

**Project Maths  
and the  
Irish Maths Teachers Association**

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## Introduction

On the 10<sup>th</sup> September 2012, the following letter was sent to each branch of the Irish Mathematics Teachers Association (IMTA). 'The executive of the IMTA wishes to avail of the experience of Maths teachers nationwide in order to facilitate the successful introduction of Project Maths at all levels in both the Junior Cert and Leaving Cert courses. We accept that aspects of the course need to be adjusted, and will make submissions to the relevant bodies over the coming months, having sought the opinions of the teachers charged with delivering the syllabus countrywide.

To this end, the IMTA Council encourages all Branches to hold an open forum meeting where all maths teachers in their catchment area are invited to investigate ways to contribute to the experience-based evolution of Project Maths.

We are confident that these meetings will provide us with a unique insight, which will allow our submission to ensure that the PM course meets the needs of our students in the long term. It is envisaged that the findings which emerge from these meetings will be co-ordinated by the executive and form the basis of the IMTA submission mentioned above. The branch meeting should preferably be held during September, with the opinions noted by a designated Branch Committee member and submitted to the executive before the AGM in Cork on the 20th October.

Be advised that the IMTA is one of the partners in the Project Maths initiative and the only Maths organisation that is permitted to have an input into the development of the programme. Advice on the conduct of the meeting will issue to your Branch Representative under separate cover.'

## Branch meeting template

It was recommended that each meeting should be broken up into three clear sections to allow for the smooth transition between points of discussion. It was suggested that these would be: **Content, Methodology and Assessment.**

This document outlines problems identified by the branches of the Irish Mathematics Teachers Association and suggested solutions to these issues provided by our membership. Each branch of the IMTA, without exception, made submissions towards this work and these have been compiled and presented in what follows. The pertinent issues are presented under the headings used at the meetings. Each problem is described and the suggested solution is denoted by bullet points.

## **Content**

### **Syllabus detail**

Much more detail is needed in the syllabi at all levels. The current syllabi are proving to be inadequate. It has already been demonstrated that there are gaps in them. For example, for 2013 there is no mention of the Binomial Theorem but in parts of the course it is needed, for example in the proof of de Moivre's Theorem. It was added in for 2014 as a result. We are disturbed that items get added into the successive syllabi without teachers being explicitly told about them; e.g. graphing of trigonometric functions of the type  $f(\theta) = a + b\sin c\theta$ . Does the lack of detail mean that anything and everything can be included through the use of "scaffolding", even if not explicitly mentioned in the syllabi? For example, the single word "simulation" has been used to justify the inclusion of the Central Limit Theorem.

Our members are very worried that students at Foundation level are being forgotten about since there is no clear view as to what they should be covering.

- Detailed clarification of course content is urgently needed. The Association would recommend the publication of a checklist-like document detailing topics and sub-topics for each section. Alternatively, a detailed list of what is not on the new courses in comparison with the old courses would be equally beneficial. Immediate clarification is required as to the indicative Junior Certificate content that is presupposed for those following the Leaving Certificate syllabus at Foundation level.

### **Syllabus content**

The syllabus is seen as too long, with timing becoming an issue due to the volume of content.

An added concern here is the inclusion of all the material at lower levels in higher levels, such as the need to cover the Trapezoidal Rule at higher level. Some items appear short and simple to teach initially but turn out to be very time-consuming. Examples are types of functions, and present values.

There is broad consensus that the topics of statistics, and constructions in geometry, are over-represented. Strand One is currently too long, especially as it takes so much time for proper coverage and to include the new methodologies.

This situation might improve when students come through with knowledge from Junior cycle but it still eats into time. The number of Geometry constructions in Strand Two is excessive. It is extremely difficult to achieve the learning objectives related to geometry. In the spirit of Project Maths, alternative valid proofs of theorems should be accepted. Students and teachers repeatedly report that they do not know where to start with this material and it is not improving with exposure.

Some teachers feel that Strand Three is too broad and that there is intense pressure on them to try and get it covered using the new methodologies.

It is noted that there is material that is currently deferred and is due to be added in coming years. There is not enough material (e.g. Calculus) on the Leaving Certificate Higher and Ordinary Level courses for students hoping to pursue Engineering / Science Courses. Members are concerned that these students are not as well prepared for their 3<sup>rd</sup> level courses as they were in the past.

A number of branches report that some of the new topics are quite difficult to teach. Financial Mathematics is an example.

- The Association would prefer to see less content in Strands 1 and 2 and in the area of Financial Mathematics and would like the inclusion of more calculus. Teachers have found the area of conditional probability to be time-consuming and very difficult for students to handle. If deferred material is introduced, it will only make the burden of content worse.
- Our membership feels that the deferred material should not be introduced.
- The removal of vectors should be reviewed and its restoration should be considered in light of the removal of material from the first two strands.
- It is recommended that some of the constructions in Geometry be removed. The current series of constructions is time-consuming and does not particularly bring any great benefit to the students.

## Methodology

It is acknowledged that students enjoy the active approaches that are part of the new teaching methodologies. It is reported that there is a better understanding of the links between the topics with the new methodologies. There is also a feeling that the perception of mathematics as an abstract subject is dissipating, in line with the introduction of more material linked to life. However, teachers feel that they have to abandon the new methodologies and revert to 'chalk and talk' at times to ensure that content is covered. Teaching Leaving Certificate mathematics classes outside of school timetables is becoming the norm across the country. Teachers now feel that it is impossible and unmanageable to cover the content in the class time provided. The IMTA believe that it is unacceptable to expect teachers to operate in this way. Every branch of the IMTA reports that there is not enough time to do investigations since the course is so long. The NCCA's recommendation of the number of hours

required to deliver the course is grossly unrealistic and underestimated. An example is the topic of Complex Numbers at Leaving Cert Higher level. Teachers feel that it takes at least four to five weeks to cover this but that the recommendation is three weeks.

