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Measuring the impact of the cost of living, commuting and working on university students' performance in mathematics

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A recent qualitative study found that the cost of living, commuting and working were negatively affecting first-year service mathematics students' attendance and experience at Maynooth University. The research further suggested that these factors may also influence academic performance; however, quantitative evidence examining this relationship remains scarce, particularly in the Irish context. This paper addresses that gap by linking the survey responses from the qualitative study with departmental engagement and performance records. The results are nuanced, with commuting emerging as the most consistent negative predictor across measures of academic performance, and the effects of working and the cost of living varying across outcomes and model specification.

1. Introduction

In recent years, in Ireland and the UK, there have been growing concerns regarding the rising costs associated with attending university (Erskine & Harmon, 2023; Kemhadjian *et al.*, 2023; Dabrowski *et al.*, 2024; UCDSU, 2024; Mulligan & Mac an Bhaird, 2026). For example, Dabrowski *et al.* (2024) documented how students are surviving a cost of living crisis by employing strategies such as cutting back on essentials like food, clothing and heating. These financial pressures are further exacerbated by an ongoing shortage and increasing unaffordability of student accommodation, resulting in many students being forced to commute to university, often from distant locations (HEPI, 2023; Jones & Rushall, 2024; UCDSU, 2024; Mulligan & Mac an Bhaird, 2026). Research indicates that commuting generally has a negative impact on the student experience, with students arriving late or missing classes due to unreliable public transport, experiencing fatigue due to lengthy commutes and having reduced opportunities for social engagement due to the need to return home in the evenings (Thomas & Jones, 2017; Thomas, 2025; Mulligan & Mac an Bhaird, 2026).

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At the same time, to ameliorate their financial position, many students have no choice but to seek part-time employment to meet living and study expenses (Schofield, 2024; Mulligan & Mac an Bhaird, 2026). As a result, paid employment has now become a common feature of the student experience, with reports suggesting that around 57% of Higher Education (HE) students in Ireland work during term time (Erskine & Harmon, 2023). Research into the impact of working while attending university is mixed (Nidogon Višnjić *et al.*, 2024), with some studies suggesting that paid employment is not necessarily detrimental to students' academic outcomes. However, such findings frequently arise in contexts where students' employment is closely related to their field of study (Clynes *et al.*, 2020). Other research suggests students engage in paid employment out of necessity rather than for career development (Brennan & Dempsey, 2018), accepting '. . . time poverty to avoid financial poverty . . . ' (Schofield, 2024, p. 514).

In a companion paper, Mulligan & Mac an Bhaird (2026) investigated the impact of the cost of living, commuting and working on first-year service mathematics students at Maynooth University (MU). Their qualitative findings illustrated that these issues do not occur in isolation but instead weave a complex web that culminates in significant systemic barriers to student attendance and engagement with university. For example, students who could not find or afford accommodation near campus frequently relied on long daily commutes, which limited their time on campus for evening study and social engagement. Students also developed strategies to determine when to attend campus in order to minimise their expenses. At the same time, the financial pressures associated with the cost of living and commuting often necessitated students to undertake part-time work, further restricting the time available for study, assignment completion and down-time.

While existing research in Ireland and the UK provides valuable qualitative insight into students' lived experiences (Thomas & Jones, 2017; Dabrowski *et al.*, 2024; Thomas, 2025; Mulligan & Mac an Bhaird, 2026), it does not reveal whether these challenges translate into measurable differences in academic performance. In particular, it remains unclear whether structural factors such as the cost of living, commuting and working are associated with differences in academic outcomes. Addressing this issue requires the integration of student-reported experiences with objective academic performance data.

This study builds on the earlier qualitative work of Mulligan & Mac an Bhaird (2026) by analysing quantitative data collected from the same cohort of first-year service mathematics students. Survey responses were linked with departmental performance records across multiple continuous and summative assessment components. Using multiple linear regression analysis, this study aims to establish whether the cost of living, commuting and working are associated with differences in students' continuous assessment (CA) and examination performance. In doing so, this study contributes to a more comprehensive understanding of how structural factors associated with attending university may impact student achievement.

We begin this study by reviewing relevant literature on the impact of the cost of living, paid employment and commuting on student performance. Then, we describe the study design, data collection process and the statistical analyses conducted, as well as a brief description of the various modes of assessment used by the Department of Mathematics and Statistics at MU. In Section 4, we present our findings and suggest a model to quantify how students' commute/work status and CA performance relate to their final examination grade. We discuss these findings in relation to the wider literature and conclude by summarizing the main contributions of this paper to this important topic, while considering the implications of our results for institutional supports and national policy responses to student precarity.

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2. Literature review

Understanding the factors that shape student academic performance has long been a focus of HE research, with student attendance emerging as one of the most consistently examined variables. In Ireland, quantitative studies have demonstrated a significant association between attendance and academic achievement (Kirby & Mc Elroy, 2003; O'Dwyer, 2011). For example, O'Dwyer (2011, p. 5) reported that '. . . each 10% increase in lecture attendance result[s] in an approximately 3% improvement in examination performance, on average'. International research, across diverse HE contexts, echoes these findings (Sharma *et al.*, 2005; Snopce & Alija, 2015; Khan, 2018; Khan, 2022), reinforcing the conclusion that regular attendance at scheduled teaching activities is a strong predictor of academic achievement.

In light of this evidence, several initiatives have been implemented within HE Institutions (HEIs) to encourage student attendance at scheduled classes. For example, at MU a scheme was introduced in 2010–2011 and 2011–2012 to encourage first-year mathematics engagement, especially for students with weaker mathematical backgrounds (Burke *et al.*, 2013). Assignment submission rates and tutorial attendances were monitored and, if these fell below a certain threshold, students were contacted, advised of supports in place and encouraged to improve their engagement. The authors found that contacted students in those years demonstrated significantly higher attendance and assignment submission rates when compared to an equivalent cohort of students from 2009–2010 who would have met the contact criteria prior to the scheme's introduction. Using multiple regression analysis, the researchers also reported that, among other factors, the number of assignments submitted was a positive predictor of final examination performance, while tutorial attendance was highly correlated with assignment submission (Burke *et al.*, 2013).

While many initiatives aim to increase attendance at scheduled teaching, broader concerns regarding student under-preparedness for first-year mathematics and the subsequent impact on student achievement have prompted additional institutional reactions. One of the most widespread responses has been the provision of dedicated mathematics learning support (MLS) (Lawson *et al.*, 2020). Over the past two decades, MLS has become embedded in many institutions across several countries, with substantial quantitative evidence indicating that students who avail of this support achieve higher grades than those who do not (Jacob & Ní Fhloinn, 2019). MLS has also been shown to be particularly effective for students considered at risk of failing due to their mathematical background (Berry *et al.*, 2015).

