INERME Conference Extended Abstracts

Contents

Animating Economics with MANIM: A Python-Based Approach

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Educators newly undertaking the teaching of economics frequently confront substantial challenges in selecting and effectively integrating appropriate technological tools, a task made increasingly complex by the rapid pace of digital innovation and the growing heterogeneity of contemporary student cohorts (7). Over the past quarter century, academic economists have observed significant innovations in educational technology, shifting from traditional approaches to more interactive and engaging methods that enhance both teaching and learning effectiveness (11). Animations through several software platforms, including R and Python, have long been used for technology-enhanced teaching in economics (13). In addressing these challenges, such instructors operate at the vanguard of a broader digital transformation in education—one that demands a fundamental reconfiguration of pedagogical paradigms and imposes a distinct set of instructional requirements

(6). This imperative is particularly pronounced within economics education, where the need to render abstract and often mathematically sophisticated concepts accessible has driven an ongoing pursuit of pedagogical innovations that can both enhance conceptual understanding and prepare students to navigate the complexities of an interconnected global economy (22; 4).

A central challenge in the design of effective instruction lies in mitigating the risk of cognitive overload. As (10) explain, Cognitive Load Theory (CLT) asserts that instructional materials should be structured to optimise learners' inherently limited cognitive capacity, thereby supporting the acquisition of meaningful knowledge. This concern is particularly salient in economics education, where students are frequently required to engage with abstract and mathematically intricate content. For example, introducing constrained optimisation through Lagrangian multipliers necessitates the simultaneous grasp of multivariable calculus, economic intuition, and algebraic manipulation. When such material is conveyed exclusively through dense symbolic derivations, students may become easily overwhelmed.

Research grounded in CLT and the Cognitive Theory of Multimedia Learning (CTML) consistently demonstrates that well-designed animations can address this issue by offloading working memory demands, but only when certain design principles are observed (16). Poorly designed animations risk exacerbating overload through the transient information effect, where learners cannot revisit fleeting information (2; 24). Segmentation, dividing content into digestible, learner-controlled steps, has been shown to reduce extraneous load and improve transfer in complex topics (9; 18). Similarly, learner pacing controls and integrated visual–symbolic presentation improve model building and retention (19; 15; 3). Studies in mathematics and science education (5; 25) suggest these principles are especially beneficial for high element interactivity domains, where conceptual and procedural knowledge must be integrated.

In economics and mathematics instruction, these principles are highly relevant (26). Consider dynamic topics such as shifts in supply and demand, changes in equilibrium, or solving constrained optimisation problems: animations can sequentially reveal relationships, link symbolic derivations to graphical intuition, and pace transitions to match learners' processing ability (17; 2). This scaffolding decomposes complex reasoning into manageable steps, reducing extraneous load while preserving essential load needed for deep learning (14; 1; 12; 8). Crucially, recent advances in educational technology now enable instructors to implement these design principles with unprecedented flexibility.

The Mathematical Animation Engine (MANIM) is one such technology. A Python- based, open-source library, MANIM allows instructors to design vector-based animations that can be precisely segmented, paced, and annotated in alignment with CLT and CTML guidelines. Unlike static diagrams or generic slide transitions, MANIM's programmatic control enables tight coupling between symbolic and graphical representations, smooth temporal sequencing, and targeted use of signalling cues, all of which have been shown to mitigate overload in mathematically intensive subjects. As such, MANIM is not merely an animation generator but a cognitive scaffolding tool that operationalises multimedia learning theory in the economics classroom.

Originally introduced by (20) through his 3Blue1Brown YouTube series, MANIM attracted substantial interest for its capacity to generate visually compelling, step-by-step representations of abstract ideas. The public release of its source code in 2022 (21) spurred further development, culminating in the establishment of the official MANIM Community website (23), which now hosts comprehensive documentation, tutorials, and user support. All animations presented in this study were developed using the MANIM Community Edition.

To the best of our knowledge, MANIM has not yet been subjected to systematic examination within the context of economics education. While a small number of emerging studies, such as (4), have illustrated its potential for content presentation, this area remains underexplored. The present study seeks to address this gap by demonstrating the application of MANIM-generated animations in technology-enhanced instruction for economics. Unlike commercial animation tools, MANIM benefits from a robust open- source development community, regular updates, and extensive educational resources. As illustrated in Table 1, it combines the flexibility of open-source software with strong community support and seamless integration with Python-based tools, offering distinct advantages over alternative visualisation platforms, particularly for economics educators. While GeoGebra, Mathematica, and Maple each provide valuable capabilities for visualising mathematical concepts, they are constrained by limitations such as restricted animation flexibility, high licensing costs, or proprietary restrictions. MANIM addresses these challenges through its fully customisable, Python-based animation framework, enabling the creation of discipline-specific, high-quality visualisations tailored to the instructional needs of economics. There are both pedagogical and practical grounds for advocating the adoption of MANIM in economics instruction. Its ability to produce concise, visually coherent, and pedagogically structured

animations makes it particularly well-suited for conceptually dense material. Moreover, its open-source status, accessibility, and script- based interface afford considerable adaptability, especially for instructors already familiar with Python. While educators and students with limited programming experience may encounter a moderate learning curve, particularly when developing advanced applications such as game theory simulations, the potential benefits are substantial.

Traditional teaching methods, often reliant on static diagrams, may be insufficient for illustrating the dynamic processes underpinning economic models. By contrast, animation enables instructors to depict temporal changes, such as shifts in supply and demand, equilibrium adjustments, and comparative statics, in a more intuitive and engaging manner. Consequently, MANIM offers a powerful means of enriching and modernising the teaching of economics. Finally, this study also acknowledges the limitations of MANIM in economics instruction, including the initial setup requirements and the necessity for intermediate-level Python proficiency, which may pose challenges for both instructors and learners.

