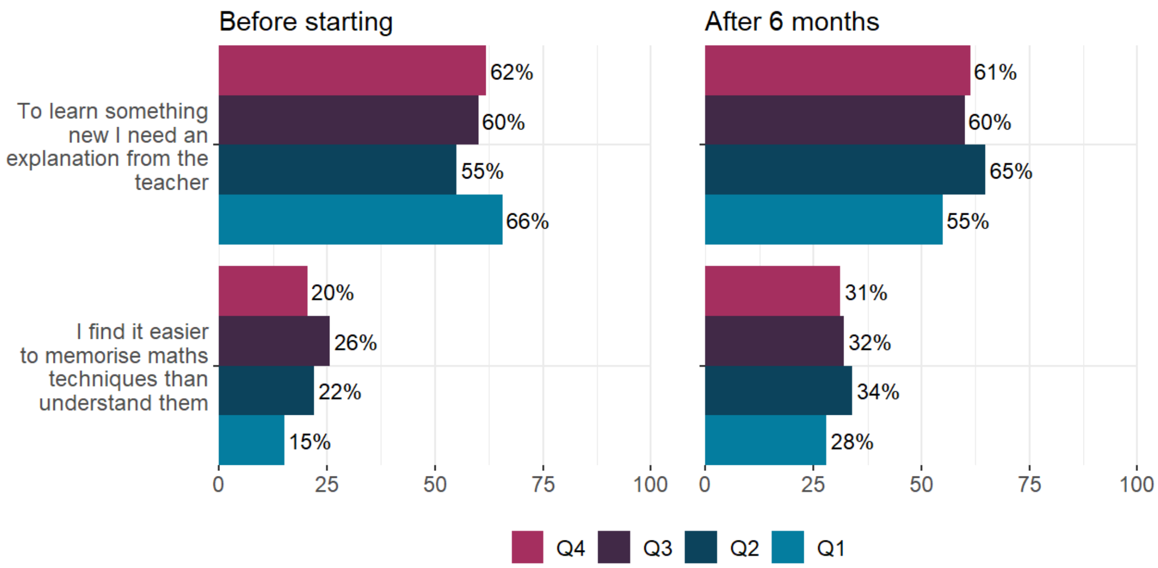

Figure 23: The percentage agreement (agree a lot or little) across two statements investigating student learning strategies for survey 1 (left) and survey 2 (right), split by IMD quartile (Q1 is most disadvantaged) (Q1 is most disadvantaged) (N=93 in Q1, 91 in Q2, 125 in Q3 and 186 in Q4).

5. Curriculum and pedagogy

After completing one semester at university, respondents were asked to reflect on the change since learning mathematics at school or college (Figure 24). The vast majority of students report that university mathematics is *'much more difficult'* than A level or equivalent. Nevertheless, the majority of students prefer the curriculum content of their mathematics degree compared to the topics covered in school and college. However, there is less support for the pedagogic practices found in universities with only 38% preferring the teaching style at university compared to 43% preferring the teaching style at school or college.

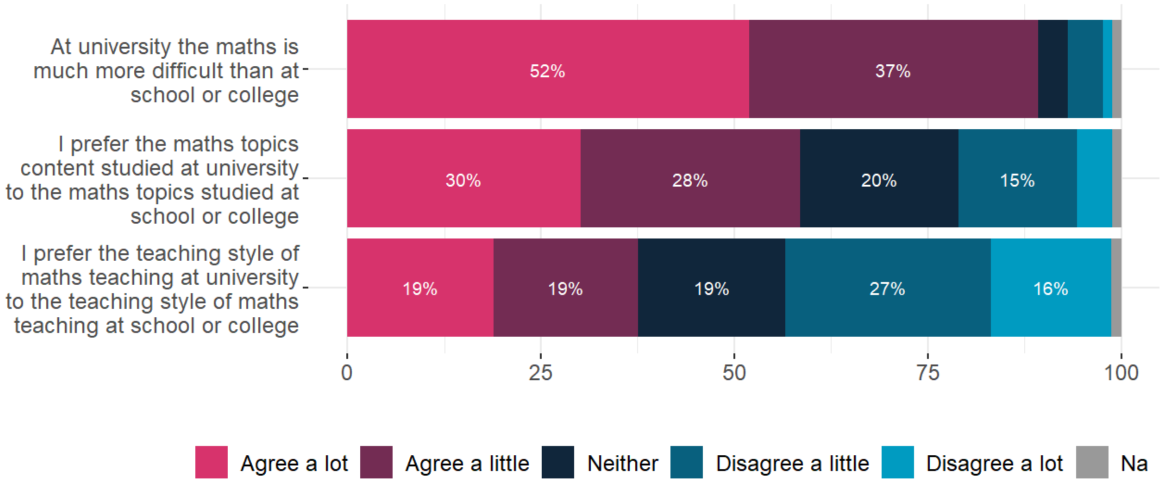

Figure 24: The agreement ratings across multiple statements comparing student experience of university with their previous experience of school or college (N=723).

The data provide some clues to explain these views on university teaching (Figure 25). A majority of students report that university lectures contain too many new ideas and move on to new topics too quickly. During this transition phase, students report struggling with the pace of learning and a lack of time for reinforcement, repetition and revision. Only 64% report they need to attend all timetabled teaching sessions to do well, which has fallen from 92% who anticipated that they would need to do so prior to starting the degree. Reasons for missing teaching sessions are discussed in the next section. Part of the difficulty may also come from the fact university mathematics needs to be written much more precisely compared to school or college, although most students recognise the university curriculum follows on directly from school or college.

These general trends, though, are reported differently within the student population. Female students, compared to males, are more likely to report the pace of learning is too fast, more likely to feel the need to attend all timetabled teaching sessions (Figure 26) but are 21 percentage points less likely to prefer the topics studied at university. Interestingly, when asked analogous questions before starting university, there was little difference between males and females in their expectation of studying at university. All this points to female students perceiving the transition phase to be a more difficult experience, perhaps unexpectedly so from their perspective, compared to male students.

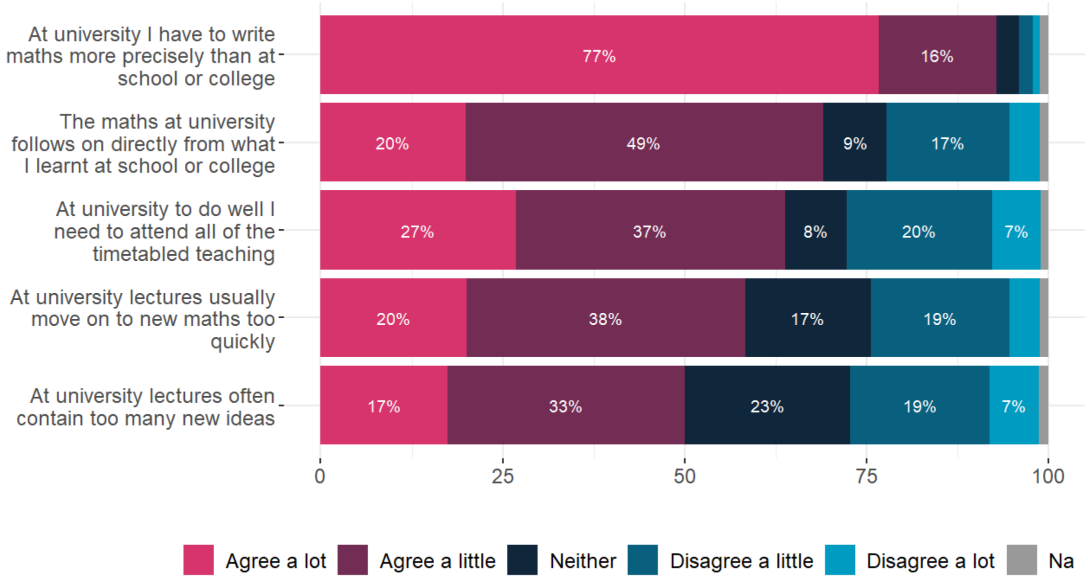

Figure 25: The agreement ratings across multiple statements regarding student experience of learning mathematics at university (N=723).

