

CASE STUDY

Involving students in co-creating an open educational resource in mathematics and statistics via enterprising education methods

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Abstract

This case study investigates the use of two enterprising education mechanisms at the University of St Andrews to facilitate student co-creation of mathematics and statistics support resources. It explores what these mechanisms are and how they work, and how these mechanisms have contributed to the establishment of an accessible and inclusive OER in mathematics and statistics co-created by students.

Keywords: students as partners, digital learning resources, accessibility, inclusivity, enterprising education, vertically integrated projects

1. Introduction

1.1. Students as co-creators of open educational resources in mathematics and statistics

An *open educational resource* (OER) is defined to be ‘...*learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others*’ (UNESCO, 2026). OERs form a cornerstone of United Nations Sustainable Goal 4 (UN, 2025); examples include MIT OpenCourseWare, Khan Academy and Wikibooks (Nguyen, 2025). All of these contain sections on mathematics and statistics but tend to be skewed towards US use. In the UK, there have been several initiatives to provide authoritative OERs in mathematics and statistics, such as MathCentre (MathCentre, 2025), StatsTutor (Owen et al., 2010) and Helping Engineers Learn Mathematics (Harrison et al., 2009). However, none of these UK-based resources have involved students in their creation and rely on LaTeX-generated pdfs for distribution, compromising digital accessibility.

Involving students as co-creators of teaching resources is a wide area of both study and practice (Mercer-Mapstone et al., 2017), and students have been directly involved in co-creating OERs (Cox and Masuku, 2023). Co-creation activities specifically in mathematics and statistics can be found in (Cornock, 2021), (Cox and Masuku, 2023) and (Richard and Brady-Van den Bos, 2024). However, these were focused more on existing university courses, rather than the wider area of mathematics and statistics support. Involving students in co-creation of resources has also been shown to facilitate inclusivity of materials and draw awareness to EDI issues in education (Curtin and Sarju, 2021).

1.2. Mathematics and statistics support at St Andrews

Mathematics and statistics support at St Andrews is minimal. While there has been historic one-to-one support, provided by graduate teaching assistants (GTAs) on an ad hoc basis (Ahmed et al., 2018), this was discontinued in 2024 due to staffing concerns. Presently, any module-specific maths and stats support is provided by module teaching teams and not through a central support unit. Personal discussions with Directors of Teaching (DoTs) and students across the University, together with the observed anxiety surrounding mathematics and statistics as a service subject (Bromage et

al., 2022), highlighted a need for comprehensive, inclusive, bespoke mathematics and statistics support for non-specialists in St Andrews.

1.3. Vertically integrated projects (VIPs) and enterprising education

The primary mechanism for this case study is a Vertically Integrated Project (VIP). These projects are designed to *‘engage students in long-term, large-scale, multidisciplinary research as they work alongside faculty and graduate students to solve real-world challenges’* (VIP consortium, 2025). Evolving from the engineering-only EPICS program at Purdue in 2006 (Coyle et al., 2006), VIPs were fully established as a multi-disciplinary venture at Georgia Tech in 2009 (Baxter et al., 2011). Over 50 universities across the world now host VIP programmes, with three in the UK; Strathclyde, Bath, and St Andrews (Mitka et al., 2023). VIPs at UK universities almost exclusively focus on research projects, with some EDI-focused examples; but to date, no VIP in the UK solely focuses on co-creation of resources to support learning of a STEM subject. Together with the STEP programme (see Section 2.1), the VIP programme at St Andrews provide examples of mechanisms for *enterprising education*, defined as *‘...the process of developing students in a manner that provides them with an enhanced capacity to generate ideas, and the behaviours, attributes, and competencies to make them happen’* (QAA, 2018). Students on the VIP programme at St Andrews typically agree that this endeavour develops their transferable skills under this umbrella of enterprise education (Mitka et al., 2023).