Keywords: MANIM, Python, Economics, Animations, Technology Enhanced Learning

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Appendix A. Tables

Software	Key Features	Advantages	Disadvantages	How MANIM Overcomes Them
MANIM	Open-source; Python-based; Extensive learning resources.	Free, high-quality customizable animations, works with Jupyter Notebook, lightweight rendering.	Requires Python knowledge, not interactive like GeoGebra.	—
GeoGebra	Web-based; Interactive graphs; Moderate tutorials; Non-commercial free use.	Easy access, interactive environment, good for quick visual explanations.	Limited animation and weak scripting capabilities.	Enables step-by-step animations and full Python scripting for complex models, improving depth and customization.
Mathematica	Proprietary; Paid; Advanced symbolic computation; Limited free learning resources.	Powerful symbolic computation, advanced graphing, rich mathematical library.	Paid software, heavy computational requirements.	Free, lightweight, open-source alternative with efficient rendering, reducing system load while offering visual flexibility.
Maple	Proprietary; Paid; Strong symbolic/numerical computing; Limited free documentation.	Good algebraic problem-solving, strong numerical methods.	Paid, less flexible for visualizations.	Fully customizable, open-source animations tailored for economics, offering dynamic visualization capabilities beyond static output.

Table 1: Comparison of MANIM and Alternative Tools

Engaging with reluctant Maths students

Alex Squires

Students enter onto Economics degrees with varying levels of competency and confidence in maths. This variation can be especially large across different degree programmes where A-Level maths, or equivalent, may not be part of the entry grade criteria. Supporting those with lower levels of maths ability is especially important as competency, and confidence, in maths is correlated with success in economics degrees (Al-Bahrani, Buser, and Patel, 2018). For this reason many universities offer students pre-arrival maths courses e.g. Brendon-Penn et al. (2024).

At the University of Manchester students without A-Level maths are offered a separate first year first-semester module to those with the qualification. The module, '*Introductory Mathematics*', covers algebra and differential and integral calculus alongside their applications in economics. The module is large, typically over 250 students, with students from nine different degree programmes.

Despite having this introductory module many students fail to properly engage with the course and still struggle with the content. For example, uptake of additional support, such as office hours and revision sessions, is often low. Assessments results are also mixed with relatively high failure rates in comparison to similar level Economics modules.

In this talk I will describe how I have adapted my student support on this first-year introductory maths unit that has led to greater student engagement, especially from those who struggle with maths. These changes include offering additional support sessions for student with low scores on an early summative assessment and adapting office hours to make them more accessible. These changes are also designed to be familiar in style to prior teaching practices and to aid the transition to university as detailed in Johnson and Squires (2024). These simple adaptions have been well received with student feedback, such as below, highlighting their value.

"The extra revision/help sessions were very helpful. As someone that does not really enjoy maths, the more personal sessions were vital."

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Workshop “Macroeconomic Model Simulation Made Easy: Introducing the ‘DIY Macroeconomic Model Simulation’ Website”

Karsten Kohler

The teaching of macroeconomics at the undergraduate and postgraduate levels often grapples with the challenge of bridging mathematical theoretical exposition and intuition. While mathematical modelling provides a rigorous framework to study economic phenomena, students frequently struggle to develop an intuitive understanding of models and their dynamics. This is where computer simulations can be helpful as they allow students to solve economic models numerically and visualise their results through plots. They enable a comparison of a model’s results under different scenarios, helping to develop an understanding of the causal mechanisms embedded in a model. However, many instructors face practical and pedagogical hurdles when attempting to integrate numerical simulation into their teaching—whether due to a lack of time, resources, or coding experience.

This workshop introduces the **DIY Macroeconomic Model Simulation website** (https://macrosimulation.org), a free and open-access resource that helps address this gap by enabling educators and students to simulate, visualise, and analyse a wide range of macroeconomic models using the open-source programming languages **R** and **Python**. The platform offers pre-coded simulations, explanatory texts, and exercises that support the integration of numerical methods into macroeconomics education without requiring extensive programming knowledge.

Building on the insights shared in a showcase article for the Economics Network (Kohler 2024), this workshop will demonstrate how the **DIY Macroeconomic Model Simulation website** can be used to complement and enhance traditional macroeconomics teaching. The website includes simulations of canonical models from standard textbooks—such as the IS-LM model—as well as simulations of historically and methodologically diverse frameworks. These include models from **classical political economy** (e.g. Malthus, Ricardo) and **heterodox approaches** (e.g. Post Keynesian models.

By simulating these models numerically, users can explore how changes in assumptions and parameter values affect dynamic outcomes—such as growth, inflation, unemployment, and income distribution—over time. This not only supports more engaged student learning but also promotes a critical engagement with model structure, assumptions, and economic paradigms. The site’s structure encourages inquiry-based learning, where students can compare model scenarios, visualise key results, and experiment with alternative policy interventions.

The workshop will proceed in three main parts:

Overview of Content and Use Cases: We will begin with a walkthrough of the website’s structure, available resources, and their potential applications in economics modules.

Numerical Simulation Explained: Next, we will offer an accessible introduction to the mathematical and computational logic behind the simulations.

Hands-On Practice and Discussion: Participants will then have the opportunity to experiment with the simulations on their own laptops (access to R and/or Python is required). Guided by the facilitator, attendees will work through a selected model—modifying parameters, interpreting outputs, and (time permitting) discussing possible classroom applications.