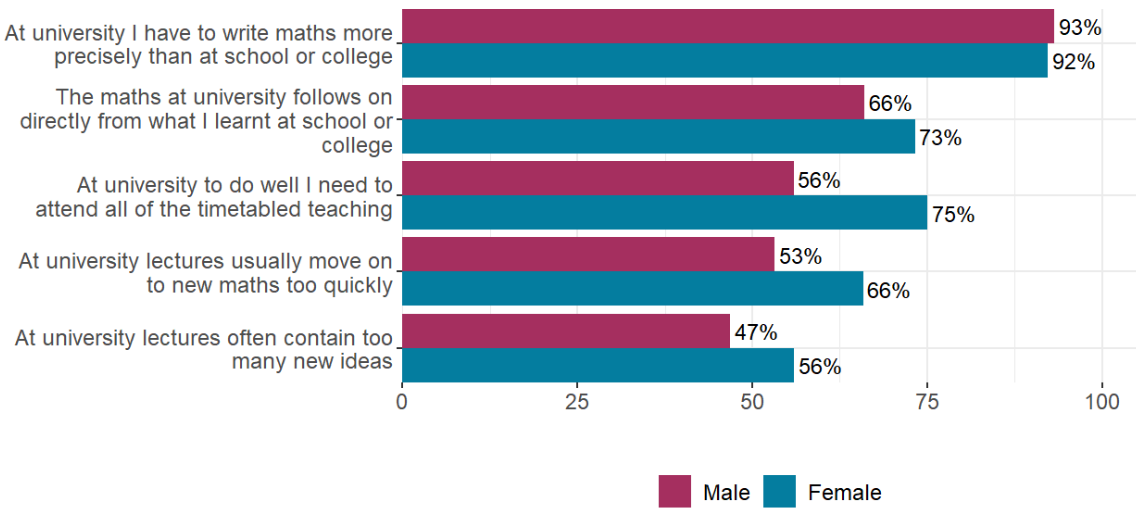

Figure 26: The percentage agreement (agree a lot or little) across statements regarding students' experience of learning mathematics at university, split by gender (N=284 females and 397 males).

The pace of learning is generally reported as a problem similarly across universities with different entry requirements (Figure 27). However, students at universities with higher entry requirements are less likely to report the curriculum follows on from school or college, suggesting a bigger jump in demand at these institutions, with the percentage reporting the programme to be much more difficult 20 percentage points higher at these institutions compared to those with the lower entry requirements. Although being stretched more in terms of difficulty, students at the universities with the highest entry requirements are less likely to feel the need to attend all timetabled teaching. This could be evidence of greater independent learning at these institutions, or a reflection on differences in pedagogy between the different institutions.

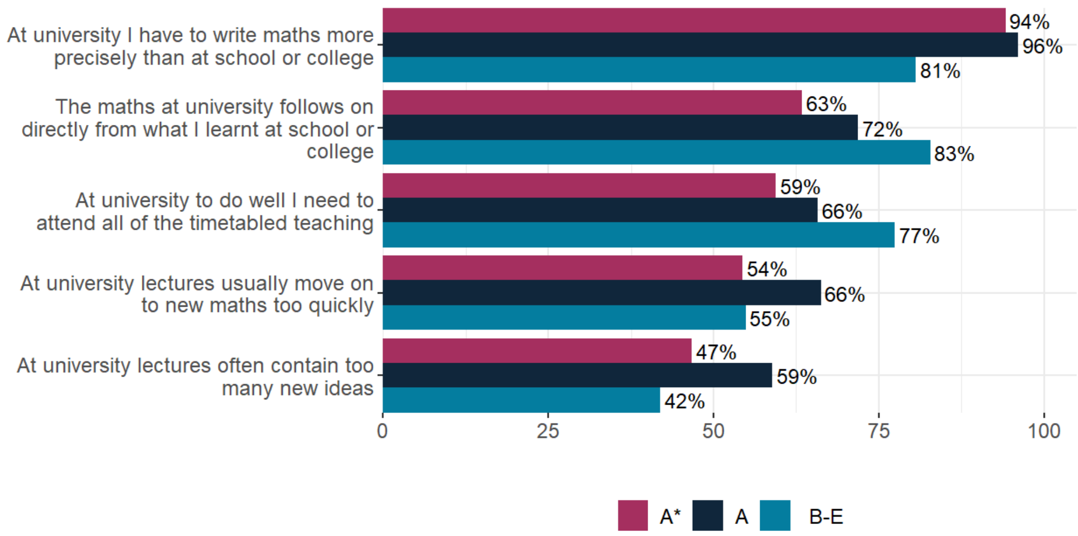

Figure 27: The percentage agreement (agree a lot or little) across statements regarding student experience of learning mathematics at university, split by the typical entry requirement of the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

As one might expect, there are strong associations between these measures and expected first year mark (Figure 28). Students who consider themselves on track for lower grades are much more likely to report the pace of learning is too fast, the curriculum does not follow on and dissatisfaction with the style of teaching at university, compared to their peers. What is more surprising is that students who are struggling academically are only marginally more likely to report the mathematics as being much more difficult than school or college. There is little relationship between the necessity to attend all timetabled teaching sessions to do well and self-reported expected outcomes. It seems nearly all students find the transition phase challenging but clearly not all students are making the 'jump'. There were, however, no notable differences between students of different socio-economic status in this regard.

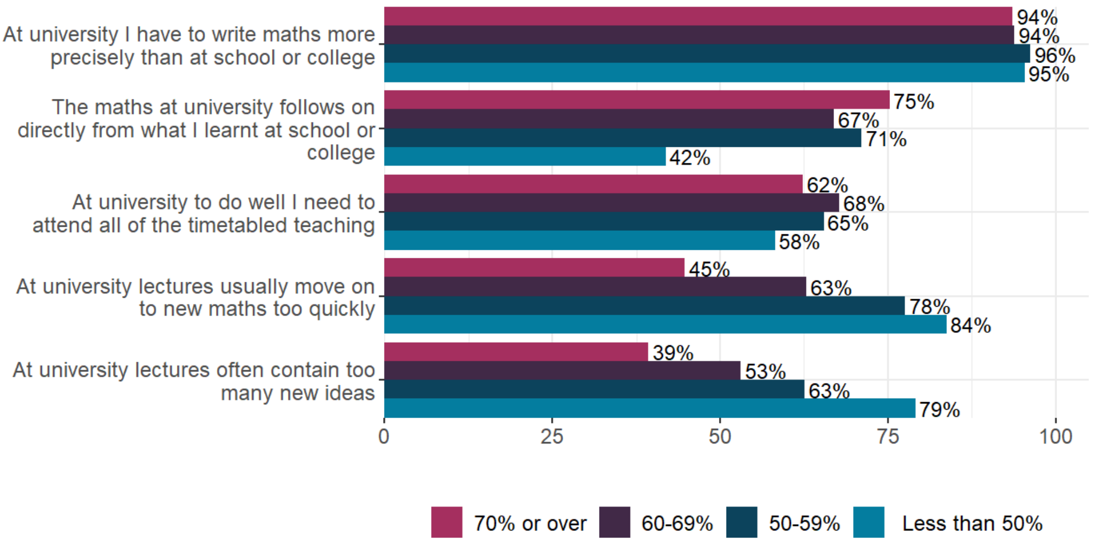

Figure 28: The percentage agreement (agree a lot or little) across statements regarding student experience of learning mathematics at university, split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

6. Attendance and feedback

Of the respondents, 55% of male students reported they attended all or almost all timetabled teaching sessions each week compared to 63% of female students (Figure 29).