2. Mechanisms and participation

This case study investigates two mechanisms employed to involve students in creating accessible mathematics and statistics resources: the *Summer Teams Enterprise Programme* (STEP, Section 2.1) and the VIP programme (Section 2.2).

2.1. First mechanism: STEP

From (University of St Andrews, 2025a), STEP is:

“...an opportunity for undergraduate students to invest 7 weeks in participating in a fully-online skills development programme, where they will work on a real-life project designed and supported by University staff, gain virtual team-work experience in a group of diverse students, contribute to the University’s learning and teaching through working on impactful outputs, and get this experience listed on their HEAR [Higher Education Achievement Report] transcript.”

Staff are invited yearly to propose a STEP project, running between academic years. Staff do not directly supervise; projects are ‘sponsored’ by academics and administered by a GTA acting as a mentor. Any STEP project is self-contained and is expected to be completed in that summer. Continuing from (University of St Andrews, 2025a) *“The typical minimum time commitment is 4-6 hours/week over the course of 7 weeks of the programme”*; leaving 28-42 hours for students to complete the project.

The STEP project *‘Creating supplementary learning resources in the School of Mathematics and Statistics’* was proposed and ran in 2023. Split into two teams and with one GTA between them, 15 students from a variety of years and disciplines participated in and completed the project.

2.2. Second mechanism: VIP

At St Andrews, the VIP scheme is run by the International Education and Lifelong Learning Institute (IELLI), a cross-discipline academic school of the University. From (University of St Andrews, 2025b):

“A ...VIP is an ongoing research project led by an academic supervisor and made up of a team of students from any level of study (the ‘vertical’ aspect). The team of students can come from different subject areas with diverse backgrounds and skills across both arts and science. Students can earn credits and receive a grade for the project. They may be able to remain on the project for several semesters....”

With their line manager’s permission, staff can design and supervise a VIP, to start in either Semester 1 (S1, September-December) or Semester 2 (S2, January-April). Each VIP is designed to run over several semesters. Staff have complete discretion over assessment structure, subject to approval by IELLI.

Students are invited to apply for at most two VIPs by IELLI twice a year, who handle these applications centrally. A list of applicants is then passed to the supervisor, who has full control over selection of students. The credits earned by a student are flexible, with course-loads to suit their degree programme (with 10 credits as a minimum). A student who takes 10 credits would be expected to spend 100 hours on the project.

Extending the above STEP project, the VIP *Creating accessible online mathematics and statistics resources* was established in September 2024, running in both S1 and S2. The students applied to participate in either S1, S2, or both. The selection criterion was enthusiasm for the project, with no reference to the student’s wider grade record. In total, there were 13 students (observed 5M/8F) who took part in 2024/25, with 7 in each semester (see Figure 1). Enrolled student degree programmes varied from mathematics and computer science to cell biology and art history, bringing diverse perspectives to the VIP.

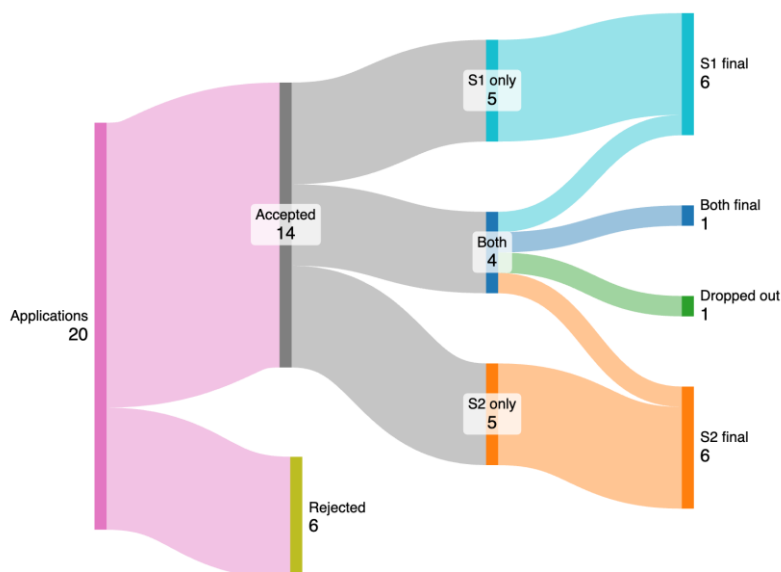


Figure 1: Flow of VIP students from application to participation in 2024/25.