The workshop is aimed at anyone interested in integrating computational tools into their pedagogy. Whether attendees are experienced in coding or complete beginners, they will gain a practical understanding of how to use the **DIY Macroeconomic Model Simulation** website to create a more interactive, exploratory, and pluralist learning experience for students.

In summary, this workshop provides an opportunity to explore how digital tools and open-access educational resources can help make abstract economic models more tangible and engaging. It showcases how simulations can enhance conceptual clarity, promote student inquiry, and support methodological diversity in the teaching of macroeconomics.

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Wednesday 11:30 Room 1.03

Workshop: Applications for Mathematics in Economics. A Contest

Rainer Voßkamp (University of Kassel)

Applications play an important role in mathematical economics (ME) (Feudel, 2025; Voßkamp, 2023; Voßkamp, Feudel, Monaghan, 2025). A glance at textbooks (e. g. Sydsaeter et al. 2021, Chiang et al. 2015; Merz Wüthrich, 2013) shows that there are a large number of standard applications from micro- and macroeconomics. These are particularly related to functions, differential and integral calculus (e.g. production and cost functions, determination of profit maximums, basic problems in the theory of the household and the theory of the firm). Furthermore, there are presumably many applications that ME teachers use in their courses, but which many ME teachers may not be aware of.

The workshop focuses on applications that are typically covered in an introductory ME lecture in the first or second semester. In addition, the focus is primarily on examples from the field of economics. However, examples from the field of business administration are also welcome. Against this background, applications from the twelve areas listed below will be discussed.

In the workshop, participants will briefly present their favorite applications from all areas of ME that are particularly suitable for ME courses in the first year of study. These examples may include lesser-known applications or modifications to established applications. All participants can spontaneously name/present their applications without registering (a maximum of 5 minutes per application). The aim of the workshop is to create a collection of these applications that can serve as inspiration for our own courses.

Furthermore, we briefly want to discuss the general importance of economic applications in ME: To what extent can applications motivate students to learn mathematics? Can a solid foundation of ME knowledge be created in students by working on applications (only)? Should we discuss applications only after we have taught the mathematical foundations?

Regarding the workshop schedule:

a. Introduction and presentation of one or two examples by the workshop organizer (10 min)

b. Kick-off (5 min)

c. N presentations by the workshop participants (30 min)

d. Creation of a collection and discussion. (10 min)

e. Secret ballot and election: ME Application of the INERME Conference 2025 (5 min)

All workshop participants can discuss their applications with a focus on economics and/or mathematics and/or university didactics.

A technical note: You can present your applications with or without a projector presentation. It is not certain whether a blackboard or similar will be available.

If you have any questions prior to the workshop, please send an email to vosskamp@uni-kassel.de. I will respond after my vacation at the beginning of September.

Topics

1. Propositional logic

2. Sets, Cartesian products, relations, functions

3. Elementary fundamentals: geometry, arithmetic, algebra

4. Linear algebra: linear equation systems

5. Linear algebra: matrices

6. Sequences and series

7. Functions with one independent variable

8. Differential calculus for functions with one independent variable

9. Functions with several independent variables

10. Differential calculus for functions with several independent variables

11. Integral calculus

12. Difference and differential equations

13. Miscellaneous topics

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Continuous E-assessment and the Impact on Students' Engagement and Performance

Panagiotis Giannarakis, Maria Psyllou, Emanuela Lotti & Daniel Cernin

Engagement in online materials available on Blackboard has been a critical issue especially during the pandemic, where face to face teaching flipped to synchronous or asynchronous teaching and blended learning. The aim of educators during the COVID period was to find innovative ways to engage students via blended learning. This was particularly relevant in first year courses, like Mathematics for Economics where, due to the large amount of material, learning could be particularly challenging. One tool for engaging students with the online materials is continuous e-assessment. Continuous e-assessment has many positive externalities on students' performance and engagement. While there is various evidence supporting the view that continuous on-line multiple-choice tests stimulate engagement and revision, some authors also raise concerns that learning may also be negatively affected if very anxious students perceive the tests as a stressful weekly activity.

Holmes (2015 & 2018), among others found that introduction of e-assessments led to a significant increase in virtual learning environment activity. The use of e-assessment in the form of multiple-choice questionnaires continued in the post-Covid era. The question that arises is how successful continuous e-assessment on engaging students with the online materials was and whether this had any impact on students' performance on the final exam.

There is more limited evidence on demographic differences regarding engagement and performance in on-line testing. Nerby et al (2015) show that female students are more likely to engage in on-line quizzes, but only when the participation to the on-line tests is associated with a low risk while Latif and Miles (2020) did not find significant gender differences, but they detect a positive impact of continuous e-assessment on international students. The demographic aspect is particularly relevant in our opinion, due to the on-going debate on having more female students studying Economics and also in supporting International students in their first year where language barriers may hinder the learning process.

In this project, we focus on first year Maths for Economics module. We collected data from 2020 to 2025. In the first year of the pandemic, online tests were introduced in the module only as a method of engagement, where full marks were given upon completion of the tests (formative assessments). After the pandemic, online tests in these modules were used as a method of engagement and assessment with weight increasing over time from 10% to 20% (summative assessments). This set up allows us to test the impact of formative and summative e-assessments on students' engagement with online materials and on their performance in their final exams. In fact, while the increase in engagement may be associated with an increase in exam performance, the literature shows mixed evidence on the impact of continuous assessment on final exam. We are using a test in week 1 to control for ability (i.e. pre-existing knowledge before starting the University). More specifically, we test whether weekly formative or summative e-assessments lead students to engage more with the online materials of each topic on Blackboard. We also test whether formative or summative e-assessments are associated with better performance in students' final assessment and whether there are differences across gender, programme of study and fees status. Overall, we found that women engage more with the online material and perform better in the e-assessment. However, the performance on final exam is mixed with some evidence of women performing worse than men.