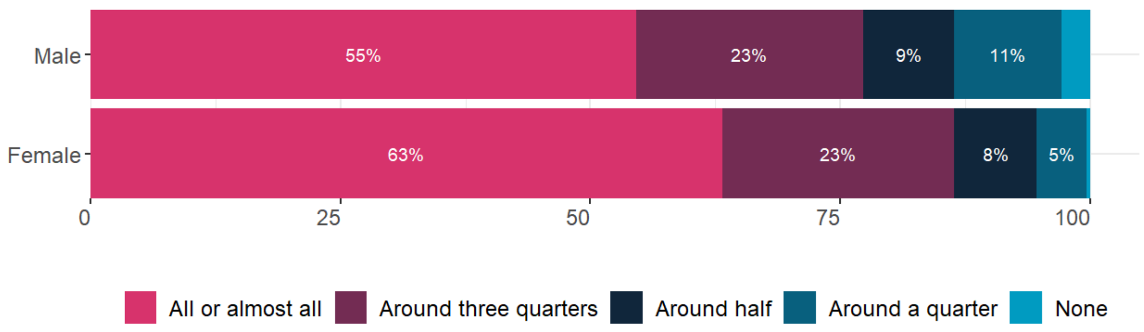

Figure 29: The proportion of timetabled sessions attended, split by the respondent’s gender (N=280 females and 383 males).

Those who attend more timetabled sessions are more likely to be anticipating higher grades (Figure 30). However, this may not be evidence of a causal relationship, since there was little difference in the perception of how necessary attendance is among the different expected outcomes groups (Figure 28).

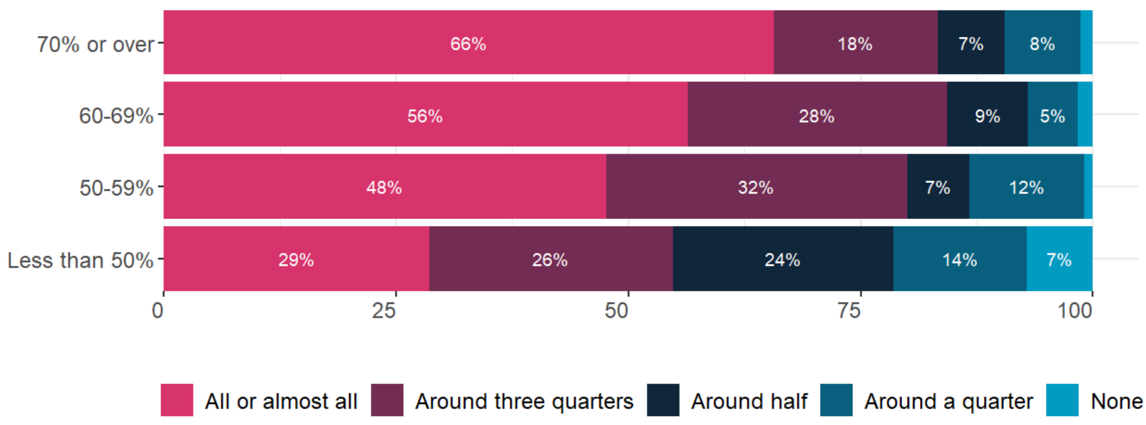

Figure 30: The proportion of timetabled sessions attended, split by the respondent's expectation of their overall first year average mark (N=294 expecting over 70%, 243 between 60-69%, 105 between 50-59% and 42 less than 50%).

For those who miss sessions, reasons for absence such as *‘health’* or *‘disability’*, are relatively uncommon (Figure 31). The most common reasons are that *‘I don’t find the session useful’* and *‘I would prefer to study on my own’*. This suggests some students are self-managing their learning, viewing teaching sessions as a resource which they may opt-in to. However, many students also report missing sessions because they have *‘fallen behind’* or due to *‘poor timekeeping’* which suggests that not all students are able to successfully self-manage their learning, and this may be a skill that needs developing during the transition phase. Although many students must support themselves financially, not many cited *‘employment’* as a reason for absence.

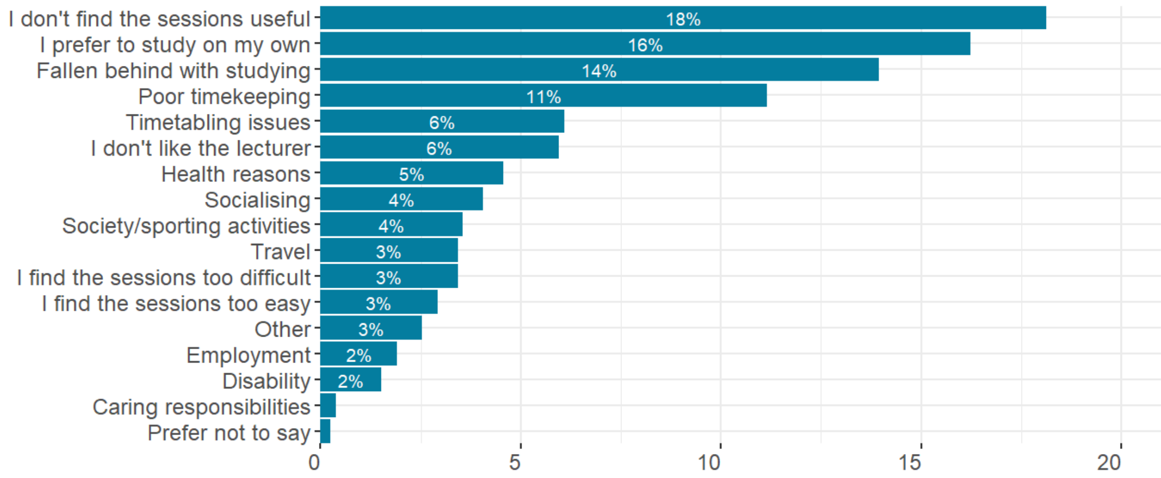

Figure 31: Percentage of times each reason was given for being likely to miss timetabled sessions (N=723).

Overall, 82% of students said they had received marks within the first six months of their course and 80% said they had received feedback. However, the data shows that students at different universities have different experiences. For example, two-thirds of students at a prestigious Russell Group university had not received marks but all had received feedback. Whereas a quarter of students at a different large Russell Group university had not received feedback even though nearly all reported receiving marks. At a third university, which has similar entry requirements to the Russell Group, over a third of students reported not receiving feedback and nearly three-quarters had not received marks at the time of the survey.

Of students who received feedback, only 26% strongly agreed that the feedback was useful, with 54% agreeing a little. Those on track for lower expected grades were less likely to find their feedback useful (Figure 32). Therefore, another challenge of the transition phase is helping students to recognise different forms of feedback, which may be less personalised than in the small class teaching received in school or college, and acting on it appropriately. Of those who received marks, 79% reported that they were happy with their grades.