The assessment structure is as follows:

- 20%=5×4% *reflective logs*, short written pieces reflecting on progress during a two-week period,
- 30% *group posters and presentation* at the semestral internal VIP showcase,

- 50%=40% *final portfolio* + 10% *final reflective log*, consisting of all the student's individual work for the project plus a longer reflective log summarising the semester.

These assessments are marked wholly by the project supervisor; as per School policy, they are vetted both internally and by an appropriate external examiner.

Importantly, the final portfolio need *not* contain any creation of resources. As VIPs emphasise interdisciplinarity, it is possible to contribute to the project in different ways other than writing materials; see Section 3.2 for more.

All 13 students enrolled in 2024/25 completed and passed the VIP.

2.3. Maximising impact

Given the congested market for OERs (Section 1.1), ensuring points of difference for student outputs is key. Here's how the project maximises impact:

Accessible: To create a truly accessible OER, a markup language was sought that has the best of all worlds: instant accessibility (such as html); printable material (such as pdfs); and editability (docx formats). The markup language Quarto provides all these from a single source file and integrates extensive documentation and website-building facilities (Figure 2). Accessible design principles (such as suitability for colour-blindness) were discussed and followed.

The screenshot shows a web page titled "Arithmetic on complex numbers". At the top, there are three tags: "ARITHMETIC", "ALGEBRA", and "COMPLEX NUMBERS". Below these, the author is listed as "Charlotte McCarthy". A summary section states: "Doing arithmetic using complex numbers is a core concept in mathematics as it allows you to perform calculations in the complex plane. This guide covers addition, subtraction, multiplication, and division on complex numbers." A recommendation follows: "Before reading this guide, it is recommended that you read [Guide: Introduction to complex numbers](#)." At the bottom left, there is a "Narration of study guide:" section with a play button icon and a progress bar showing "0:00 / 32:04". On the right side, there is a sidebar with "On this page" links: "Introduction", "Addition and subtraction", "Multiplication", "Division", "Quick check problems", and "Further reading". Below this, "Other Formats" are listed: "PDF" and "MS Word". At the bottom right, there is a "Translate" section with a "Select Language" dropdown menu and a note "Powered by Google Translate".

Figure 2: An example of Quarto website output on a html page. Access to pdf and docx outputs are on the right. The 'narration of study guide' is the result of a student-led project to provide downloadable mp3 narrations of materials.

Inclusive: Written in the second person ('you' not 'we'), materials use 'simpler' English than one may normally find in traditional learning resources. This includes avoiding jargon, context, and words like 'easy' and 'clear' which can alienate learners. The aim is to cater for those who may have specific learning difficulties, or who speak English as a second language. To ensure this, a house style guide --- inspired by the British Dyslexic Association style guide (British Dyslexic Association, 2023) --- was written before the STEP project began.

Free-to-use: The materials are hosted on a publicly available, free-to-use website called St Andrews Resources in Mathematics and Statistics (STARMAST, <https://starmast.org>). All resources are

licensed under the terms of a Creative Commons CC-BY-SA 4.0 license, cementing the students' work as an OER.

Granularity: Resources are aimed to be as granular as possible, improving accessibility of information and ensuring a clean division of labour among student contributors. They consist of: *study guides* which introduce a single topic in mathematics/statistics with associated *question* and *answer sheets*; *factsheets* providing summaries of a single topic; *proof sheets* which go into more detail about where results come from; and *overviews* that bring together key ideas from many other guides.