Lecturing on Demand: Empowering Students to Take Initiative in a Flipped Classroom

Morten Brekke, morten.brekke@uia.no, University of Agder, Grimstad, Norway

This contribution outlines how universities can support students in acquiring fundamental mathematical skills, to help them succeed in economics or other disciplines where mathematics serves as a foundational subject. At our university, there has historically been an unacceptably high failure rate in mathematics courses for economics and engineering students. To address the challenge of underprepared students entering engineering programs, two bridging mathematics courses have been restructured to emphasize flexible, student-centred learning. The redesigned courses integrate digital resources, formative assessment, and peer-led instruction to foster mathematical competence and self-regulated learning. Early results indicate improved student outcomes and reduced failure rates in engineering calculus.

Introduction

As part of our efforts to increase enrolment in the engineering program at our university, we offer two bridging mathematics courses: MA-006 and MA-007. MA-006 is a six-week intensive summer course, while MA-007 runs parallel to the standard calculus course during the semester. These courses are specifically designed for students who meet university entrance requirements but lack sufficient mathematics background, as well as for those with vocational certificates. The courses are mandatory for continuing in the bachelor's program in engineering. In 2024, I took over the responsibility for these courses and implemented substantial changes. Previously, the courses followed a traditional format consisting of lectures, exercise sessions, and a written exam. Drawing on my prior experience delivering flexible online versions of these courses, I introduced a new approach. My earlier work demonstrated that students in these online courses performed just as well in engineering mathematics Calculus 1, as those with full mathematics specialization (Brekke, 2014). Additionally, the use of flipped classrooms and digital portfolios showed positive outcomes in the bachelor's program in electronics (Brekke, 2016). I was also inspired by the success of a mathematics bridging course for economics students at our university (Landgärds, 2018 and 2019), particularly the use of diagnostic tests and student teaching assistants. This led to the belief that effective strategies in mathematics teaching for economics students could be equally beneficial for engineering students and vice versa.

About the changes

MA-006 and MA-007 have been redesigned into more flexible learning formats, where traditional lectures are de-emphasized in favor of self-paced study, digital resources, and interactive problem-solving sessions. The course content is sequenced to align closely with the topics covered in engineering Calculus 1. Short, pre-recorded videos covering the curriculum are made available to students, and live lectures are only held upon request. To facilitate planning, students must notify us of specific topics they wish to cover by 12:00 the day before the scheduled lecture. If no requests are made, I held open office hours at the campus coffee bar during the lecture slot, offering support and answering questions. In the summer course MA-006, all teaching is delivered by teaching assistants (experienced students who have received training in pedagogy and didactics). Their involvement ensures peer-level guidance and fosters a supportive learning environment. A key component of the course design is the use of the computer-aided assessment tool STACK (Kinnear, 2018), which allows for the creation of individualized tasks and automated feedback. We emphasize retrieval practice, based on the "testing effect," which shows that actively recalling information improves long-term retention more effectively than passive review (Roediger & Butler, 2011). Consequently, we apply a test-enhanced learning approach, where frequent testing is integrated into the learning process (Brame & Biel, 2015). In my view, regular testing is essential for the success of this method. To ensure student engagement and continuous effort, these tests contribute to the final grade. This approach requires students to begin working from day one, rather than postponing their efforts until just before the exam. Our experience indicates that students spend significantly more time on the subject under this model. To support this, we have reduced both lecture hours and exercise sessions, freeing up time for independent study. The reduction in exercise sessions is made possible by our MatRIC Drop-In centre a low-threshold student-run support service funded by the faculty. Open daily throughout the semester, it has proven highly successful in providing mathematics assistance. This initiative not only supports students but also helps reduce the workload for teachers.

Conclusion and findings

The concept of on-demand lectures emerged during the planning of the intensive summer course MA-006, which covers a broad curriculum in a short time frame. To maximize students' opportunities for practicing mathematical problem-solving, we chose not to confine them to three hours of daily lectures. Given the extensive support available on campus, it was more important to adopt a format that fosters self-regulation and stress management. Students are encouraged to take responsibility for their own learning, organizing their study routines, seeking help when needed, and balancing rapid progress with deep understanding. They are provided with a suggested progress plan that includes tasks aligned with the curriculum and learning objectives. By incorporating STACK-based assessments with multiple attempts allowed over a typical one-week period, we also aim to reduce exam-related anxiety. This student cohort is highly diverse in terms of both mathematical background and age, which presents additional pedagogical challenges. Delivering the entire curriculum through traditional lectures would be inefficient, as many students already possess foundational mathematical knowledge and would not be sufficiently challenged. This is why we adopted an on-demand lecture model: students who require additional support can request specific topics for deeper exploration, allowing us to adjust the pace and ensure that no one is left behind. There is no need to rush through the syllabus simply to cover all content.

Student feedback from 2024 has been positive, with an average rating of 4.2 out of 5. While many students appreciated flexibility and autonomy, some expressed a desire for more mandatory lectures with challenging topics. In response to this, a minor adjustment in MA-006 was made in the summer 2025: Teaching assistants selected daily lecture topics based on questions raised the previous day, as students were not yet ready to make requests themselves. A recurring suggestion from students is that I should choose the "difficult" topics for lectures. However, I deliberately refrain from doing so, as the goal is to encourage students to reflect on their own learning needs and take initiative. We observed the failure rate in Calculus 1, dropped from 21% to 11%, and there was a general increase in high grades. These results suggest a positive impact from the revised course structure. This teaching approach aligns well with my pedagogical philosophy and is particularly suited to educational programs where mathematics serves as a supporting subject. However, its success relies heavily on the presence of well-trained and competent teaching assistants, as well as robust support structures such as the MatRIC Drop-In center.