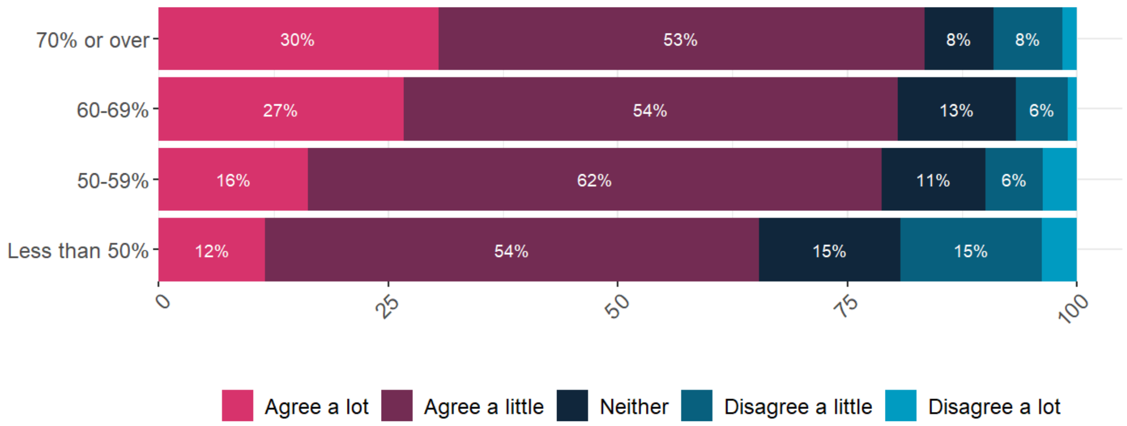

Figure 32: The proportion of students who have received feedback who find the feedback useful, split by the respondent's expectation of their overall first year average mark (N=253 expecting over 70%, 195 between 60-69%, 80 between 50-59% and 26 less than 50%).

7. Coding and programming

One clear difference between mathematical courses at university and those in school or college is the introduction of specialist software and programming languages such as Python or R. For most mathematics students this presents a new challenge with only 30% reporting confidence in coding before starting university (Figure 33). After six months, this has risen to 39% with 36% finding it easy, but these numbers might still be considered too low given that 62% are expecting to use coding after their degree.

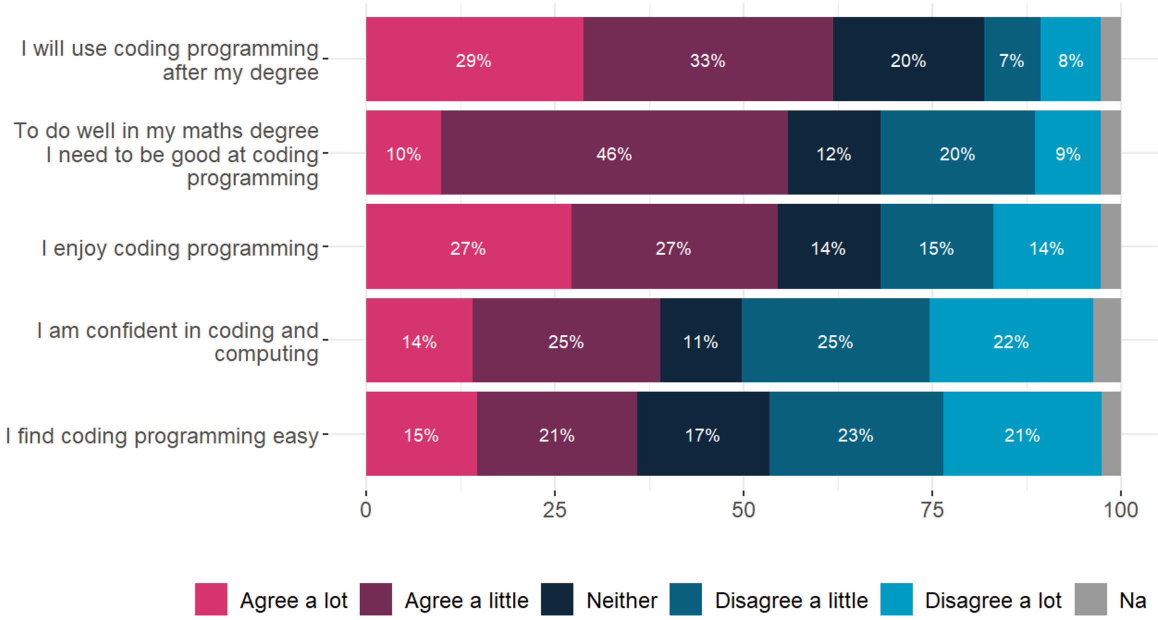

Figure 33: The agreement ratings across multiple statements on coding and computing for survey 2 (N=723).

There is a clear gender difference regarding coding (Figure 34). Male students are 17 percentage points more likely than female students to report confidence in coding before starting their degree and this gap does not substantially change in the first semester. Despite finding it harder and less enjoyable than male students, female students are more likely to recognise they need to be good at coding to do well in their mathematical degree so supporting female students with coding may help address wider confidence issues too.

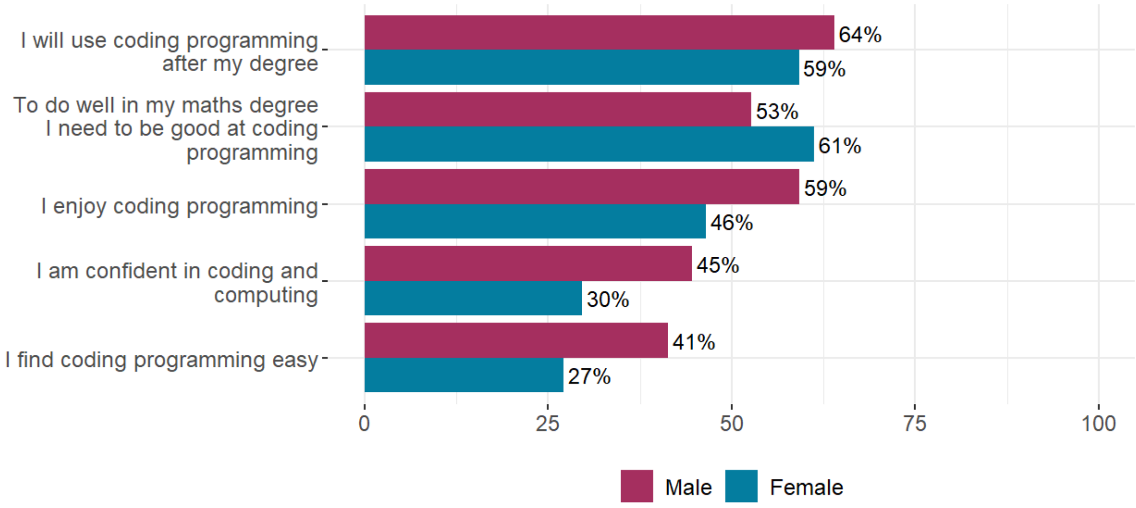

Figure 34: The percentage agreement (agree a lot or little) across statements on coding and computing for survey 2, split by gender (N=284 females and 397 males).

Students attending universities with higher entry requirements were marginally more confident in coding, prior to starting, than students who attend other universities. However, that gap grows over the first semester, with students at universities with higher entry requirements much more likely to find coding easy and enjoyable than students elsewhere (Figure 35). From the data we cannot tell if this gain at 'elite' universities is due to more specific teaching on programming or some other factors.

