Observatory for Mathematical Education

Transition to university mathematics

Technical Report 2025/03

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Abstract

This technical report presents the design and validation of two surveys conducted by the Observatory for Mathematical Education to explore undergraduate mathematical science students’ experiences of transitioning to university. The first survey, administered in September 2024, captured students’ expectations before beginning their degrees, targeting those who had accepted offers to study mathematical sciences undergraduate programs in the UK. A follow-up survey, conducted between February and March 2025, generated insights into how students’ perceptions had changed after their first term. This report details the survey development process and evaluates the validity of the responses by examining survey design, sample representativeness, and patterns of missing data, providing technical assurance of the quality of the findings.

1. Introduction

The Observatory for Mathematical Education ran two surveys to capture the views on the transition to university for undergraduate mathematical science students. The first survey ran before students had started their mathematical science degrees allowing us to capture their expectations of starting their degree. The follow up survey ran 6 months later allowing us to compare student expectations with their reported experiences and see how their views had changed within their first term at university.

The first survey was conducted in September 2024 and distributed to all students who had accepted an offer via UCAS to study an undergraduate mathematical sciences degree in the UK. For the purposes of this study, a mathematical sciences degree was defined as any program with at least 50% mathematical content. This would include, for example, single and joint honours programmes involving mathematics or statistics. Since most UK universities do not begin their autumn term until later in September, the majority of respondents had confirmed their place but had not yet commenced their studies. This timing was intentional, as the aim was to capture students' expectations prior to starting university.

The second survey was conducted between February and March 2025 and was open to all individuals who had completed the initial survey and had opted-in to receiving the second survey. For most respondents, this represented the midpoint of their first year studying mathematical sciences. However, those who had deferred, withdrawn, or not started their studies were also invited to participate.

This report describes the survey design process and the validation of the responses. The validation focused on two key aspects: the representativeness of the responding sample and missingness of responses. These analyses serve to provide technical assurance of the quality and robustness of the survey data.

2. Methods

2.1 Survey design

Survey 1 is made up of a minimum of 52 items. Due to routing, some students were asked additional questions about prior qualifications and demographics. The survey included two scales of 16 items in total, designed to measure students' *confidence in mathematics,* and *beliefs about the nature of mathematics*. Both scales were shortened, since inclusion of too many items could prove demanding for participants and reduce response rates. The *confidence in mathematics* scale (6 items) was adapted from the 12-item confidence subscale of the widely-used Fennema-Sherman scales (FSMAS, Fennema & Sherman, 1976) and included an additional new item about confidence in computer programming. This scale has previously been validated for use with secondary school pupils in the United States (Fennema & Sherman, 1976) and has been used in international comparative tests such as TIMMS and PISA (Metsämuuronen, 2012). The *nature of mathematics* scale (10 items) was adapted from the 19-item Conceptions of Mathematics Questionnaire (Crawford et al., 1998), which was piloted with upper secondary mathematics students and validated on first year university mathematics students in Australia. The scale represents two major dimensions - fragmented and cohesive conceptions of mathematics - which appear to correspond to the two belief dimensions found by Blömeke et al. (2009) of mathematics as calculations, and mathematics as models and explanation. Two new items were added to cover aspects that appeared to be missing from the original scale, namely memorisation and creativity. As these scales have been shorted and they are being used for a new population – entrants to undergraduate mathematics degrees in England – we report the results item-wise and do not need re-validate the scales.

The remaining 36 survey items included questions on prior education and demographics (8 items), as well as on preferences for learning mathematics (15 items) and expectations of learning mathematics at university (13 items). The latter were translated into English from Swedish from research by Bengmark et al. (2017) into success factors in transition to university maths, which therefore provided appropriate items for the context of school-to-university to transition. One item was added about the use of artificial intelligence (AI) tools for learning maths. Rather than being combined to form a scale, these items will be analysed item-wise in the main study and hence do not require scale validation.

Demographic data was captured in survey 1 via students self-reporting. This included gender, ethnicity, mature student status (over 21 at the beginning of their undergraduate), home/international status, postcode for home students and previous school type. This data was collected so we could understand differences in the transition to university between demographics. It also allowed us to check our sample seems representative of the population.