Interactivity: The site makes use of interactive elements to assist learning. Each study guide has a set of automatically marked 'quick check' questions, enabling users to check their knowledge in real-time. The website enjoys free use of the Desmos API to produce bespoke interactive graphs. Generative AI is used to help develop interactive flowcharts and calculators.

2.4. Evaluation and data collection

No specific student feedback for the STEP project was made available.

The VIP project was evaluated using the standard St Andrews Module Evaluation Questionnaire (MEQ). This is a fully anonymised survey, running in both S1 and S2, containing Likert-scale and free-text questions.

Qualitative data were also obtained from the reflective logs written by the students themselves, detailing the students' feelings and reflections on their project work. Where these data have been sourced in this way, written consent has been sought and granted from the relevant student. These students retained the right to withdraw consent for usage up until submission of the paper, as well as receiving a final draft copy before submission.

3. Student outputs

3.1. STEP

The condensed nature of STEP, and lack of supervisory time with the project sponsor, meant that outputs were restricted to resource creation. These included guides, questions, and answers on topics in algebra, geometry, and trigonometry. The twelve topics covered provided a base for expansion, allowing the more open-ended VIP to build on the existing framework of the website.

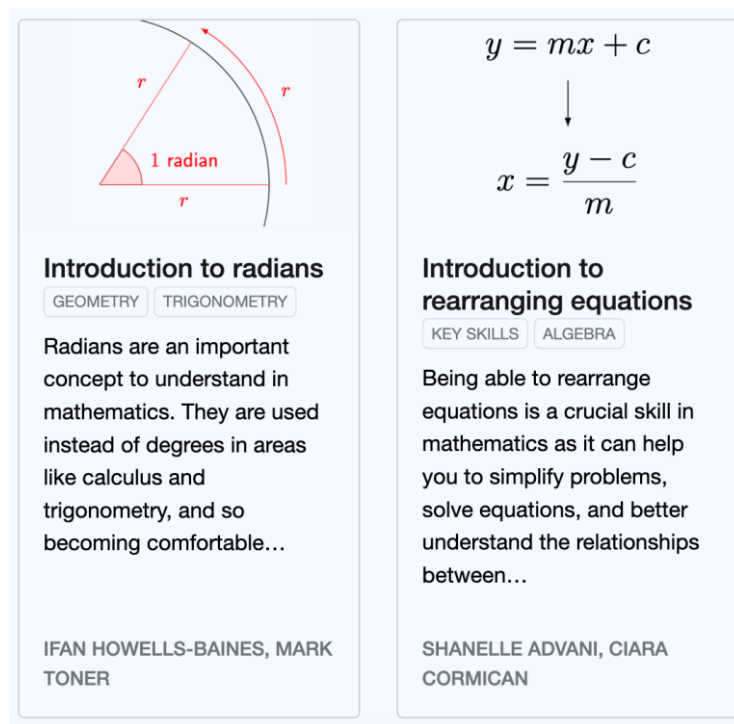


Figure 3: Two examples of the twelve study guides created by students on the STEP project.

3.2. VIP

The open-ended nature of the VIP, allied with a greater focus on interdisciplinarity, allowed the project to encourage a greater breadth of student outputs, including research into accessibility tools, website back-end work, and marketing.

At the start of each semester, each student met individually with the project supervisor to discuss how best they could contribute, allowing students to have agency over their work and to utilise their individual strengths. For instance, computer science students worked on the website back-end. Here are some more examples:

Materials: guides, questions and answers on topics ranging from rationalising the denominator to partial differentiation, setting up new types of content such as overviews and interactive calculators.

Website backend: domain name, emails, security, hosting, and analytics; search engine optimisation; custom website style based on accessible design principles; feedback boxes and mailing list setup with CAPTCHA (Figure 4).