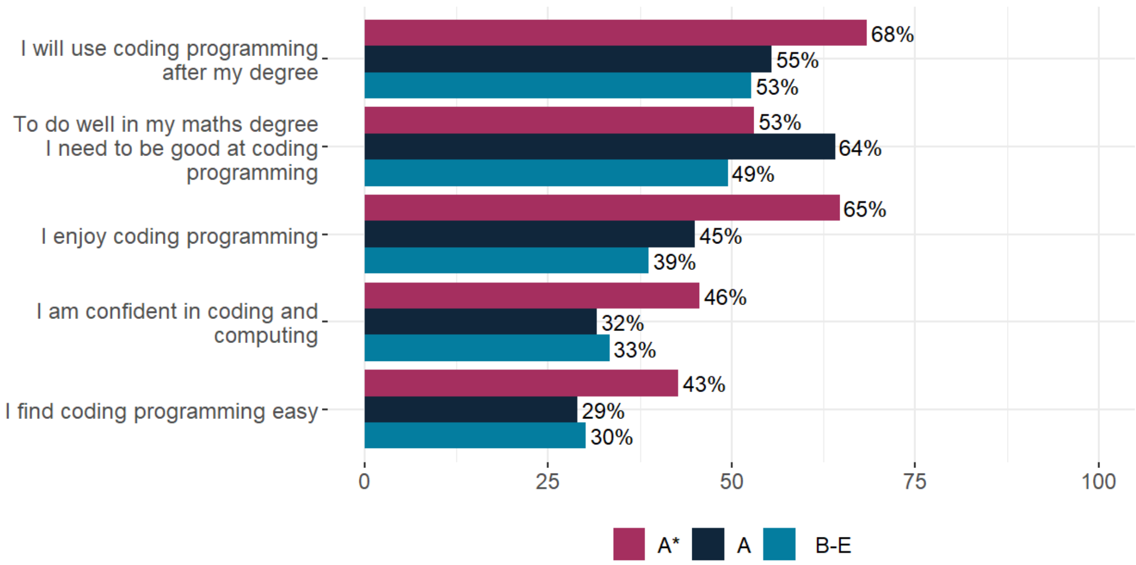

Figure 35: The percentage agreement (agree a lot or little) across statements on coding and computing for survey 2, split by the typical entry requirements at the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

There is some evidence that students from wealthier areas start university with more confidence in coding, but this gap has narrowed after the first semester (Figure 36). If the gap prior to starting was due to inequitable availability of computing resources, then there is some evidence that university resources are reducing the disparity. Interestingly, self-reported confidence in computing prior to starting the degree is a reasonable predictor of expected first year mark (Figure 37), much more so than confidence in mathematics itself (Figure 13). There is some evidence, therefore, that extra-curricular knowledge and skills may be a differentiator between students who successfully transition to university.

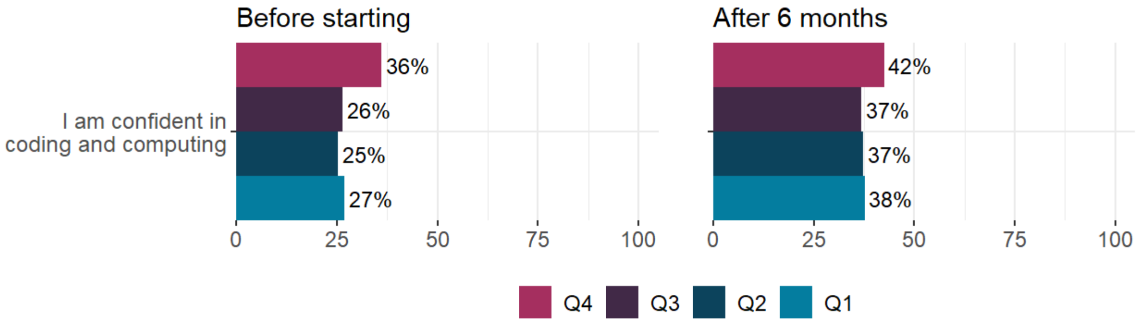

Figure 36: The percentage agreement (agree a lot or little) for confidence in coding and computing for survey 1 (left) and survey 2 (right), split by IMD quartile (Q1 is most disadvantaged) (N=93 in Q1, 91 in Q2, 125 in Q3 and 186 in Q4).

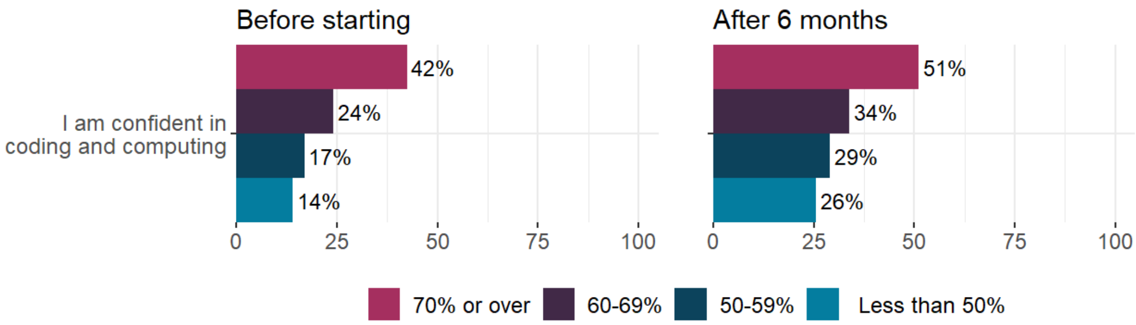

Figure 37: The percentage agreement (agree a lot or little) for confidence in coding and computing for survey 1 (left) and survey 2 (right), split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

8. Nature of mathematics

Students were presented with ten statements about the nature of mathematics and asked to agree or disagree with each of them. There was large support for statements which conveyed mathematics as an 'exploratory' subject in terms of solving problems multiple ways, new ideas, creativity, and helping us to understand the world. There was less support, although still reasonably large, for mathematics being 'formulaic' in terms of rules, equations, calculations, definitions and facts. Most university mathematics students do not think the subject is separate from the real world and only the study of numbers, although some branches of mathematics might fit that definition.