While predictors of academic performance, such as student attendance, have received sustained attention, considerably less research has examined the impact of the structural and economic barriers students face when participating in HE. In particular, there are few quantitative investigations on the impact of the cost of living, paid employment and commuting, especially within an Irish context. Existing work is predominantly qualitative or Likert-style and relies on students' self-reported perceptions. Such studies typically document the hardships students endure and their perceived impact on learning, rather than analysing objective performance data. By way of example, in 2018, researchers investigated the financial cost of second-level initial teacher education at eight universities in Ireland. With 391 responses to their survey, Prendergast *et al.* (2021) found that 44% considered dropping out due to financial stress. The authors further argue that high costs perpetuate a predominantly white student population, and, as a result '. . . the invisible faces are those who cannot enrol and may have been lost to the teaching profession altogether, irrespective of their academic ability or their suitability to the role' (Prendergast *et al.*, 2021, p. 600). Similarly, the influence of the costs associated with attending university in Ireland is laid bare in a 2015 qualitative report on why students drop out. Using institutional data from 16 participating HEIs, one of the major factors identified was financial pressure, which was '. . . a concern for many students particularly in terms of living expenses, accommodation, and travel costs . . . Fees were also an important factor in the decision to discontinue a course' (Moore-Cherry *et al.*, 2015, p. 8).

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A notable exception to the predominantly qualitative literature on the cost of living is a study conducted at Northumbria University that also incorporated performance data (Harding, 2011). In this study, 183 first-year social science students completed a survey at the start of the academic year, with a subset of 72 respondents completing a follow-up survey at the beginning of year two. Survey topics included motivation for degree choice and self-assessed academic strengths and weaknesses. This data was analysed alongside the students' mean first-year grade and whether they had achieved a pass mark for all their modules. Harding found that students with savings and no debts at the start of the academic year were less likely to work long hours and were substantially more likely to pass all their modules on the first attempt (77% compared to 50% among those with debt and no savings). They also observed that students owing money to family and those who missed loan payments were unlikely to pass.

Research on the financial pressures associated with attending university is commonly discussed in tandem with term-time employment, and is again, predominately qualitative or based on student self-reported Likert-style data. For example, at the Open University, where students are distance learners, Schofield (2024) surveyed 816 psychology students in 2023 to examine changes in students' experiences from enrolment to the end of the academic year. Students reported a moderate effect of the cost of living on their studies. The researchers identified that one of the top three reasons for withdrawing from or deferring a module was the student need for additional time for paid employment, with students working more hours per week at the end of the module compared to the start. Students who reported increased study engagement tended to work fewer hours per week than they had at the start of the course, whereas the reverse was true for those who increased their working hours.

Studies of later-year students point to similar patterns in the relationship between paid employment and academic performance. A survey of 1012 final-year undergraduate students across six universities in the UK found that 53% worked during term time, with performance records available for 74% of respondents (Callender, 2008). They found that students working an average of 15 h per week were a third less likely to obtain what the researchers termed a 'good degree' (a first- or upper second-class classification) than comparable non-working students. In their conclusion, the authors stated that financially poor students '. . . worked for a short-term cash benefit and emerged from university with large debts, a history of working in bars and shops, and poorer degree results. Their more affluent and successful peers worked for a longer term career benefit and emerged with lower debt, interesting CVs, and good degree results' (Callender, 2008, p. 374). Similar findings were reported by Brennan & Dempsey (2018) at the University of Galway who analysed student self-reported data, rather than institutional performance records. They received survey responses from 109 undergraduate and 71 postgraduate students, and of the 69 students who stated they were in paid employment, 32% indicated that this had a negative impact on their academic performance, and many respondents reported working out of necessity rather than for career development.

Some studies suggest that the academic impact of working while studying is more nuanced than a simple binary positive or negative outcome. Instead, these studies report that the effect is contingent on the number of hours worked per week. A longitudinal Norwegian study used register data from the national educational database to track students over three consecutive years, starting with 5200 students in 2003, and dropping to 3291 students in 2005 (Hovdhaugen, 2015). The researchers found that the risk of drop-out is higher in first year than in later years. In particular, a first-year student working full-time (more than 30 hours per week) had a one-in-five probability of dropping out, compared with a one-in-ten risk for those working fewer than 19 hours per week or not at all.

Quantitative research into the impact of commuting on student grades is uncommon, both in Ireland and internationally. A recent HEA report on student progression across 17 Irish HEIs highlighted this lack of institutional-level research. Seven HEIs reported that additional data were required to address student

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non-progression, with three HEIs referring specifically to commuting students. The report author stated that '. . . insufficient attention [is] provided to vulnerable groups such as . . . commuting students . . . ' (Stritch, 2025, p. 3). Existing Irish research on commuting tends to be qualitative in nature, emphasizing the hardships commuting students face (Thomas, 2025; Mulligan & Mac an Bhaird, 2026). These challenges have been linked to student withdrawal from HE. For example, researchers at University College Dublin (UCD) (Redmond *et al.*, 2011) interviewed 25 first-year students who had withdrawn from their studies in 2008–2009. Redmond *et al.* found that almost three quarters of these students lived at home and most of these commuted 2 hours per day. Students attributed missing lectures and reduced social engagement within the university to the demands of commuting. The report authors recommended that commuting demands be acknowledged with '. . . more consideration given to identify ways of integrating students who commute long distances . . . ' (Redmond *et al.*, 2011, p. 65).

A small number of international studies have examined the impact of commuting on student performance via quantitative methods. For example, at the University of Plymouth, Webb & Turner (2020) analysed outcomes for 14,553 undergraduate students enrolled in 2015–2016, representing almost the entire undergraduate cohort. The researchers considered whether students had passed all their modules and also whether students' module grades were in line with a 'good degree' ($\geq$ 60%). Using the students' postcodes, they defined three groups: students normally living within the city boundary ('Living at Home'), students who relocated within the city boundary ('Relocated Students') and those living outside the city boundary ('Commuters'). The analysis also controlled for variables including age, gender, socioeconomic status, year of study and prior academic achievement on entry to university (UCAS score). The results provided little evidence that commuting students were less likely to pass all their modules overall. However, among male students aged under 21, good degree performance was more likely for those 'Living at Home', with an odds ratio of 1.90. For females aged under 21, the likelihood of obtaining a 'good degree' was higher for both 'Living at Home' (odds ratio 1.48) and 'Relocated Students' (odds ratio 1.71), compared with 'Commuter Students'. No statistically significant association between living arrangements and academic performance was observed for students aged over 21.

