

## Results of the Irish Mathematical Society Survey on the Review of the Leaving Certificate Mathematics

In September 2024, the Irish Mathematical Society (IMS) decided to conduct a survey of its members in order to gather their views on the proposed changes to the Leaving Certificate Mathematics Curriculum. The IMS tasked the Irish Committee for Mathematics Education (ICME) which is a subcommittee of the IMS to design and administer the survey. A link to the survey was emailed to all IMS members in October 2024. In addition, the link was made available through MathDep (a mailing list for mathematicians in Ireland) and it was also circulated by the Irish Statistical Association. By the closing date at the end of October, the survey had received 40 responses (3 from university mathematics departments, and 37 from individuals). The respondents were academics from a wide range of universities in Ireland. As such, we believe that the results of the survey are representative of the views of the Irish university mathematics community.

The survey comprised of seven open questions. The results for each question are presented below.

### ***Question 1: In what topics (if any) on the present syllabus would you like to see the students show more understanding and proficiency?***

It seems that there are two main areas of concern here.

The first is Algebraic Skills (including arithmetic and especially algebraic manipulation, solving equations etc). This was mentioned in 22 responses. The responses highlighted a perceived lack of fluency when working with algebraic expressions.

The second major area of concern is Calculus. There were 17 mentions of this topic. In addition, there were 4 mentions of functions and 3 of graphs. Some responses called for students to work with more complex functions when differentiating or integrating.

Other topics that were mentioned: Linear Algebra (2 mentions), Matrices (2 mentions) and Vectors (3 mentions).

There were 5 mentions of formal mathematical language, logic or proof.

There were 4 mentions of trigonometry and 4 of statistics or data analytics.

There were 3 mentions of Geometry.

### ***Question 2: In what topics (if any) on the present syllabus would you like to see more depth included?***

The main topics mentioned here were Calculus (21 mentions) and Algebra (16 mentions). Other topics included Statistics and Probability (4 mentions), AI and Computational Thinking (3 mentions), Geometry, Analysis, Trigonometry and Combinatorics (1 mention each). In addition, there were 6 mentions of an increased focus on proof and reasoning and 4 mentions of the lack of understanding of fundamentals of current students. Many of the respondents called for a focus on the 'why' and not just the 'how' of mathematics.

**Question 3: What topics (if any) do you think could be reduced or removed from the syllabus?**

There were 7 responses which indicated that nothing should be dropped or reduced and two people suggested bringing back options. Twelve responses called for a reduction in the amount of Probability and Statistics with 5 responses calling for hypothesis testing to be removed. Five responses called for a reduction in Geometry, with one response calling the axiomatic approach to teaching this subject into question. Other topics that were mentioned were Trigonometry (3 mentions), Financial Maths (3 mentions), Complex Numbers (2 mentions), integration (1 mention) and real-world applications (1 mention). One respondent called for more applications and less focus on proof. Four respondents mentioned that developing understanding was more important than covering lots of topics. Seven respondents did not answer this question.

**Question 4: Do you think that reasonable levels of justification of mathematical procedures should be specified in the syllabus?**

There were 35 responses to this question. Of these 28 (80%) answered yes, one (2.85%) answered no, two (5.7%) said that they did not understand the question and four (11.4%) were unclear. Twenty-five of the responses emphasized the need for students to see justifications and explanations of mathematical procedures in order to develop understanding. One response stressed that clearly specifying justifications in the syllabus would help teachers and textbook writers.

**Question 5: How should students' learning in relation to the Leaving Certificate Mathematics syllabus be assessed?**

There were 37 responses to this question. The majority of responses (25 or 68%) favoured traditional examinations as the best method of assessment. Six responses (16%) favoured the use of continuous assessment, projects or group work as part of the assessment process, one respondent (2.7%) said they were unsure of how the syllabus should be assessed and two responses (5.4%) were unclear.

Many responses had suggestions on how the current system could be improved. Seven responses called for the use of oral examinations and four suggested having an extra examination at the end of 5<sup>th</sup> year. Five responses expressed fears that the advent of AI would make plagiarism more likely if projects were introduced. Some respondents called for changes to the style of questions on the Leaving Certificate exams: one asked for the context questions to be reduced, three expressed concerns that current questions are too wordy and disadvantage some students, five asked for the addition of shorter questions which focus on basic skills, one called for questions to ask for more justifications or explanations, and one response called for more choice on the exams.

**Question 6: Other Leaving Certificate subjects now have 40% of the grade based on an investigation or project and 60% based on a written examination. What is your view of such a model for Leaving Certificate Mathematics?**

We received a total of 40 responses to this question. Of these,

- 7 (17.5%) were in favour of the proposed model,
- 28 (70%) were against,

- 4 (10%) were unsure, and
- there was 1 (2.5%) other response.

Five distinct reasons were mentioned in favour of the proposal. Each reason was mentioned exactly once.

1. Project work is useful.
2. It encourages inquiry-based learning.
3. It allows the application of maths to real-world problems.
4. It fosters critical thinking, creativity and problem-solving.
5. It reduces exam stress.

There were eleven distinct reasons provided against the proposal. Below are the top 5 most frequently mentioned, along with their respective number of mentions:

1. The existence of Generative AI makes implementation of such assessment too difficult, 12 mentions.
2. There is a risk of plagiarism, help from others or excessive teacher assistance, 8 mentions.
3. Project work is not appropriate for assessment, 6 mentions.
4. The proposal would exacerbate inequalities in the education system, 4 mentions.
5. It would take time away from developing core mathematical skills, 2 mentions.

A significant number of respondents also included suggestions should the proposal be implemented:

- In regard to project assessment, four suggestions were made:
  1. Less than 40% weight on project work, 4 mentions. There were two explicit recommendations of 10% and 25% maximum.
  2. Oral examination, 3 mentions.
  3. Provision of more exams, spread over the two LC years, 2 mentions.
  4. Development of online assessment giving feedback, 1 mention.
- Provision of specific training and resources for teachers, 1 mention.

One respondent suggested that applications be included in exams rather than integrating project work into the syllabus.

***Question 7: Other Leaving Certificate Science syllabi (for example Physics) are now specified in terms of learning outcomes alone. Would you prefer that the new Leaving Certificate Mathematics curriculum be specified in terms of learning outcomes alone, as a combinations of topics and learning outcomes, or in some other way?***

There were 36 responses to this question. Of these 2 (5.5%) wanted learning outcomes only, 14 (39%) wanted a combination of topics and learning outcomes, 5 (14%) said that they did not want learning outcomes only, 4 (11%) wanted topics only, 2 (5.5%) wanted a more detailed syllabus, 2 (5.5%) wanted to leave this as they are, 5 (14%) said they had no opinion, and 2 (5.5%) were unclear.

Some of the reasons respondents gave for not using learning outcomes only were: the difficulty of describing mathematics in this way, worry that this method would make it harder for textbook writers and teachers to cover the syllabus. One response called for the NCCA to produce a complete

mathematical treatment of the syllabus which could be used by teachers. Another response called for better qualified teachers.

There does not seem to be support for using learning outcomes only.

### **Summary**

The results of this survey show that mathematicians working in Irish universities are worried about the mathematical education of second-level students. A common theme is their concerns about the lack of algebraic fluency that first-year university students display. The respondents call for a renewed focus on Algebra and Calculus, with possibly less emphasis on Statistics. They also stress the need for justification and the development of mathematical understanding. Most respondents are very concerned about the proposal to award 40% of the marks in the Leaving Certificate Examinations to project work.