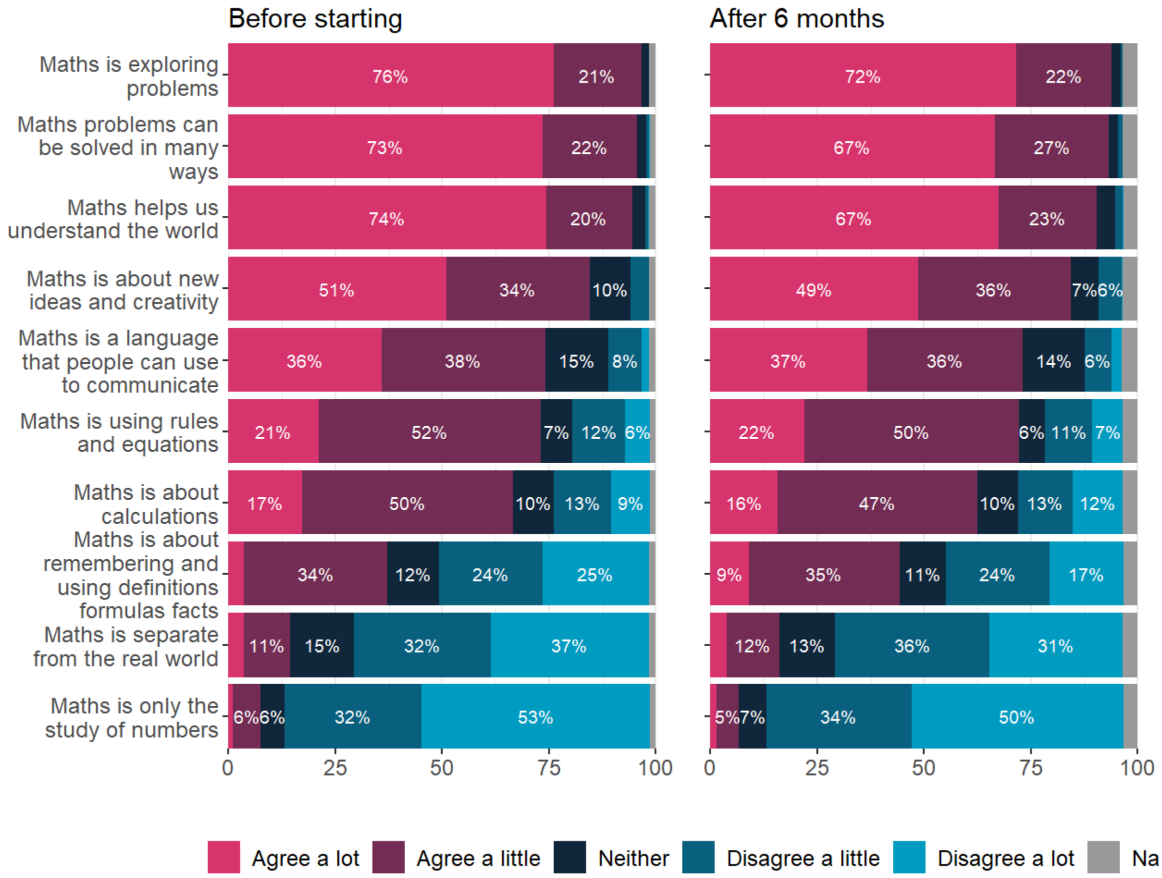

Figure 38: The agreement ratings across multiple statements on the nature of mathematics for survey 1 (left) and survey 2 (right) (N=723).

The results presented in Figure 38 show student opinion after six months of university is similar to prior to starting their degree. The fact that their view of mathematics has not substantially changed in six months is notable given earlier observations about mathematics at university being more difficult and needing to be written more precisely. The formal introduction of proof, more rigorous definitions of calculus, and greater emphasis on coding, for example, have not greatly changed students' perception of the nature of mathematics.

The 'exploratory' view of mathematics is held by nearly all sub-groups of students. There are more notable differences, though, in who holds a more 'formulaic' view of mathematics. For example, female students are more likely to subscribe to this view compared to male students, and this difference was present before starting university even though both genders had, presumably, been exposed to the same mathematics curriculum at school (Figure 39).

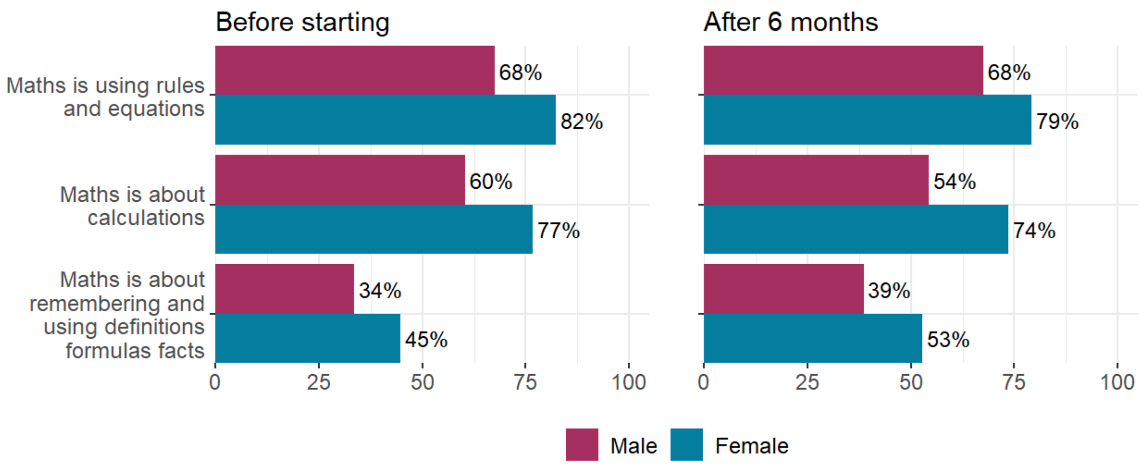

Figure 39: The agreement ratings (agree a lot or little) across multiple statements on the nature of mathematics for survey 1 (left) and survey 2 (right), split by gender (N=284 females and 397 males).

Students who attended school or college in the UK were much more likely to hold a 'formulaic' view of mathematics (Figure 40). Again, this difference existed prior to starting to university which may point to a different emphasis in the UK school mathematics curriculum compared to overseas equivalents.

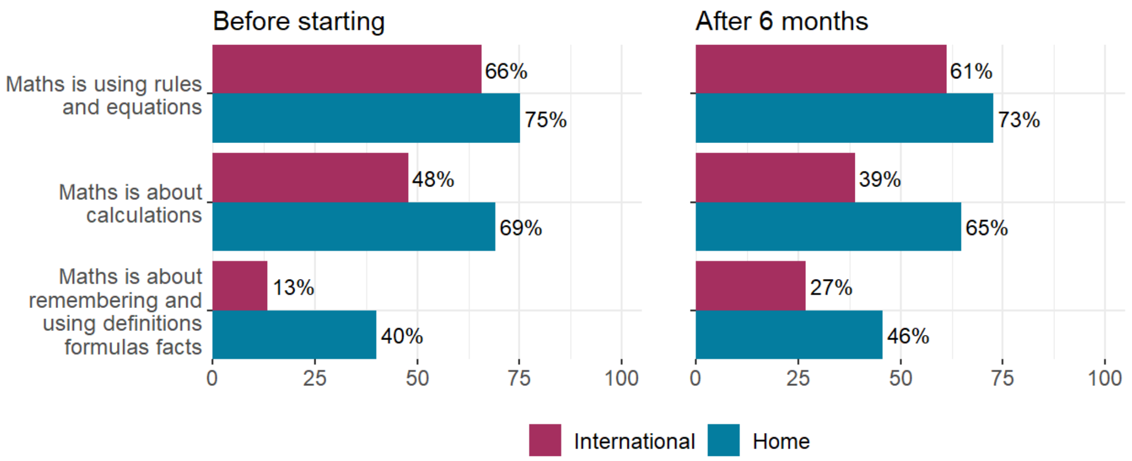

Figure 40: The agreement ratings across multiple statements on the nature of mathematics for survey 1 (left) and survey 2 (right), split by domicile (N=634 home students and 67 international students).

Students entering universities with higher entry requirements are less likely to hold a 'formulaic' view of mathematics (Figure 41). It is likely these students may have additional qualifications such as A level Further Mathematics or prepared for university admissions tests which may have changed or broaden their view of mathematics. However, views of mathematics don't necessarily correlate with expected first year marks, although there is some evidence that those who think they are on track for lower grades are more likely to describe mathematics as remembering and using definitions, formulas and facts (Figure 42).