Similarly, a report by London Higher (2019) investigated the relationship between commuting and progression into second year for students enrolled in six London universities. Using Higher Education Statistics Agency data, they studied almost 20,000 first-year students across the academic years 2013–2014 to 2015–2016. They were able to determine the students' continuation outcomes and, using students' term-time postcode, they calculated estimated commute times by public transport. At University One, findings suggest that with each 10 minutes of travel, a student's likelihood of progressing decreased by 1.5%. At University Three, this likelihood dropped by 0.63% for every 10 minutes travelled. At University Four, they determined that for every minute increase in travel time there was a 0.6% reduction in the odds of student progression. At the remaining three universities, travel time was not found to have a statistically significant effect on student progression.

In summary, while cost of living pressures, commuting and working are consistently identified as significant barriers to student performance, much of the existing literature is qualitative in nature. By contrast, quantitative studies that link these structural barriers to objective academic performance data remain scarce, particularly within the Irish context. This study contributes to addressing that gap.

3. Methodology and background information

This study adopted a mixed-methods design (Lodico *et al.*, 2010) in which qualitative and quantitative data were collected during the same data-collection phase. In doing so, '. . . the strengths of both approaches are combined, leading, it can be assumed, to a better understanding of research problems than

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either approach alone' (Creswell & Garrett, 2008, p. 322). In March 2025, using the Jisc Online Surveys software, a student survey was conducted to gather first-year service mathematics students' views on lectures, tutorials and the Mathematics Support Centre. This was followed by questions regarding their finances, costs associated with attending university, their accommodation situation, commuting and paid employment. At the conclusion of the survey, students were invited to provide their consent for the researchers to access their departmental records (engagement and performance) and link this data with their survey responses.

Ethical approval for this study was granted by MU's Research Ethics Committee. Following the close of survey data collection, 415 student responses were recorded, which corresponded to a response rate of 37% of first-year service mathematics students at MU. Of these, 299 had granted access to their departmental records from semester 1 of the 2024–2025 academic year, including their end of semester module exam results. These students constitute the sample used for the quantitative component of this study. First-year service mathematics modules are taken by students across a range of degree programmes, principally within Arts, and Science where mathematics is compulsory in first year. The academic data relates to Differential Calculus (Calculus 1) modules which are consistent in content and structure across first-year service mathematics. All statistical analyses and visualizations were conducted using the statistical software R. In Sections 4.1–4.4, multiple linear regression models were constructed to assess whether commuting (yes/no), working (yes/no), students' financial situation and gender were significantly associated with CA components, exam performance and overall module grade. Sections 4.5 and 4.6 investigate the association between commute time and working patterns, respectively, and overall module grades. Finally, Section 4.7 presents a multiple linear regression model examining predictors of exam performance as a function of student's CA and commute/work status. Model assumptions were checked in all cases prior to interpretation. Statistical tests were conducted with a significance level of $\alpha = 0.05$ and full analysis of variance (ANOVA) tables for Sections 4.1–4.6 can be found in Appendices A and B in Supplementary material. The summary table for Section 4.7 can be found in Appendix C in Supplementary material.

Given the breadth and richness of the dataset, findings are reported across complementary studies. The first paper (Mulligan & Mac an Bhaird, 2026) focuses on the qualitative survey responses, while this paper examines quantitative engagement and performance data.

As an indicator of how students' financial situation impacted their studies, students were asked to indicate their level of agreement with the statement 'In semester 1, my financial situation impacted on my level of engagement/attendance with the academic aspects of university life, e.g. lectures/tutorials/Mathematics Support Centre etc.'. Students had the option to choose from a five-point scale: 'Strongly negatively impacted', 'Negatively impacted', 'Neutral', 'Positively impacted' and 'Strongly positively impacted'. Responses from the two negative categories and the two positive categories were collapsed to form a three-point scale (Negative, Neutral and Positive) of their perception of their financial situation. In addition, since there is no universally recognized definition of a commuter (Thomas, 2025), we chose to adopt the following: 'For the purposes of this survey, we define a commuter to be someone who is not normally living in Maynooth during the week. Were you a commuter in semester 1?'

As this research examines the impact of cost of living pressures, commuting and working on students' ability to attend and engage with university life, the authors acknowledge the possibility of non-response bias in this study. It is possible that the students most impacted by the topics under investigation did not participate, precisely due to constraints imposed by those factors. To mitigate this risk, several reminders were issued, and the survey was administered online to allow students participate at any point during the data-collection period. Furthermore, data regarding students' mathematical background prior to entry to MU was not collected as part of this study. As prior attainment has frequently been identified as a

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predictor of first-year academic performance (Faulkner *et al.*, 2014), the absence of this variable should be considered when interpreting the findings.

MU is a medium-sized university (c.13,500 undergraduate students (Higher Education Authority, 2024)) located in Maynooth, Co. Kildare, approximately 25 km west of Dublin City Centre. MU teaches primarily in-person and attracts students from a broad range of academic and socioeconomic backgrounds through Ireland's national undergraduate admissions system. It offers programmes which are similar to those in other Irish HEIs, across the Arts and Humanities, Science and Engineering and Social Sciences faculties. Maynooth is reasonably well connected to Dublin and the surrounding region via public transport. More regional towns and villages are generally serviced by public and private buses, which can have limited frequency and often require passengers to first travel to Dublin city to change to a Maynooth route (Mulligan & Mac an Bhaird, 2026). As is common across Irish HE, there is a severe shortage of affordable student accommodation (USI, 2024). In 2025–2026, MU owned 1262 purpose-built student accommodation bed spaces, ranging in cost from €5411 to €7003, inclusive of utilities (Maynooth University, 2025). While up-to-date national figures on commuting students are not readily available (Moore-Cherry *et al.*, 2015), commuting is an issue for students across Irish HEIs (UCDSU, 2024), and MU is no exception (Mulligan & Mac an Bhaird, 2026).