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Preparedness and Perception: Investigating the Influence of A-Level Mathematics on Economics Undergraduates

Karishma Patel and Adam Thompson (Aston University)

Background and Rationale

Many UK economics degree programmes require A-Level Mathematics, though some do not. Ongoing debate within the UK higher education literature questions whether it should be a formal entry requirement. This debate is particularly relevant when considering factors such as student experience, retention, and progression. While international studies suggest a positive relationship between prior mathematics study and economics performance (e.g. Arnold & Rowaan, 2014; Ballard & Johnson, 2004), UK-based evidence is more limited, mixed, and largely predates the significant 2017 A-Level reforms (e.g. Lumsden & Scott, 1987; Jones, 2013).

Beyond academic preparedness, perceptions of ability also influence success. Everingham et al. (2013) emphasise that self-perception can shape outcomes independently of actual ability. In the UK, Darlington and Bowyer (2017) found that economics students tend to see A-Level Mathematics as good preparation for their degree. Similarly, annual surveys by The Economics Network indicate that students without A-Level Mathematics are more likely to feel their degree falls short of expectations, often citing the mathematical content as a key concern.

Although few studies focus specifically on economics students' perceptions of mathematical ability, evidence from the US highlights its importance. Al-Bahrani et al. (2018) found that mathematical confidence, when controlling for ability, strongly predicts economics performance. This suggests that students' self-belief may significantly shape engagement, achievement, and the overall academic experience.

This paper explores the interplay between prior mathematics education, self-perceived ability, and academic performance among first-year economics students. Specifically, it investigates (i) whether students with A-Level Mathematics perform better in their first year, and (ii) how perceptions of mathematical ability evolve over time, with a particular focus on differences within the sample based on whether they have A-Level Mathematics.

Methodology

To investigate these research questions this study used a quantitative design, drawing on two distinct data sources. The first strand analysed anonymised student-level data from Aston University (UK) records, including module grades, prior qualifications in mathematics and economics, and demographic variables such as age, gender, and school background. Three performance metrics were created: an economics score (average of microeconomics and macroeconomics), a quantitative score (average of mathematics and statistics), and an overall first-year average. Ordinary Least Squares (OLS) regressions were used to estimate the impact of A-Level Mathematics on these outcomes incorporating controls for academic and demographic background. One model used the full sample to assess the effect of having studied A-Level Mathematics; another focused on the subset that had studied A-Level Mathematics, using A-Level grade as a predictor.

The second strand tracked students' perceptions over the academic year using online questionnaires administered in September 2024 and January 2025. The survey captured prior study and Likert-scale responses on mathematical confidence, enjoyment, anxiety, and self-assessed ability. Changes over time were analysed using paired-sample t-tests, and between-group comparisons by A-Level Mathematics status used independent t-tests. While the two datasets could not be linked at the individual level, both included A-Level Mathematics status, allowing for cohort-level comparisons. Together, the two strands offer insight into both the subjective and objective experiences of students adjusting to the mathematical demands of university-level economics.

Preliminary Results and Implications

Preliminary Ordinary Least Squares (OLS) regression analysis suggests that studying A-Level Mathematics is not a strong predictor of overall first-year performance on economics degree programmes at Aston University. This finding held across all three student cohorts, even when controlling for demographic and academic background. Similarly, A-Level Mathematics was not significantly associated with performance in first-year quantitative modules (mathematics and statistics) in any cohort. Results for core economics modules (microeconomics and macroeconomics) were mixed: no significant effect was observed in two cohorts, while one showed a weakly positive association at the 10 percent significance level. These findings suggest that, although A-Level Mathematics may offer some familiarity with quantitative material, it does not consistently translate into improved academic performance.

Analysis of students' self-reported perceptions focused on a matched sample of 49 students, including 30 male participants, with near equal representation of those with (n = 25) and without (n = 24) A-Level Mathematics. Among students without A-Level Mathematics, mathematical anxiety decreased over the first semester, but confidence and self-assessed ability also declined slightly. In contrast, those with A-Level Mathematics reported both reduced anxiety and increased confidence and perceived ability by the end of the academic year. These contrasting trends suggest that while anxiety may decline as students adjust to university-level mathematics, prior preparation may influence the development of confidence and self-belief over time.

The findings have important implications for curriculum design and student support initiatives. Understanding how confidence shifts throughout the first year can inform strategies to enhance student engagement and retention, ensuring that all students, regardless of their prior mathematical background, are adequately supported in their transition to university-level economics.

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A comparison of introductory mathematics modules within a mathematics programme and an economics programme

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In this case study, we reflect upon course content, notably the lecture notes and assessment questions, which have been utilised within introductory mathematics modules included in economics programmes and mathematics programmes delivered by the University of Birmingham. These programmes are delivered in the UK, as well as in international education settings.

Specifically, we provide a qualitative comparison of the lecture notes and assessment questions, which we contextualise within the wider literature. We then provide a quantitative comparison of mathematics assessments which utilises the Mathematical Assessment Task Hierarchy (MATH) taxonomy [2] to classify mathematics questions. This is used to form comparisons with MATH classifications for mathematics examination questions from A-levels and first year undergraduate modules [1], amongst questions from other qualifications.

The perspective of the author is that of a mathematician working within a School of Mathematics, albeit who has taught introductory mathematics courses on an applied mathematics with economics programme in an international transnational education setting.