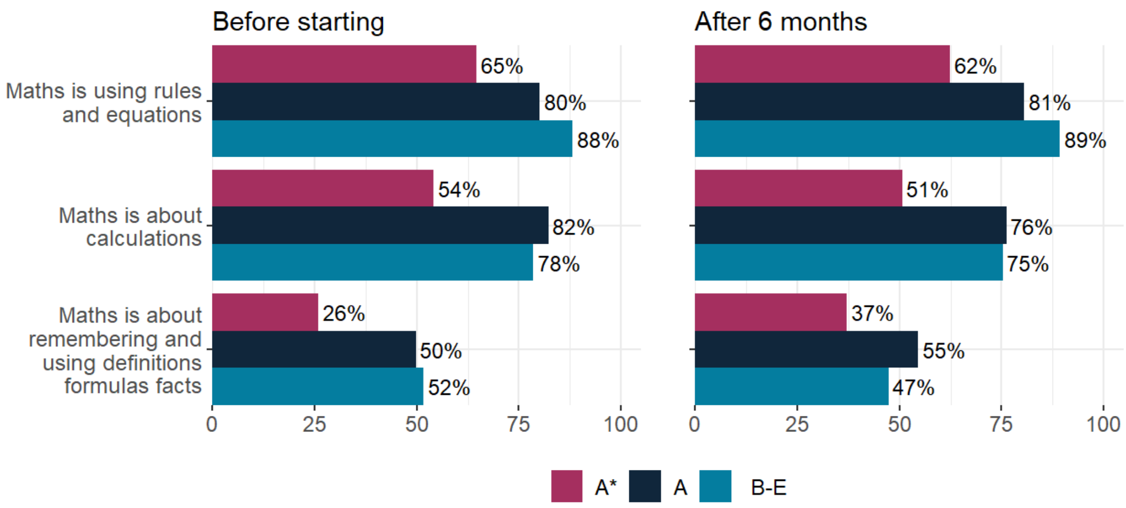

Figure 41: The agreement ratings across multiple statements on the nature of mathematics for survey 1 (left) and survey 2 (right), split by the typical entry requirements of the respondent's university (N=377 with typical A* entry requirement, 231 with an A entry requirement and 93 with a B-E entry requirement).

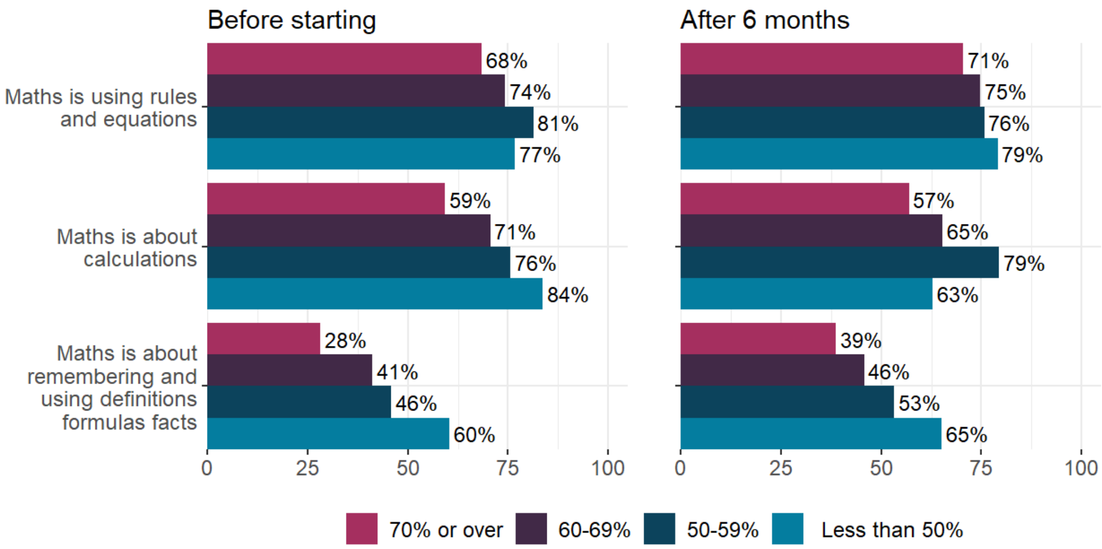

Figure 42: The agreement ratings across multiple statements on the nature of mathematics for survey 1 (left) and survey 2 (right), split by the respondent's expectation of their overall first year average mark (N=295 expecting over 70%, 245 between 60-69%, 107 between 50-59% and 43 less than 50%).

9. Student plans and aspirations

Although this report focuses on the first year of university, students were asked about their future career plans. After the first semester of university, 98% of students said they would like their future career to involve mathematics, with only 2% saying they intend to avoid mathematics in their career.

Following their undergraduate programme, 42% say their next step will be to start employment (with others seeking work-based training programmes) and 27% are aiming to complete further study at university (Figure 43). Of those intending to complete further study, 91% are planning to study a master's degree with 44% aiming for a doctoral programme. If they are to study a further programme, nearly all students said they will apply for programmes with a large mathematical component. Male students are 4 percentage points more likely to favour further study than female students. Unsurprisingly, there is strong correlation between a student's expected first year mark and their intention to do further study. A fairly large proportion of first year students (24%) have no clear plan for whether they will start employment or further study after their undergraduate degree.

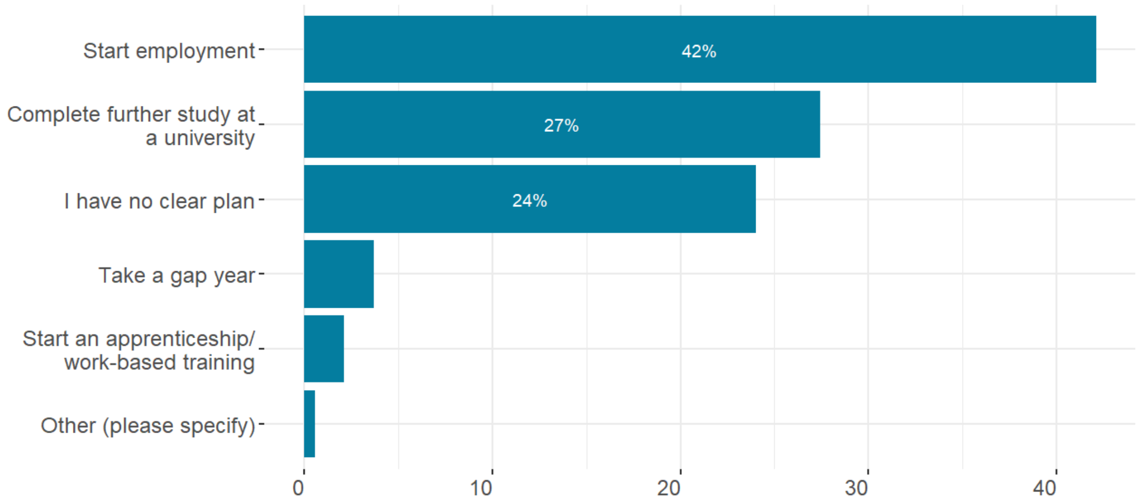

Figure 43: Proportions of students' current plans after completing their mathematical sciences degree (N=703).

Conclusion

The transition to university is seen by many as a rite-of-passage. Some aspects of the transition, for example increased independence, might be highly anticipated by students but there are also unexpected educational challenges. In terms of curriculum, the transition from school to university mathematics sees the introduction of formal proofs, the use of specialist software and coding, or the application of formal mathematics to solving open-ended problems. However, in the analysis above 69% of students can see how university curricula build on school and college qualifications, and the first semester of university does not change their overall perception of the nature of mathematics.

Student experience

In the first semester of university, many mathematical sciences students are struggling with learning mathematics, with only 26% very confident in mathematics after the first semester, compared to 57% prior to starting. For many, therefore, the first semester will be an unfamiliar test of their academic resilience. Consequently, 89% of the participating students report that university mathematics is much more difficult than their prior qualifications. While it might be expected that university courses stretch students more than school or college this is, most likely, an uncomfortable experience for many with the potential to impact their sense of belonging in the student mathematical sciences community.