Before presenting the results, we outline the structure of first-year service mathematics at MU for context. At MU, students take modules (typically Differential Calculus, Introduction to Linear Algebra and either Introduction to Statistics or Integral Calculus) as part of either Science or Arts degree programmes. For the Differential Calculus modules considered in this study, students have five assignments spread across weeks 3–10 of the 12-week semester 1. These assignments contribute 15% to students' CA and are supported by corresponding in-person small-group tutorials, during which tutors normally review the submitted assignment problem(s) and answer student questions. In addition, students complete, at their own pace, a series of proficiency and practice quizzes hosted on Moodle (the Virtual Learning Environment used at MU) which contribute a further 10% to CA. Students also have one in-class midterm exam worth 10%. The remaining 65% of the module grade is determined by a summative, closed-book, supervised examination held at the end of the semester. The topics covered and assessed in these courses are consistent and typical of similar first-year service mathematics modules in other HEIs.

4. Results

Table 1 summarizes the demographics of the students in this study. The four 'non-binary' and four 'prefer not to say' students were removed from the multiple linear regressions prior to analysis as the subgroup sizes were too small to support reliable statistical modelling.

In Sections 4.1–4.4, we report on multiple linear regression analyses conducted to examine whether commuting status (yes/no), working status (yes/no), gender and perceived financial impact were associated with student performance across individual CA components, as well as in the final exam. Here, categorical predictors were coded using sum-to-zero contrasts, and because the models included interactions and unequal group sizes, Type III sums of squares were used to test the main effects and interactions. With the exception of the final module grade, the residuals showed slight departure from normality; however, they were not considered severe and given the reasonably large sample size and the absence of influential observations, were judged unlikely to materially affect inferences. Also, in Sections 4.1 and 4.3, some heteroscedasticity was observed. For this reason, HC3 heteroscedasticity-consistent covariance estimates were used for the corresponding hypothesis tests, standard errors (SE) and confidence intervals (CI). To provide additional context, we also briefly describe the corresponding submission or completion rates.

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TABLE 1. *Participant demographics*

Gender	Commuters Work	Not Work	Non-commuters Work	Not Work	Total by gender
Male	48	44	11	17	120
Female	68	60	19	24	171
Non-binary	1	3	0	0	4
Prefer not to say	2	1	0	1	4
Status totals	119	108	30	42	299

4.1. Assignments (n = 291)

Assignments contribute 15% to students' final module grade. Submission rates were high for these 291 students, with a mean of 93.9%, and 239/291 students achieving a 100% submission rate.

In the multiple linear regression analysis of assignment grades, working status was not statistically significant in the initial model and was therefore removed ($F(1, 283) = 0.10$, $p = 0.748$). The final model was statistically significant ($F(6, 284) = 5.25$, $p < 0.001$) with an adjusted $R^2 = 0.07$. Commuting status emerged as significantly associated with assignment grades ($F(1, 284) = 18.46$, $p < 0.001$), with model-adjusted mean grades of 69.79% for commuters and 80.63% for non-commuters, a difference of 10.84 percentage points (SE = 2.52, 95% CI [5.88, 15.80]). Neither gender nor perceived financial impact played a significant main effect. However, a significant interaction between gender and perceived financial impact was observed ($F(2, 284) = 6.16$, $p = 0.002$), which indicates that the association between perceived financial impact and assignment grades was not the same for males and females (see Fig. 1). Among male students, assignment performance differed significantly by perceived financial impact. Those reporting a positive financial impact achieved higher model-adjusted mean grades (82.9%) than those reporting a neutral financial impact (72.0%), a difference of 10.9 percentage points (SE = 3.99, $p = 0.017$, Tukey adjusted). Although males with positive perceived financial impact also achieved higher grades than those reporting a negative financial impact (70.4%), this difference did not reach statistical significance ($p = 0.072$). In contrast, no statistically significant differences in assignment performance were observed across perceived financial impact categories among female students (all $p > 0.20$).

4.2. Moodle quizzes (n = 291)

Moodle quizzes contribute 10% to students' final grade. Overall submission rates were high, with a mean of 93.30%, and 249/291 students achieving a submission rate of 100%.

In the multiple linear regression analysis of Moodle quiz grades, gender was not statistically significant and was removed from the initial model ($F(1, 283) = 1.09$, $p = 0.298$). The final model was statistically significant ($F(6, 284) = 2.63$, $p = 0.017$) with an adjusted $R^2 = 0.03$. Commuting status emerged as significantly associated with Moodle quiz grades ($F(1, 284) = 4.28$, $p = 0.040$), with non-commuting students achieving higher model-adjusted mean quiz scores (68.81%), compared with commuting students (62.21%), a difference of 6.6 percentage points (SE = 3.20, 95% CI [0.32, 12.90]). Neither working status nor perceived financial impact exhibited a significant main effect. However, a significant interaction between working status and perceived financial impact was observed ($F(2, 284) = 5.09$, $p = 0.007$), which means that the association between perceived financial impact and

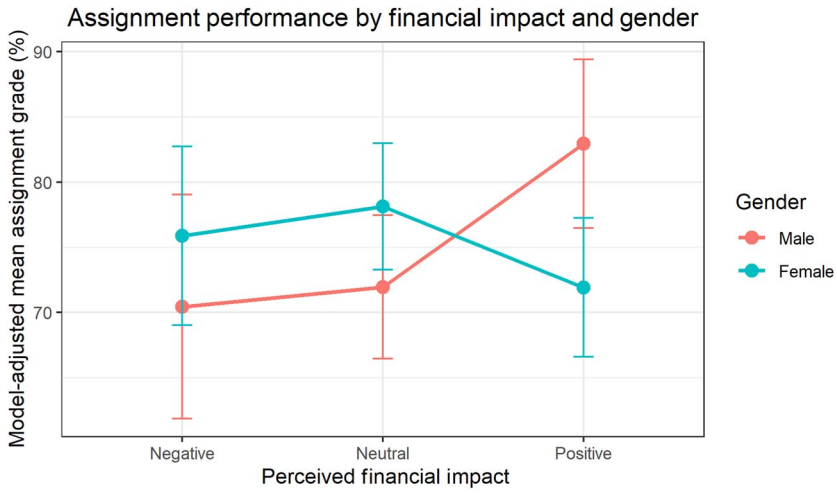

FIG. 1. Interaction plot illustrating the differences in model-adjusted assignment grades by perceived financial impact and gender, with 95% CIs displayed.