Feedback

Your feedback is appreciated and useful. Feel free to leave a comment here, but please be specific with any issues you encounter so we can help to resolve them (for example, what page it occurred on, what you tried, and so on).

Name:

E-mail:

Feedback:

☐ I'm not a robot  reCAPTCHA
[Privacy](#) - [Terms](#)

Figure 4: Custom feedback box, appearing on all materials.

Accessibility and interactivity: setting up partnership with Desmos, R&D of accessibility tools such as text-to-speech mp3 narrations (Figure 2), using generative AI to help develop interactive learning tools (Figure 5).

Hypothesis testing interactive flowchart

Are you comparing means in your hypothesis test μ ?

Figure 5: Hypothesis testing interactive flowchart, created with the help of R Shiny Assistant.

Marketing: developing a brand-kit (including logo and colour scheme) that provides a distinctive visual identity while following accessible design principles, establishing a social media presence (Figure 6).

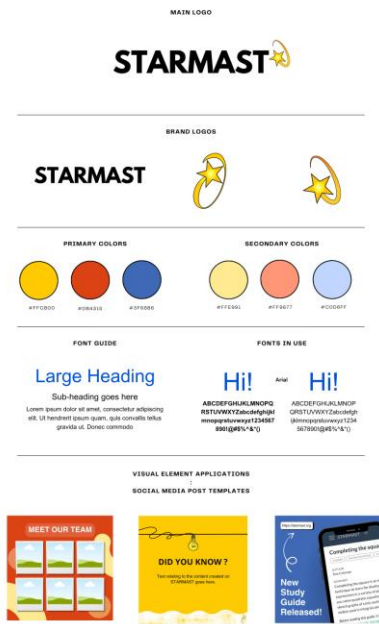


Figure 6: (left) brand-kit created by the S1 team. (right) Instagram template for announcing the release of new material.

Student outputs are demonstrated at the VIP showcase, allowing students to promote their work using posters and presentations (see Figure 7).

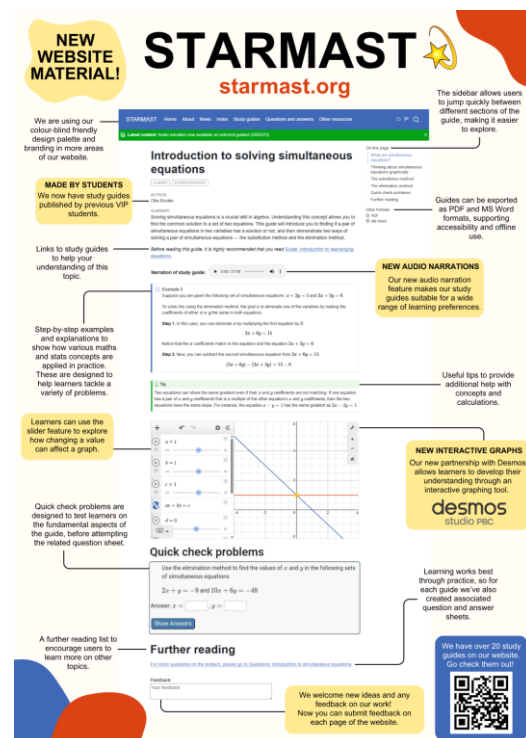


Figure 7: A pair of posters from the S2 2024/25 VIP conference.

4. Outcomes and discussion

4.1. Student and supervisor perspectives on the VIP

Student feedback on the VIP focused on a few strands. The first was on transferable skills that are common to enterprising education schemes:

'I have developed a whole host of valuable skills that I would never have had an opportunity otherwise' (MEQ)

'I also got to develop lots of transferrable skills including teamwork, presentation, time management.' (MEQ)

Students found the focus on accessibility useful:

'I also have a much better understanding of the considerations required when creating accessible documents.' (MEQ)

'Following STARMASST's style guide encouraged me to consider how even the tiniest of details in written content can affect the accessibility of the piece.' (reflective log)