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Enhancing Mathematical Competencies in Economics Education Using Maple Learn

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This paper addresses the importance of teaching mathematics in undergraduate economics program in Canada. It explores the nature of mathematical competencies required for advancement in economic studies, emphasizing the use of mathematical software as a teaching tool in mathematics classes. The paper demonstrates how various skills required in economics are related to mathematical competencies. The current economic crisis has drawn attention to economic thinking and the teaching of mathematics in economics, particularly due to the lack of skills among finance personnel. Providing economics students with a better educational experience in mathematical competencies as a creative skill in their courses and degree programs could better prepare them for the current labor market. Today's labor market demands graduates who can apply abstract knowledge in non-standard and constantly changing situations. This represents a shift from a society that values knowledge alone to one that emphasizes the importance of competent, adaptable citizens.

Enhancing First-Year Economics Students' Engagement with Mathematics Through Student-Produced Videos

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First-year economics students enrolled in the Mathematics-for-Economists course often struggle to recognise the relevance of mathematics to their broader studies (Landgärds-Tarvoll, 2024), which can impact their motivation. At the University of Agder, this course is traditionally delivered in large lectures by a single instructor, in combination with group work facilitated by student mentors. The student mentors are second- or third-year economics students.

In an effort to enhance the quality of teaching and student engagement, the SPVME (Student-Produced-Videos-in-Mathematics-Education) project integrates the 'student voice' into instruction by involving student mentors to create video resources on key mathematical concepts relevant to the first-year students in the mathematics course. The SPVME project shares similarities with Loch and Lamborn's (2016) Maths Relevance Project, where they study perceptions related to making mathematics relevant for engineering students through the SPVs created by higher-year students. They found that the higher-year students were uniquely positioned to understand and address the challenges first-year students face in seeing the relevance of mathematics for their vocational courses. Through the development of a set of concise educational videos in line with the design principles in Guo et al. (2014), mentors aim to present mathematical concepts in an accessible and relatable manner by explaining their practical significance in other economics courses in the 'student voice'.

The student-produced videos were produced and distributed to the first-year students during the spring semester 2025. At mid-semester, we distributed a questionnaire that posed three video-specific questions to the first-year students. 98 of the enrolled students completed it. This initial study investigates the first-year students' use of the videos and their perceptions related to implementing such resources in the course. In continuation of this work, we aim to understand the perceived affordances and constraints of SPVs and how such resources can act as an interdisciplinary bridge highlighting the relevance of mathematical concepts in economics. Usage analytics captured 1,319 individual plays or downloads across the 16 SPVs released during the semester. In aggregate, students streamed 3,659 minutes of content, equivalent to approximately 61 hours of viewing. The typical video attracted 82 view events on average (median = 84, range = 54–113), while the total watch-time per video varied from 1.5 to 6.9 hours. Because each video was short (2–5 minutes), the mean stream length was 2.8 minutes, representing a mean completion rate of 78%. Thus, students usually complete a video if they open it.

Engagement was unevenly distributed across the videos. The two elasticity videos ("Elasticity – what is that" and "Elasticity – relevance in economics") alone generated 214 view events and 13.8 hours of watching time, whereas the pair of percentage-calculation and percentagerelevance videos together accounted for only 140 view events and 4.0 hours. Topics directly aligned with core syllabus items for the final examination (elasticity, derivatives, integration) drew the most interest, while remedial or supplementary material attracted more modest interest.

Students' answers mirror this pattern. In the mid-semester questionnaire, they were asked, "When in the semester do you expect the mentor videos to be most useful (e.g., pre-lecture preparation, post-lecture follow-up, pre-exam revision, or something else)?" The students' responses to the questions were coded inductively to identify themes across the participants within each question. Analysis of the 98 responses (individual responses could be assigned to more than one theme) shows that the majority, 59 utterances, emphasise the videos' value for revision of the course content for the exam. Far fewer, nine utterances, link the videos to post-lecture consolidation, and only three identify them with pre-lecture preparation. A further 29 utterances are non-specific, either because participants had not yet watched the videos or envisaged using them only if they 'got stuck', without tying their use to any particular stage of the course. Daily usage statistics corroborate these intentions: viewing remained low through January, rose modestly in late February and mid-March when, e.g., the elasticity videos were released, and climbed sharply during the two weeks leading up to the 5th of May examination, peaking on the 30th of April with almost 400 plays and more than 1,200 streamed minutes. The temporal spike, coupled with topic-specific popularity, indicates that students used the mentor videos primarily as last-minute revision aids, precisely as they had predicted in the questionnaire.

In response to the second item of the questionnaire, students were asked "In what ways do you find that the mentor videos have been useful, and what challenges or limitations have you encountered when using them?" The analysis shows that 61 students perceived the videos to be a useful resource in their studies, highlighting videos as concise and flexible resources that clarify concepts and make revision easier. Out of these, 11 students also contributed challenges or limitations. For example, some found the videos to be too short and shallow, including too few examples, and specifically mention that the videos cannot replace real-time interactions with the mentors. The remaining responses do not discuss usefulness or challenges.

The results from this initial study indicate that SPVs were primarily used by first-year economics students as a strategic revision aid leading up to the final examination. Students in general perceived the videos as useful for clarifying concepts and making revision easier, though some limitations were noted. This understanding of the perceived affordances and constraints of SPVs, derived from student usage statistics and survey data, serves as a crucial bridge to future work. Recognising that first-year students value the 'student voice' during revision opens avenues for exploring how SPVs might likewise support regular early-semester learning while highlighting the relevance of mathematical concepts in economics.

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Understanding the transition from A levels to university

Alex Squires and Annika Johnson

The way in which A-Level Maths and Economics is often taught and assessed differs from undergraduate studies, which can make the transition to university challenging for students. For example, A-Level exams assess a limited and fixed syllabus which students can typically revise for effectively by using the large numbers of past papers, mark schemes and examiners reports available. A-Level learning resources are also generally provided to students and there is rarely need for wider reading or use of typical university style resources such as textbooks.