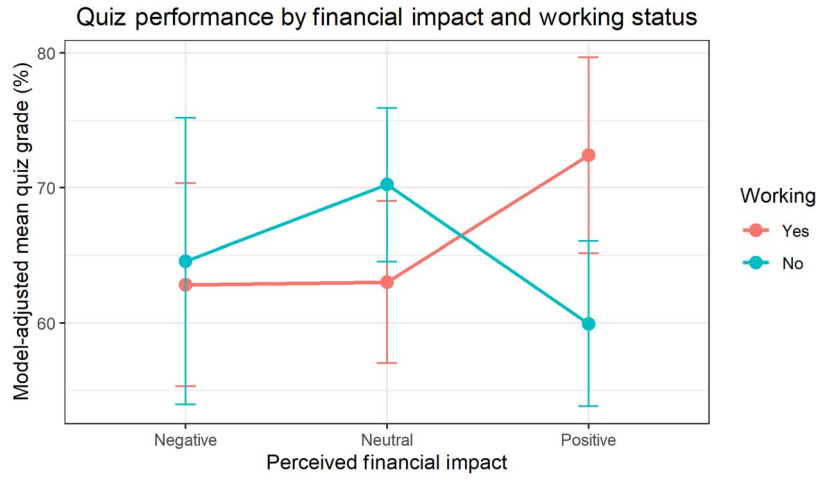

FIG. 2. Interaction plot illustrating the differences in model-adjusted quiz grades by perceived financial impact and working status, with 95% CIs displayed.

Moodle Quiz performance differed depending on working status (see Fig. 2). Among working students, no statistically significant differences in quiz performance were observed across perceived financial impact categories. In contrast, among non-working students, those reporting a neutral financial impact achieved significantly higher model-adjusted mean quiz scores (70.2%) than those reporting a positive financial impact (60.0%), a difference of 10.2 percentage points (SE = 4.15, $p = 0.037$, Tukey adjusted). No other pairwise differences were statistically significant.

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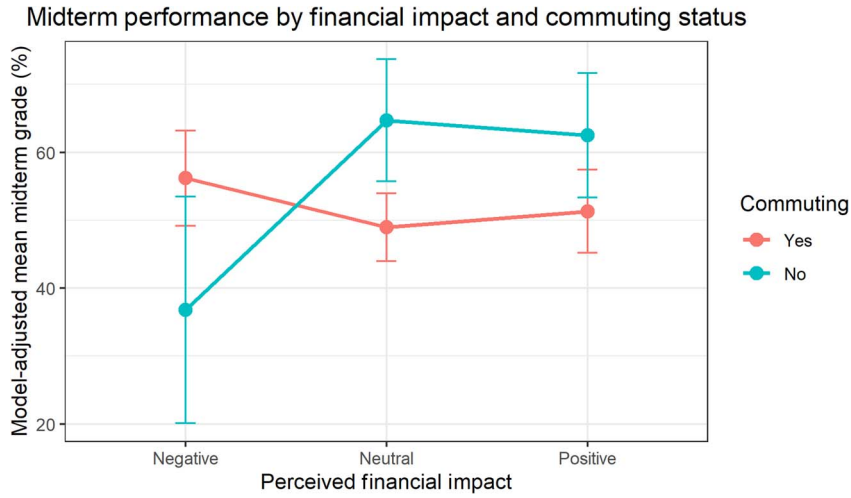

FIG. 3. Interaction plot illustrating the differences in model-adjusted midterm grades by perceived financial impact and commuting status, with 95% CIs displayed.

4.3. *Midterm test (n = 288)*

Students have a midterm test that is worth 10% of their final module grade. Of the 291 students in the sample, three had an explained absence. Of the remaining 288 students, 250 sat the test.

In the multiple linear regression analysis of the midterm test grades, working status was not statistically significant and removed from the initial model ($F(1, 280) = 0.004$, $p = 0.949$). The final model was statistically significant ($F(6, 281) = 3.97$, $p < 0.001$) with an adjusted $R^2 = 0.06$. Gender was significantly associated with midterm test performance ($F(1, 281) = 5.79$, $p = 0.017$), with male students achieving higher model-adjusted mean midterm scores (57.1%) than female students (49.7%), a difference of 7.4 percentage points (SE = 3.05, 95% CI [1.34, 13.3]). Neither commuting status ($F(1, 281) = 0.39$, $p = 0.531$) nor perceived financial impact ($F(2, 281) = 2.18$, $p = 0.115$) exhibited statistically significant main effects. However, a significant interaction between commuting status and perceived financial impact was observed ($F(2, 281) = 5.68$, $p = 0.004$), indicating that the relationship between perceived financial impact and midterm performance differed between commuting and non-commuting students (see Fig. 3). Among commuting students, midterm scores did not differ significantly across perceived financial impact categories (all $p > 0.227$). In contrast, among non-commuting students, those reporting a negative financial impact achieved lower model-adjusted mean midterm scores (36.8%) than those reporting a neutral financial impact (64.7%) a difference of 27.9 percentage points (SE = 9.63, $p = 0.011$, Tukey adjusted). They also achieved a lower model-adjusted mean score than those reporting a positive financial impact (62.5%), a difference of 25.7 percentage points (SE = 9.66, $p = 0.022$ Tukey adjusted). No other pairwise differences were statistically significant.

4.4. *Raw exam result and overall module grade (n = 291)*

The final examination is closed book, supervised and 2 hours in duration.

In the multiple linear regression analysis of final examination scores, perceived financial impact ($F(2, 285) = 0.86$, $p = 0.425$), gender ($F(1, 287) = 1.45$, $p = 0.229$) and working status

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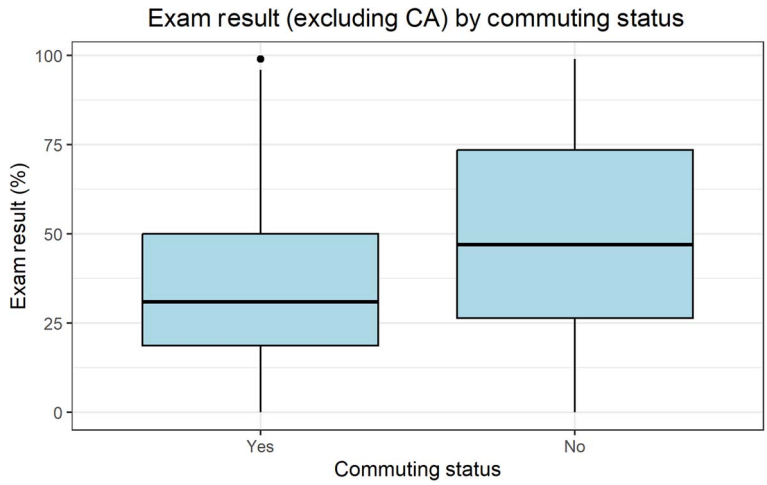

FIG. 4. Boxplot illustrating differences in exam results by commuting status.