Survey 2 was specifically designed to enable longitudinal analysis by comparing responses from the same individuals to identical questions posed six months earlier. For the majority of participants, this represented a transition from the period just before starting their university studies to the midpoint of their first year. The intention was to capture how students' expectations matched their reality and how their views may have shifted during this early stage of their academic journey. To ensure consistency and allow for meaningful comparisons, most survey items from survey 1 were repeated in survey 2, with only minor adjustments where necessary to reflect the students' current stage of study. Survey 2 followed two main routing options, a) participants currently studying a mathematical sciences degrees and b) those that were no longer studying a mathematical sciences degree.

Participants in route (a) completed a minimum of 76 items. As in survey 1, this included the items from the two key adapted scales: the nature of mathematics items (10 items), and the confidence in mathematics items (5 items, with one item from survey 1 removed as it referred to school/college and was no longer contextually appropriate). Nine items adapted from the expectations of university mathematics learning items were included, now rephrased to reflect students' current experiences. The 16 items related to learning mathematics from survey 1 were also retained, with one additional item included in survey 2 relating to the use of mathematics support centres.

New content in survey 2 included questions on students' attendance, anticipated academic performance (grades), future educational and career plans, and their experiences with coding and computing. Unlike survey 1, survey 2 also incorporated open-ended response options, including one universal free-text item asking participants to describe how studying mathematics at university differed from their expectations.

All participants, regardless of current enrolment status, completed a 20-item measure of personality traits aligned with the "Big Five" model: extraversion, agreeableness, conscientiousness, neuroticism, and intellect/imagination. This section was drawn from the mini version of the International Personality Item Pool (IPIP) and validated by Donnellan et al. (2006). The inclusion of this scale was further supported by previous UK-based research linking personality traits to mathematics achievement at university, which found that personality was a stronger predictor than gender (Alcock et al., 2014).

Participants who were no longer studying a mathematical sciences degree were presented with a modified version of the survey. They answered 10 items on the nature of mathematics and 4 on confidence in mathematics, along with the same personality inventory. Additionally, they were asked targeted questions aimed at understanding their reasons for leaving the degree and their current and future academic or career intentions.

3. Results

Survey 1 received 1503 responses, of these 1003 were valid responses. Invalid responses were largely due to blank or near blank surveys (376). Responses were also removed due to repeat responses for an email address and ineligible courses. Of the valid responses 65 UK universities were represented.

Survey 2 was sent to the 990 students who had submitted a valid response to survey 1 and consented to receive the follow up survey. Whilst most participants were still studying a mathematical sciences degree in the UK, this was not necessary as we also wanted to capture response from students that had dropped out, changed courses or deferred. On completion of the second survey participants could opt-in to receive a guaranteed £25 high street voucher.

We received 775 responses for survey 2, of these 17 were removed as they had filled in a negligible amount of the survey. Within the valid responses 723 were still UK students studying a mathematical sciences degree. The remaining 35 were not currently studying a mathematical sciences degree: 10 were currently at university but studying a non-mathematical sciences degree, 19 were planning to complete a mathematical sciences degree in the future but had either deferred/interrupted their current studies, and the remaining 6 were no longer at university and did not plan to complete a mathematical sciences degree in the future. No participant who was not currently at university planned to reapply for a mathematical sciences degree in the future.

Survey 1 took on average (median) 6 minutes to complete and 75% of respondents had completed the survey within 9 minutes. The second survey took on average (median) 9.5 minutes to complete and 75% of participants had finished in under 15 minutes.

3.1 Sample representativeness

The target population for this study comprised students beginning an undergraduate mathematics degree at a UK university in the 2024/25 academic year. Survey 1 invitations were distributed via UCAS to all individuals with a confirmed offer to study a mathematical sciences degree in the UK. This outreach covered a total of 6815 eligible students.

It is important to note that some students may have entered their degree through alternative routes not captured in our sampling frame. For instance, international students applying directly to institutions, rather than via UCAS, were excluded. Similarly, students who had deferred their university place in a previous year and commenced study in 2024/25 may not have been included in the UCAS contact list.

While the survey was sent to the full population of eligible students identified through UCAS and is therefore expected to yield a broadly representative sample, an assessment of representativeness, mainly using the self-reported demographic data captured in survey 1, was still undertaken to verify this assumption.

The gender distribution of respondents to the first survey indicates that 38.1% were female. This is compared to the national figure of 34.0% females entering mathematical sciences degrees in the 2023/24 academic year, according to data from the Higher Education Statistics Agency (HESA).