In contrast assessments at university require creativity and independent thinking, which are not required in A-Level exams, and alternative approaches to assessment preparation beyond relying on past papers. As a result, students may mistakenly believe that the methods they used to prepare for their A-Levels will be effective at university.

In this talk we will draw upon our experiences of teaching A Levels and at university (Johnson and Squires, 2024) and highlight the key differences in teaching and assessment methods. We will discuss how the A Level system works, how students are assessed, and what resources they are typically given. We will contrast this to typical university practices and highlight how these differences can cause some students to struggle. Finally, we will show how understanding these differences can help university lecturers in supporting students to make a smooth transition to university level study and be better prepared for their assessments.

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Academic performance, background and pre-existing quantitative skills of Economics starters: Mind the Gap!

Thomas Gall, Panagiotis Giannarakis, Emanuela Lotti

Do incoming students differ in their pre-existing knowledge in quantitative skills, and are these differences associated with demographic characteristics? If so, what is the link between pre-existing knowledge in quantitative skills and academic performance at university? Quantitative skills are critical to academic success in Economics, yet incoming university students often display wide variation in their prior knowledge, shaped by diverse educational backgrounds. This paper investigates whether these skill differences are systematically associated with student demographics and whether they help explain early academic performance in Economics programmes, beyond other demographic characteristics. This appears relevant as other studies have found evidence for "awarding gaps", i.e. differences in students' academic performance by demographic characteristics (see in particular Bottan et al. 2022, who also include a measure of preparedness).

To address these questions, we combine quantitative skill tests at the start of students' university career with demographic information from survey and administrative data. We use these data (i) to map pre-existing knowledge overall and by relevant demographic characteristics, (ii) to link pre-existing knowledge to first year exam results and (iii) to measure the extent to which any links between demographic characteristics and academic performance can be explained by differences in pre-existing knowledge.

We developed a diagnostic testing framework tailored to the first-year Economics curriculum at a Russell Group university. The diagnostic test framework is based on versions that have already been deployed successfully elsewhere (e.g. pre-calculus concept assessment at several universities in the US, MathsFit in Dublin, Mathematical Diagnostic Test in Edinburgh), adjusted to our setting. These tests tend to be reasonably highly correlated with academic performance (see e.g. Akveld & Kinnear 2023, Carlson et al. 2010, Mullen & Cronin 2013)

We administered the diagnostic tests to two cohorts of incoming in the academic years 2023/24 and 2024/25, yielding more than 600 observations. We then combine the test scores with survey and administrative data to map students' pre-existing knowledge overall and by demographic stratum (gender, geographic origin, socio-economic background) and examine their link to first-year exam outcomes in two core modules: Mathematics for Economics and Principles of Microeconomics. Indeed, the diagnostic scores, combined with coarse demographic information (gender, overseas status, A levels, course), yield reasonable predictions of first-semester marks, with root mean squared errors between 13 and 15, potentially allowing to distinguish students at risk to fail from those who are likely to achieve better than average marks. We also find that using the diagnostic test in addition to the demographic information that is typically contained in admission records improves the predictive power, in particular for Mathematics for Economics.

We identify differences in exam outcomes, in particular in the form of a home bias favouring UK students, and, in a restricted sample, a downward bias for students that identify as Black and Asian Chinese. We also find a bias favouring male students in Microeconomics, most pronounced among home students. Otherwise we find no indication of gender bias. Similarly, we do not find evidence for gaps in modules gaps by socio-economic status, measured by whether students satisfy any of the criteria for contextual admissions.

Using simple regression analysis and Oaxaca-Blinder decompositions, most of these gaps are mitigated or indeed disappear when including measures of pre-existing knowledge, such as the diagnostic test results and A-levels, as control variables. In particular the home bias in Mathematics for Economics disappears when controlling for both diagnostic test results and A-levels (but not when controlling for only one of the two). This result strongly suggests that educational remedies could possibly mitigate initial differences in subject knowledge for university starters in most cases where module mark gaps are observed. However, pre-existing knowledge seems to matter little for students that identify as Black, raising the need of further investigation. The performance gap linked to Black ethnicity remains large and significant, albeit reduced in size when controlling for pre-existing knowledge, in particular A levels. Generally, we find that including diagnostic test results on top of A-level information increases both explanatory and predictive power, except for the bias against students identifying as Black.

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Thursday 11:00, Room 1.03

Rethinking Assessment in Economics and Statistics Education: Responding to AI's Challenge

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The rapid rise of artificial intelligence (AI) is reshaping higher education, challenging long-established teaching and assessment practices, particularly in mathematics-intensive modules. Conventional formats such as timed problem sets, formula-based tasks, and standard essays are increasingly vulnerable to AI-driven solutions. This shift raises pressing concerns about academic integrity, the validity of assessment outcomes and the cultivation of independent critical-thinking skills.

This paper examines a case from a statistical module where student performance improved markedly over recent years, despite only limited changes to assessment design. The pattern strongly suggests that AI tools may have played a significant role in enabling this improvement (Sova et al., 2024). These findings resonate with Corbin et al. (2025), who show that students and instructors often struggle to define the "line" between acceptable and unacceptable AI use.