($F(1, 288) = 3.48$, $p = 0.063$) were removed from the initial model due to non-significance. The final model was statistically significant ($F(1, 289) = 14.38$, $p < 0.001$) with an adjusted $R^2 = 0.06$. In this model, commuting status was the only factor significantly associated with final examination performance, with non-commuting students achieving higher mean examination scores (49.6%) than commuting students (36.2%), a difference of 13.4 percentage points (SE = 3.55, 95% CI [6.48, 20.50]). Figure 4 displays final examination results (excluding CA components) by commuting status.

Finally, CA scores were combined with students' final examination results to obtain overall module grades.

In the multiple linear regression analysis of overall module grades, perceived financial impact ($F(2, 285) = 0.75$, $p = 0.475$), gender ($F(1, 287) = 1.48$, $p = 0.225$) and working status ($F(1, 288) = 2.12$, $p = 0.146$) were removed from the initial model due to non-significance. The final model was statistically significant ($F(1, 289) = 19.78$, $p < 0.001$), with an adjusted $R^2 = 0.06$. In this model, commuting status was the only factor significantly associated with the overall module grade, with non-commuting students achieving higher mean module grades (59.97%) than commuting students (48.26%), a difference of 11.71 percentage points (SE = 2.63, 95% CI [6.53, 16.9]). Figure 5 displays final module grades (including CA components) by commuting status.

4.5. *Effect of commute time on module grade (n = 299)*

In the student survey, commuting students provided details regarding their one-way commute time in 20-min intervals. These data were collated with students' final module grades to examine any differences in performance by commute time. The results are presented in Fig. 6, with the grades of non-commuters included for comparison.

Figure 6 suggests a gradual decline in academic performance as commute time increases. The assumptions of a one-way ANOVA were considered and satisfied, and applying this (excluding non-commuting students) indicated a statistically significant effect of commute time on final module grade ($F(5, 221) = 2.56$, $p = 0.028$). However, subsequent Tukey *post-hoc* tests did not identify any statistically

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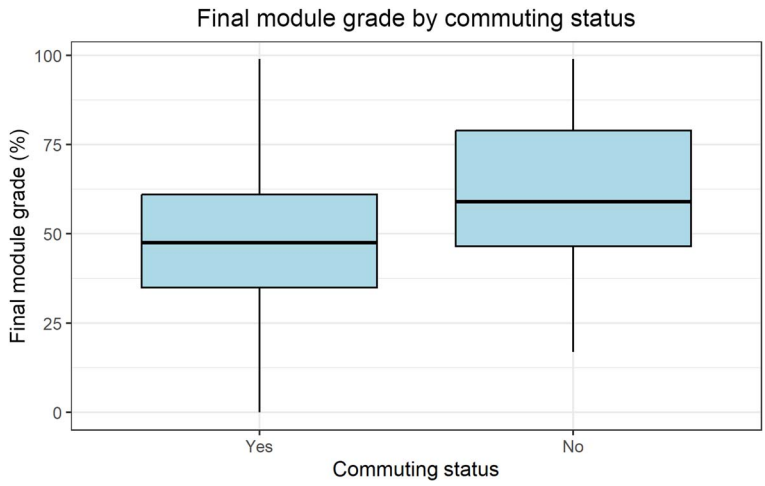

FIG. 5. Boxplot illustrating differences in module grade by commuting status.

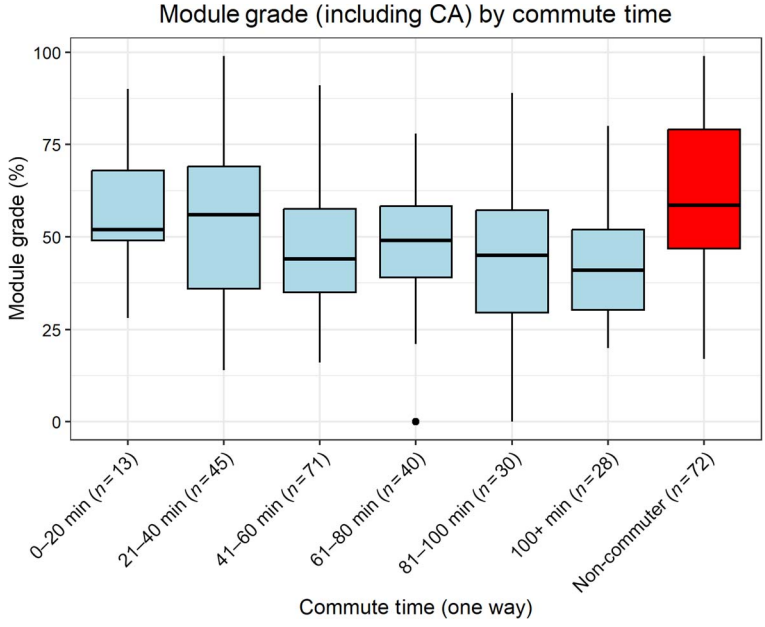

FIG. 6. Boxplot illustrating differences in module grade by commute time.

significant pairwise differences between commute time categories. Two students had a module grade of 0%; however, it is unclear whether these grades are due to the effects of commuting or to other factors.

4.6. Effect of work pattern on module grade (n = 299)

In the survey, working students provided information on their weekly work patterns. To examine the impact of these patterns on academic performance, students were categorized into three groups:

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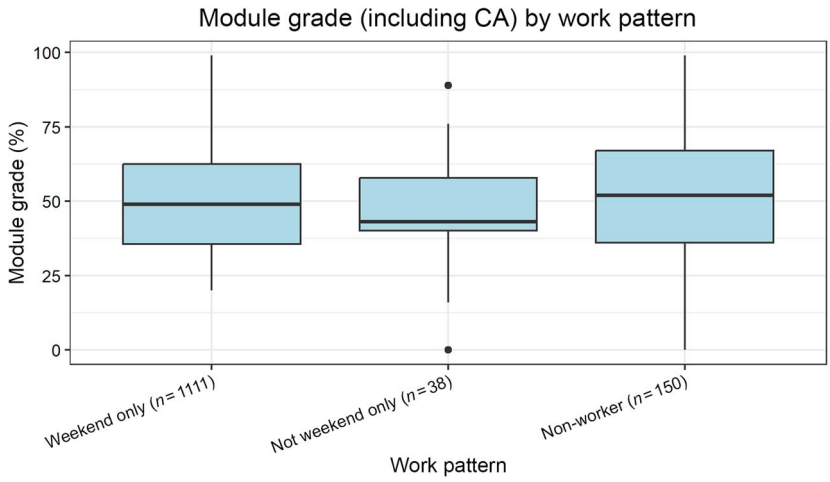

FIG. 7. Boxplot illustrating differences in module grade by work pattern.