'Looking ahead to a career as a secondary school maths teacher, this module ... has made me more sensitive to the different needs of learners...' (reflective log)

There were some frictions with the project, particularly when it came to teamwork:

"Although much of the teamwork was constructive, there were difficult moments. During the VIP Conference preparation... several key elements were removed by others with little prior discussion. I felt disappointed and frustrated." (reflective log)

Overall, the students found the project to be a success, noting direct impact of the project:

'I genuinely believe that this project has been so successful, challenging, engaging and enjoyable that I would not change anything...' (MEQ)

'Absolutely loved this project... I loved that I could actually see direct consequences of the work I was doing...' (MEQ)

From a supervisory viewpoint, it has been incredibly rewarding to have students bring diverse perspectives on a single common goal and then enabling them to follow through on their ideas. The opportunity to emphasise transferable skills has been refreshing, and I am now incorporating these ideas in my everyday practice. As an educator used to standard chalk-and-talk delivery and traditional closed-book examinations, it has been an unfamiliar experience to assess reflective logs and group work, but one that I feel has made me a more well-rounded practitioner.

4.2. STEP vs VIP

The structure of the STEP project had its advantages and limitations in the context of the long-term planning of the project. A short, sharp project lends itself well to providing a single resource or (as in this case) a base for a longer-term project. All the requested resources were created, and the students appeared to be satisfied with their work.

However, this was not a collaborative activity – the hands-off supervision arrangement did not allow for clear communication between staff and students. Consequently, the resources were of

inconsistent quality with some parts missing or inaccessible. This then led to a huge staff time investment preparing resources for publication; time that could have been better spent communicating to students about *how* to create accessible and inclusive resources.

The VIP, with its open-ended nature and hands-on supervision, is more suited to a longer-term project. Weekly contact allows students to discuss issues in resource creation with the supervisor in real-time, facilitating co-creation. Any issues could then be ironed out at the point of inception; *teaching* students how to write. Allied to the fact that students receive a grade and credits for their work as opposed to a certificate, this results in a significantly higher-quality output than the STEP project – although resources still require significant editing time ahead of publication on the website.

Common to both STEP and VIP is a focus on enterprise and entrepreneurship. Throughout both STEP and VIP, students were encouraged to use the project parameters as an initial framework to research and develop their own ideas for impact. This approach particularly suits the open-ended VIP, contributing to an incredible breadth of outputs (see Section 3.2). As students can take the project across multiple semesters/years, there is a possibility that they can work on larger ideas that would not be possible in STEP; an example was the creation of downloadable mp3 narrations of study guides.

STEP and VIP facilitated different parts of a large undertaking. The STEP project (short, sharp, self-contained) is ideal for creating a ‘proof-of-concept’. The VIP then expanded this; once a framework is in place, the students use their creativity and the flexible structure of the VIP to stretch the limits of what is conceivable.

4.3. 2025/26 and beyond

The VIP project in S1 2025/26 has evolved from a proof-of-concept stage to an active part of the University community, where strategic goals now rely on feedback by end-users. For instance, after discussions with DoTs at St Andrews, STARMAS^T has now been adopted by three academic schools and IELLI for mathematics and statistics support. Any topics highlighted were worked on; this has resulted in the production of twelve study guides in S1 2025/26. Other student initiatives this term have been audits of website accessibility and analytics, an outreach strategy, a custom search-engine, and video content. There has been a greater emphasis on teamwork to avoid the friction of 2024/25, with a team-building exercise run early in the semester. Measuring the impact of resources by quantitative analytics data and qualitatively surveying end-users (students, tutors, teachers etc) is a natural further topic.

Interestingly, all the concepts above are more commonly found in a business environment rather than an academic one. It seems only fitting that the use of enterprising education methods has led to a functioning enterprise, where students are adequately compensated for their work. I am very excited to see the continued progress of the VIP, particularly regarding the creativity and enthusiasm of participating students.

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