Many students remain assessment-driven across the transition to university with 93% finding past paper questions a helpful way to learn mathematics, even though the closed nature of these questions contrasts with their view that mathematics is an open-ended, creative subject that helps them understand the world. There is an uplift in the proportion of students, from 20% to 32%, who find it easier to memorise techniques than understand them. This suggests a third of students are starting the second semester without a full understanding of foundational proofs and methods encountered in the first semester.

Before starting their degree studies, 92% of participating students thought they would need to attend all teaching sessions in order to do well, but this fell to 64% after the first semester. For some, non-attendance was a deliberate strategy (e.g. they prefer to study resources on their own) but for others it was because they had fallen behind or due to poor time keeping. Perceptions regarding the necessity of attending do not vary by self-reported ability levels, although students expecting to achieve higher grades reported attending a higher proportion of teaching sessions. This may have implications for university attendance policies.

Computing and AI

A major difference between school and university mathematics is the introduction of coding. Only 30% of students arrived at university confident in coding compared to 97% who are confident in mathematics. This immediately identifies it as an area for ongoing support during the transition phase, with only 39% confident after the first semester. A bigger contrast is found in the percentage of students using AI to help learn mathematics. This rises from 13% prior to starting to 58% after the first semester. It is unclear what is driving this increased use of AI, but potential causes include more challenging mathematical problems, fewer learning resources, better availability of AI tools, or different assessment types at university compared to school. The results show AI use is higher among students with lower expected first year mark. Given sector-wide interest in how AI will change teaching and assessment, understanding how students are using AI is important.

Preparing for university

For those helping students to prepare for university mathematics, the analysis presents some interesting challenges. While high prior attainment and confidence in mathematics may be useful for the university admission process, they do not make students immune to the challenges of transition. In fact, confidence in coding is a better predictor of expected first year mark than confidence in mathematics – 42% of students reporting they expect a first-class average were confident in coding prior to starting, compared to 14% of those expecting a third-class average (or lower). Home students, those coming from the UK school system, are three times more likely to believe mathematics is about remembering and using definitions, formulae and facts compared to international students, and this view is correlated with lower expected first year marks. This suggests a different approach to curriculum, assessment and extracurricular activities in 16-18 education, and perhaps earlier in the school system, may give students better preparation for university mathematics.

Equality, diversion and inclusion

In nearly every transition measure captured in this analysis, female students seem to be faring less well than their male peers. Female students are more likely to experience a drop in confidence in mathematics, more likely to find the pace of learning too fast and more likely to rely on memorisation. They also start university less confident than males in coding and that gap does not decrease after one semester. These differences might be partly explained by the gender attainment gap at A level[7], but the results show the gender differences during the transition phase are generally greater than might be expected given their A level grades.

In contrast to gender, there were only small differences between students of different socio-economic status. Those from the most deprived quartile were most confident about being among the best at their university but that pattern disappeared after six months. Likewise, results comparing ethnicities are not reported because there are few differences. One exception is students of White ethnicity struggling less with the pace of learning in lectures compared to other ethnicities. Given known patterns relating ethnicity and socio-economic status to prior attainment and participation in university mathematics[2], the absence of differences in this study with respect to learning mathematics in the first semester does not negate that there are wider issues that need attention.

A diverse sector

At the transition point, national qualifications are replaced by institution-specific programmes (albeit within the UK Framework for Higher Education Qualifications) which leads to the streaming of students based on prior qualifications. New students at universities with higher entry requirements relied less on memorisation or teacher explanations at school or college, have a less ‘formulaic’ view of mathematics and are more confident in coding than those starting programmes elsewhere. However, despite starting in a stronger position, their transition phase is not correspondingly easier because they also report a greater jump in curriculum (63% believe it follows on from school), struggle equally with the pace of learning, and experience a greater drop in mathematics confidence than those attending institutions with lower entry requirements.

Supporting students

This report has surfaced how changes in curriculum and teaching at the transition to university mathematics are experienced by students and how this relates to their engagement and attitudes with respect to learning and the subject. Other issues, such as how students cognitively process increasingly formal and abstract university mathematics, or wider socio-cultural and financial issues connected with transitioning to a new education phase and institution, inevitably play a role in determining whether students successfully transition.

This report has also highlighted how some student groups are more likely to have a negative transition phase than others. A deficit model approach would mean targeting learning support systems at these more vulnerable groups. However, it is also possible to view the transition ‘struggles’ experienced by many students as a positive stage in the formation of more independent mathematicians with greater knowledge, understanding, skills and competencies. The challenge, for university mathematics departments and the wider system, is how to practically support students during this phase so that transitionary ‘struggles’ are equally productive for all students.

The Observatory for Mathematical Education

The Observatory for Mathematical Education is undertaking an unprecedented ten-year programme of longitudinal research from reception to postgraduate level. This holistic, multi-scale and mixed-method programme aims to better understand our national system of mathematical education and support those trying to improve it. Further details can be found in the Introductory Report on the website.

Acknowledgements

This report was authored by Katie Severn and Chris Brignell with additional members of the Observatory team contributing to the survey design, data generation and aspects of the analysis. We are grateful to the University and Colleges Admissions Service (UCAS) for distributing the initial survey and all the students who responded. The views, findings and conclusions expressed in this report are strictly those of the authors.

Citation details

Observatory for Mathematical Education (2025). *Transitions to university mathematics.* University of Nottingham.

Endnotes

1. For a literature review, see Di Martino, P., Gregorio, F. & Iannone, P. (2023). The transition from school to university in mathematics education research: new trends and ideas from a systematic literature review. *Educ Stud Math*, *113*, 7–34. https://doi.org/10.1007/s10649-022-10194-w.
2. Brignell, C., Noyes, A. & Jacques, L. (2025). The mathematics pipeline in England: inclusion and the excellence stream, *Teaching Mathematics and its Applications, 44*(1), 28–46. https://doi.org/10.1093/teamat/hrae005
3. Ortus Economic Research. (2023). Mathematical Sciences recruitment and graduate outcomes. https://www.cms.ac.uk/wp/wp-content/uploads/2024/01/CMS_HoDoMS_MathematicalSciencesRecruitmentDiversity_FINAL120124.pdf
4. See https://www.campaignmathsci.uk/projects/maths-degrees-for-the-future-grants
5. Severn, K.E. (2025). Transition to university mathematics. Observatory for Mathematical Education, University of Nottingham. https://www.nottingham.ac.uk/observatory/documents/reports/transitionstouniversitymathematics-technicalreport-may2025.pdf
6. Analysis in Figures 1-4 is based on publicly available data from the Higher Education Statistics Agency (HESA) https://www.hesa.ac.uk/data-and-analysis/students. Analysis in Table 1 and Figures 5-8 was undertaken in the Office for National Statistics (ONS) Secure Research Service using data from ONS and other owners and does not imply the endorsement of the ONS or other data owners.
7. Not all students reported their gender as male or female. Male and female were the only class sizes with a sufficient sample size for analysis.
8. Socio-economic status was determined by the Index of Multiple Deprivation for the Lower-layer Super Output Area (LSOA) of a student's home address. As it is a relative measure, only students domiciled in England were included in this analysis.
9. A university's typical entry requirement was determined using the self-reported grades of their students in the sample, or their published standard offer for BSc Mathematics (or similar) where the sample size was small. Entry requirements are expressed in terms of the typical A level Mathematics grade but students also enter with International Baccalaureate, Scottish Advanced Highers or other qualifications.

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