'Weekend only' workers ($n = 111$), 'Not weekend only' workers (a mixture of midweek and weekend work) ($n = 38$) and 'Non-workers' ($n = 150$). This classification was adopted due to the small number of students working exclusively midweek ($n = 5$), and to facilitate comparison between the most prevalent work patterns. Figure 7 displays the overall module grades (including CA) for students in each group. Once again, the assumptions of a one-way ANOVA were satisfied, and this test did not indicate a statistically significant effect of work pattern on module grade ($F(2, 296) = 2.51$, $p = 0.083$). However, inspection of the group means suggests that students engaged in 'Not weekend only' work patterns (mean 45.1%) tended to achieve lower grades than both 'weekend only' workers (mean 50.9%) and 'non-workers' (mean 53.2%), although these differences were modest.

4.7. Predictive model (n = 288)

A multiple linear regression model was constructed to examine whether commuting status (yes = 1, no = 0), working status (yes = 1, no = 0), gender, perceived financial impact and CA components (assignment, quiz and midterm) performance predicted final examination grades. However, diagnostic assessment of this model indicated a non-linear relationship between examination performance and some CA components. Therefore, quadratic terms for all three CA components were included in the initial quadratic model. Mean-centring was used to minimize multicollinearity between the linear and quadratic CA terms (In the final model, variance inflation factors ranged from 1.02 to 1.83, indicating that multicollinearity was not problematic.). No material violations of the remaining model assumptions were identified.

Beginning with the full quadratic model, gender was not statistically significant and therefore removed ($F(1, 276) = 0.07$, $p = 0.787$). Next, the quadratic assignment term was also removed ($F(1, 277) = 0.27$, $p = 0.602$), indicating that the relationship between assignment CA and examination performance was adequately represented with a linear component in the model. Subsequently, perceived financial impact was removed as it did not significantly improve the model ($F(2, 278) = 0.94$, $p = 0.393$). Working status did not reach statistical significance in the final model ($p = 0.064$); however, it was retained as it slightly

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increased the adjusted R^2 from 0.501 to 0.505 and it is a theoretically important variable in the study. An interaction between commuting and working was also tested to assess whether these factors had a compounding impact on performance. However, this was not statistically significant ($F(1, 279) = 1.16$, $p = 0.283$).

The final model was statistically significant ($F(7, 280) = 42.85$, $p < 0.001$), with an adjusted $R^2 = 0.505$. (The full coefficient output for this model, including standard errors, test statistics and p-values is provided in Appendix C in Supplementary material.)

$$\begin{aligned}\textit{Exam Result}\ (\textit{excluding CA}) &= 37.041 - 5.644(C) - 3.732(W) + 0.253(A_c) + 0.406(Q_c) + 0.007(Q_c^2) \\ &\quad + 0.343(M_c) + 0.007(M_c^2)\end{aligned}$$

Where:
C = commuting status, coded 1 for commuters and 0 for non-commuters.
W = working status, coded 1 for working students and 0 for non-working students.
A_c= assignment CA-mean (assignment CA).
Q_c = quiz CA-mean (quiz CA).
M_c= midterm CA-mean (midterm CA).

All CA components were positively associated with examination performance. After controlling for these, commuting remained a significant negative predictor ($p = 0.020$), with commuting students achieving exam scores 5.644 percentage points lower than non-commuters. Similarly, working students were predicted to achieve examination scores 3.732 percentage points lower than non-working students, independent of their CA grade, although this difference did not reach statistical significance ($p = 0.064$).

5. Discussion

The results of this study provide clear quantitative evidence that cost of living pressures, commuting and paid employment are associated with differences in academic performance among first-year service mathematics students.

Commuting status emerged as the most consistent factor associated with academic performance in our analysis. Non-commuting students outperformed their commuting peers across assignments, quizzes, examinations and overall module grades with mean differences ranging from 6.6 to 13.4 percentage points. Crucially, commuting remained a statistically significant negative predictor of examination performance in the predictive model, even after controlling for working status and CA components. This suggests that the disadvantage associated with commuting is not fully accounted for by differences in CA performance.

This finding aligns with previous qualitative research highlighting the challenges faced by commuting students (Thomas & Jones, 2017; Thomas, 2025; Mulligan & Mac an Bhaird, 2026), but extends it by demonstrating a clear and persistent measurable association with academic outcomes. While existing quantitative studies '...suggest that there is something about the act of commuting, which may impede students in attaining higher marks.' (Webb & Turner, 2020, p. 1331), the companion paper by Mulligan & Mac an Bhaird (2026) allows these mechanisms to be identified more explicitly. Students reported missing classes due to unreliable and unavailable transport, exhaustion and burnout associated with lengthy commutes and reduced access to academic supports and study opportunities.

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The impact of commute duration on student performance is not definitive from our analysis. Although the overall ANOVA indicated significant variation in module grades by commute time, *post-hoc* comparisons did not reveal significant pairwise differences between commute time categories. However, regardless of commute duration, commuting students as a group performed worse than non-commuting students. This pattern is consistent with findings reported in London Higher (2019), who identified a negative relationship between commute time and progression into second year at three of six London universities, but no significant effect at the remaining institutions. These results raise questions about what constitutes a problematic commute duration. This issue is particularly pertinent in light of a recently published national student accommodation strategy in Ireland, which suggests that '. . . accommodation needs have not been met where commutes more than three hours round trip daily are required.' (DFHERIS, 2026, p. 14). Our findings indicate that this threshold may be too high, as commuting appears to be associated with lower academic performance, even at shorter durations.

The impact of paid employment was less consistent in our study. While nearly half of students reported working, which is broadly in-line with national figures (Erskine & Harmon, 2023), working status did not show a significant main effect association with CA components or standalone examination performance. Similarly, analysis of students' work patterns did not indicate significant differences in module grades across the various groups. Also, in the predictive model, after controlling for commuting status, assignment grade, Moodle quiz grade and midterm performance, working was associated with a predicted reduction of 3.73 percentage points in examination performance, although this did not reach statistical significance. Similar to commuting, the impact of employment may only become apparent once differences in ongoing engagement are accounted for. One possible explanation is that students are able to accommodate CA tasks through flexible scheduling, particularly as most worked predominantly at the weekend. However, the cumulative effects of time constraints and fatigue may limit their capacity to prepare effectively for high-stakes summative examinations. This interpretation is consistent with previous research highlighting the systemic demands faced by students (Mulligan & Mac an Bhaird, 2026), and with studies suggesting that the impact of paid employment becomes apparent only beyond certain thresholds of working hours (Hovdhaugen, 2015; Schofield, 2024).