To investigate this challenge, we map group of the current UK higher-education policy landscape on AI in assessment. While many universities have begun publishing guidance, our review reveals wide variation in scope, clarity, and discipline-specific detail. Few policies offer tailored frameworks for mathematics-based or statistical modules, where the influence of AI is particularly pronounced. In response, we propose practical strategies for refining assessments within a policy-aware framework that recognises the interdependent roles of university, instructor, and student. These strategies operate across three interconnected dimensions:

1. Regulation & Redesign – embedding institutional AI policy into assessment tasks, making permitted and prohibited uses explicit, and prioritising higher-order cognitive skills that are less easily automated.
2. Evaluation – incorporating process-based evidence such as annotated workings, staged submissions, oral explanations, and reflective accounts to verify authentic learning.
3. Feedback – structuring feedback to foster reflective engagement with both human- and AI-supported work, supported by institutional training and policy.

We illustrate these principles through an example from a *Quantitative Methods* module: a group-based poster project. Students collaborated to research, design, and present an applied topic, promoting authentic engagement, peer learning, and public communication while creating a natural space to discuss and regulate AI use.

By combining insights from observed student behaviour, policy mapping, and practical design examples, this paper advocates for assessment approaches that are both resilient to AI misuse and capable of harnessing AI's pedagogical potential. Such approaches will help preserve assessment integrity, enhance student learning, and prepare graduates for a future in which human–AI collaboration is routine.

Keywords: economics education, statistics teaching, assessment design, artificial intelligence, higher education policy, academic integrity

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AI Tutors for Mathematical Instructions in Economics Courses

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This study adopts a mixed-methods approach to explore how AI can enhance students' learning, with a particular focus on the mathematical aspects of microeconomics. In the initial phase, Microsoft Copilot was used during lectures to solve exercises from the University of Agder's (UiA) "Mathematics for Economists" course that are relevant to microeconomics. Students were encouraged to interact with both the AI and the lecturer.

Following the lecture, a two-step evaluation process was conducted. First, students completed a structured survey assessing their experiences with AI in the classroom. The survey included both quantitative items (e.g., Likert-scale questions on motivation, comprehension, and perceived effectiveness) and open-ended questions for qualitative feedback. Second, the survey findings were discussed in a focus group with student representatives to co-develop an improved instructional strategy for AI integration.

AI usage patterns varied: During a typical week (outside of exam periods), 42% of students reported using AI weekly, and 23% used it daily. In contrast, during exam or assignment periods, 36% used AI regularly (3–4 times per week), and 26% used it very often (daily or more). This suggests that students increasingly rely on AI tools during high-stakes academic periods. When asked about the impact of AI on their motivation, 29% reported increased motivation, while 28% noted a decrease. A plurality (43%) indicated no change.

Interestingly, while comprehension of AI-generated solutions was generally positive—42% of students found the AI's explanations easy or very easy to follow, and only 27% found them difficult or very difficult—this did not translate into a preference for AI over human instruction. In fact, 75% of students rated the AI's explanations as worse or much worse than those of a human lecturer. This suggests that clarity alone is not sufficient; students may value the contextualization, adaptability, and interactive feedback that human instructors provide, even when AI explanations are technically understandable.

One possible explanation provided by the student representatives is the presentation format: AI-generated responses often appear as dense blocks of text, which may be harder to process in a lecture setting compared to carefully designed slides that use layout, color, and emphasis to guide attention. This contrast between logical clarity and visual accessibility may help explain the apparent disconnect between students' reported ease of understanding and their preference for human explanations. These findings point to a potential gap between cognitive accessibility and instructional effectiveness, which warrants further investigation.

Xing et al. (2025) identify three major strands of research on LLMs in education, including feedback automation, domain-specific fine-tuning, and adaptive learning environments. However, none of these strands directly address the use of LLMs in live lecture or group-based instructional settings. While recent literature highlights the potential of LLMs to enhance personalized learning and provide real-time feedback (Pepin et al., 2025), most studies have examined their use in small-group or individual contexts, such as tutoring, homework support, or teacher planning. For instance, Chowdhury et al. (2025) found that LLMs outperformed human tutors in empathy and scaffolding when evaluated in blind, text-based one-on-one tutoring scenarios. In contrast, our findings suggest that in large lecture environments, students may find AI-generated explanations less effective, particularly when visual design and pacing are not optimized for group instruction. This distinction underscores the importance of context when evaluating the pedagogical value of AI tools.

Chen et al. (2024) highlight that the effectiveness of AI tools depend heavily on prompt design, with advanced strategies such as chain-of-thought and few-shot prompting yielding better learning outcomes. Matzakos et al. (2023) show that while LLMs like ChatGPT offer pedagogical advantages over traditional tools such as CAS and Wolfram Alpha, their reliability in computation remains limited. Taani and Alabidi (2024) provide empirical evidence from a teacher survey, revealing that ChatGPT is widely used to generate examples and support problem-solving, though concerns about accuracy and training persist. Together, these studies underscore the importance of structured prompting instruction and thoughtful integration of AI into teaching practices.

Based on the previous literature insights and grounded on the results from the first phase of this AI study, the second phase of the study will implement a revised instructional approach through a randomized controlled trial in an undergraduate microeconomics course. In particular, all students will first receive a brief introduction to AI and prompting techniques to establish a baseline understanding of how to interact effectively with AI tools. Whereafter, a 45-minute lecture will introduce a selected topic in microeconomics. Following this lecture, students will be randomly assigned to one of two groups for the intervention. Group A will solve a set of exercises using traditional learning aids, such as the textbook and lecture slides. Group B will work on the same exercises but will be encouraged to use AI as a learning aid.

After the intervention, all students will complete a digital test, designed to assess their understanding of the material (without digital tools). Because the grouping of students is randomized and the instructional content is the same for both groups, any observed differences in test performance can be interpreted as causal effects of the learning aid—AI versus traditional materials. This design enables a rigorous evaluation of the impact of AI on student learning outcomes in a controlled setting.

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