In terms of ethnicity, the survey respondents were composed of 3.7% Black, 25.9% Asian, 3.4% Mixed and 59.7% White participants, and then a further 3.5% choosing ‘Other’ and the remaining chose not to disclose. This contrasts with the HESA data for

2023/24, which reported respective figures of 4.1%, 17.4%, 5.3% and 68.8%, and then 1.7% for ‘other’ and the remaining unknown. The largest differences observed suggest an underrepresentation of White students and an overrepresentation of Asian students in our sample. However, it is important to note that these differences are not substantial enough to warrant adjustments or weighting of the responses.

Survey 2 was only available to valid respondents from survey 1 who had also consented to participate in survey 2. As survey 1 seemed representative of the population and all those from survey 1 were eligible for survey 2 their was no prior worry that survey 2 sample would be unrepresentative, however this was still checked.

For survey 2, 39.3% of the respondents were female, this is almost unchanged from survey 1 and again close to the HESA average, suggesting the sample maintains representativeness and we have not had a bias in gender dropping out for survey 2. Similarly the ethnicity for survey 2 respondents was very similar to survey 1 and so caused no further concerns, with 3.6% Black, 25.1% Asian, 3.4% Mixed, and 62.1% White participants, the rest choosing either ‘Other’ or declining to disclose.

It was important to assess the representativeness of universities included in our sample. In total, 65 universities were represented, although the number of students from each institution varied considerably. One university accounted for over 8% of the total sample, while eight universities were represented by only a single student. To evaluate this variation, we compared our sample distribution against HESA data on the size of undergraduate numbers in mathematics departments. This comparison revealed that institutions most strongly represented in our sample generally had larger mathematical sciences departments (with over 600 undergraduates), whilst those least represented, only appearing once in our sample, were smaller sizes (fewer than 200 undergraduates). Although the HESA data used was from the 2022–23 academic year and may be slightly outdated, it provides sufficient justification for the representativeness of our sample. As a result, we did not consider further analysis or sample weighting necessary.

3.2 Response missingness

Survey 1 exhibited minimal levels of missing data across the primary survey questions. The item with the highest proportion of non-responses was “Which university will you be attending?”, with 3.3% of participants opting not to answer. Given the consistently low rate of missing responses, no further imputation or corrective analysis was deemed necessary.

To account for variability in respondents’ experiences when evaluating the perceived usefulness of various tools, a “Not Applicable (N/A)” option was provided. For example, when asked about the helpfulness of “Using artificial intelligence (AI) tools, e.g., ChatGPT,” 24.1% selected N/A. This is interpreted as a genuine indication of non-usage rather than as missing data. Similarly, for demographic items, a “Prefer not to say” option was available, although it was rarely selected. Furthermore, for all multiple choice and Likert-type questions, every response category was selected at least once. This suggests the absence of redundant answer choices and supports the appropriateness of the provided response ranges.

In survey 2, no substantial issues with missingness were identified. The survey used conditional routing, meaning that only subsets of participants were presented with certain questions based on their prior responses. The primary route completed by 723 participants was intended for those currently studying a mathematics degree.

Within this main route, the question with the highest apparent level of missing responses (40%) asked participants to “tick all that apply” in relation to aspects of their course. However, it is reasonable that many participants selected no options, as the question design allowed for non-selection when none of the listed items were applicable. Thus, this is interpreted as valid non-response rather than true missingness.

The next highest rate of non-response (16%) was observed for a free-text item asking participants to “briefly explain how studying mathematics at university differs from your expectations before you started the course.” Given the open-ended nature of the question, a higher non-response rate is not unexpected.

As anticipated, routed questions generally exhibited higher levels of missing data, which is consistent with the survey design, as these items were not shown to all participants.

Unlike survey 1, survey 2 did contain some response categories that were never selected. For example, no respondents chose “Disagree a lot” in response to the statement “Maths problems can be solved in many ways.” While this indicates potential redundancy, the inclusion of these categories was intentional to maintain consistency with survey 1 and preserve comparability across the surveys.

4. Conclusion

The additional details presented in this report explain the provenance of the survey items and scales and set out how the survey was administered. No substantive issues were identified regarding the representativeness of the responding sample; the distribution of respondents closely aligned with expectations based on administrative data, providing confidence in the generalisability of the results. Similarly, missingness across survey responses was minimal and raised no concerns about bias. Where applicable, response options such as "Prefer not to say" and "Not applicable" were appropriately used by participants, and missing data rates for free-text responses seemed to remain within acceptable limits. Overall, the research team deem that no adjustments, such as sample weighting or imputation, are necessary.

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