In the companion paper to this study (Mulligan & Mac an Bhaird, 2026), financial issues emerged as one of the dominant themes in students' responses. Participants described how financial pressure permeated many aspects of their daily lives, influencing their decision to commute, shaping what and when they ate, and limiting opportunities for social engagement at university. This aligns with international research highlighting the pervasive effects of cost-of-living pressures on students (Dabrowski *et al.*, 2024). Given this, it is somewhat unexpected that students' perceived financial impact did not emerge as a statistically significant main effect in our study. One possible explanation is variation in how students interpreted the survey question used to capture their perception of their financial situation. Nevertheless, the appearance of their perceived financial impact within several interactions highlights the '. . . complex interplay among these factors . . . ' (Mulligan & Mac an Bhaird, 2026). These interaction effects should be interpreted cautiously, as some confidence intervals are relatively wide and overlapping, reflecting small subgroup sizes. In particular, gender showed a limited and context-dependent role in the analysis, only emerging in a significant main effect association for midterm performance and in an interaction with perceived financial impact, but not across other outcomes. Similarly, perceived financial impact did not emerge as a consistent main effect but appeared in interactions with gender, working, and commuting. This suggests that financial pressure does not affect all students uniformly but instead modifies how other structural constraints are experienced. For example, perceived financial impact influenced assignment outcomes for male students but not for female students, while among non-commuters, students reporting a negative financial impact performed worse than those reporting a neutral financial impact. This pattern

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is comparable to findings by Schofield (2024), who reported a moderate impact of the cost of living on their studies, with no gender differences at the moderate level of impact. However, Callender (2008) found that gender did have a strong effect on final-year student performance. Taken together, these findings suggest that financial pressures do not manifest as straightforward differences in academic outcomes but instead become visible through interactions with other factors such as gender, working and commuting status.

Finally, the predictive model provides insight into the relative contribution of behavioural and structural factors to examination performance. CA components were all positively associated with examination outcomes, highlighting the important role of sustained engagement in supporting student performance in the final exam. However, even after accounting for these factors, commuting remained a significant negative predictor, whereas working was associated with a predicted reduction in examination performance that did not reach statistical significance. Together, these findings suggest that differences in academic performance cannot be explained solely by variation in engagement. The absence of a significant interaction between commuting and working suggests that these factors affect examination performance independently rather than compounding one another. The model's moderate explanatory power (adjusted $R^2 = 0.505$) demonstrates that combining behavioural performance indicators (CA) with structural variables (commuting and working) provides a meaningful framework for understanding variation in student outcomes. At the same time, academic performance is inherently multifaceted and influenced by a range of factors, including prior mathematical attainment (Callender, 2008; Faulkner *et al.*, 2014). In this study, students' prior mathematical achievement was not available for inclusion, and its absence may have limited the explanatory power of the models. While the modest adjusted R^2 values observed in the individual models indicate that a substantial proportion of variation in performance remains unexplained, this is not unexpected in social science research (Ozili, 2023). Nevertheless, the consistent effect of commuting across all outcomes points to a persistent and substantive source of inequality among students.

6. Conclusion

This study examined whether cost of living pressures, commuting and paid employment are associated with differences in first-year service mathematics students' CA and examination performance at MU. By linking survey responses to departmental records, the analysis provides quantitative evidence that these structural factors are reflected in measurable differences in academic outcomes and cannot be attributed solely to variation in student engagement but are also influenced by broader structural constraints. In particular, commuting emerged as a consistent predictor of lower performance across multiple assessment outcomes, while the effects of paid employment and financial pressure were more context dependent. When considered alongside the companion qualitative findings at MU (Mulligan & Mac an Bhaird, 2026), as well as related work in Ireland (Thomas, 2025), and internationally (Thomas & Jones, 2017), these results indicate that systemic barriers associated with attending university translate to measurable educational disadvantage.

The study also highlights the value of linking student-reported experiences with institutional performance data. Despite the longstanding recommendation that 'Systematic and standardised qualitative data should be gathered as a matter of course by all higher education institutions from students who withdraw from their course' (Moore-Cherry *et al.*, 2015, p. 62), 10 years later, there remains a lack of uniformity regarding data collection across HEIs and 'Although most HEIs collect some data on reasons for non-progression, few systematically follow up with withdrawn students or track long-term outcomes.' (Stritch, 2025, p. 3). More comprehensive and coordinated approaches to data collection could enhance

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institutions' ability to identify, understand and respond to emerging challenges such as those associated with cost of living pressures, commuting and paid employment.

In light of these findings, there is a clear need for HEIs to consider how structural factors influence students' ability to attend, engage and ultimately succeed. This includes not only improved data practices but also targeted institutional and policy responses to mitigate the challenges associated with commuting, financial pressures and term-time employment. Previous studies at MU (Grehan *et al.*, 2016), across Irish HE (O'Sullivan *et al.*, 2014), and in the UK (Symonds, 2009) identified a range of factors which impacted on student engagement with mathematics; however, cost of living, commuting and working did not feature as dominant themes. The results of this paper and its companion study (Mulligan & Mac an Bhaird, 2026) suggest that these issues appear to have become more prominent and that this area of research should therefore be revisited to help determine the extent to which these emerging patterns are evident across the wider HE sector. In particular, these findings point to the importance of the next stage of our research, which includes reviewing first-year teaching structures, timetabling and supporting provision across Irish HE to better accommodate students experiencing such structural obstacles. We will also investigate practitioner awareness of these barriers for students in Irish HE. More broadly, it would be valuable for future studies to compare studies across institutions, incorporate prior attainment, consider institutional data over a longer period and include students across different subject areas and years of HE.

Finally, it is important to acknowledge that the quantitative sample considered in this paper includes only those students who completed the survey and who subsequently consented to the linkage of their survey and performance data. The opinions and performance of the students who did not participate in this study, potentially including those with lower performance or those most impacted by the topics under investigation, may have introduced a source of bias that should be considered when interpreting these findings. Nevertheless, this study contributes to the literature by demonstrating that the structural conditions under which students participate in HE are closely linked to their academic outcomes, and should be considered central, rather than peripheral, to efforts aimed at supporting student success.

Supplementary material

Supplementary material is available at *Teaching Mathematics and its Applications* online.

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