The Project Maths paradigm represents a movement away from a traditional *deductive* way of introducing a mathematical topic, to an *inductive* one. The inductive process is seen in Monte Carlo methods (concepts of probability), in geometry software (motivation of geometrical properties), and in concrete experiment with areas of figures (concepts of rational number, relationships etc.) and so on. Fully implemented, it should lead to a new sentiment about the subject. But it is very heavy on time and effort by the teacher. Leaving aside the effort, time is being identified as a key factor in the impracticality of the new order. In the inductive method of motivation and teaching (and learning), the burden of teaching moves from the teacher to the student. There, it becomes self-teaching, and to a lesser extent, group-teaching (i.e. teaching by the group).

In this model, it is a concern that the rate of absorption of the mathematical concept is close to the pace of the slowest student. The time-and-motion implications of this are that instead of a teacher teaching at what he/she considers the absorption-rate of the *average* student, with the intention of picking up the weaker learners during a class practical, he/she is forced to move at the rate of the *weakest* students (who must be helped individually) since it would be entirely contrary to the aims and the spirit of inductive learning to interrupt an investigative session when students are only part-way through it.

There are implications in this for the more gifted students too: the class is moving at a slower pace than it otherwise would. While teachers make use of various strategies to ameliorate this problem, the time-and-motion implications of its side-effects are not being measured.

The NCCA recommendation of 180 hours equates to approximately 4 periods per week. Many schools are already providing 5 or even 6 classes per week. This is likely to be eroded as school management implement cutbacks. Teachers say that no revision-time is built in to the syllabus and that students are poor at taking responsibility for their own revision. The suggested use of IT in the class is proving to be extremely challenging, and in many cases impossible, due to the lack of class time.

There are concerns that there should be parity in relation to weekly time-allocation for mathematics in all schools nationally. A growing number of teachers are volunteering to teach extra classes outside the school timetable in order to cover the

material. This is putting undue stress on teachers and pupils. If this is not addressed, it will lead to inequality emerging between schools determined by class time allocation or teacher commitment.

- The IMTA feels strongly that more time is required for teaching the Project Maths syllabus at all levels. To facilitate problem solving, it is felt that longer time periods, greater than 40 minute blocks, are now required. Some schools have already introduced this. However, if this results in only seeing the students 3 times a week it could prove detrimental. Teachers like to see their students each day and want to set homework each day also. If this is cut down to 3 days a week, there will be less homework completed, a detrimental outcome of Project Maths. An alternative to this could be five or six 40-minute class periods to complete the Junior cycle course and seven 40-minute class periods at Senior cycle.

## Resources

It is noted that the outcome expected from the Teaching and Learning Plans does not always happen. Examples of this are the T and L Outcomes in Complex Numbers and Trigonometry. For example, to fully utilise Pythagoras' Theorem at Junior cycle, full competency in algebraic transposition is assumed. This results in the lesson time being wasted as the students may not have the fundamental skills needed. It is felt that the emphasis on the new methodology is resulting in a loss of skill for the students.

- It is requested that Teaching and Learning plans be reviewed, with new ones being produced, this time to be accompanied by worksheets for students.

Teachers have found the in-service provided to date to be beneficial but believe that more could be done within these sessions to reach the needs of teachers and students. In particular, yearly plans have now become 2-year plans and these are proving useless as they quickly slip when encountering student difficulty and the level of detail in the content. It is very difficult for teachers to plan due to the hidden depths of new material and unanticipated issues arising in both teaching and learning.

- It is recommended that in-service be aimed at particular levels e.g. Junior Certificate or Leaving Certificate. Teachers feel that this would be hugely beneficial. It would also be beneficial if sample schemes of work were discussed during in-services. In-service training that focuses on Project Maths exams to date would be welcome because they would lend some certainty about the paper, the material to be covered, and the intentions of those responsible for future marking schemes.

Due to the issues of time and the pressures of coverage, the teacher is, to a large extent, dependent on textbooks. The textbook is used to help with making sense of the syllabi. Most teachers predominately use just the textbook, as opposed to resources provided by the PMDT or self-sourced materials. The textbooks frequently

have poor examples – or not enough examples – and poor gradation of questions, with problems going from the straightforward to the very difficult and missing the middle ground. It has been observed that some textbooks are very expensive and a lot of the material provided within them is proving to be irrelevant. In current times, the financial strain on parents for books that do not give full value is difficult to justify.

- It is suggested that more guidance be given to publishers/authors regarding the type of material that should be included in textbooks so that these books will be better able to meet the needs of the classroom. More should be done to provide work material for teaching and learning which is suitable for the classroom.

Although the Project Maths website has numerous good resources, it is very time-consuming for the teacher to navigate and find what she/he wants. Many of the resources are difficult to implement in large classes, or they take too much time to implement. Most of the website resources pre-date the national implementation of Project Maths.

- The resources on the Project Maths website should be revised in light of classroom experiences and outcomes.

## Assessment

The strongest concerns expressed by our members relate to assessment. It is strongly felt that the present examination structure is inadequate and the following issues need to be addressed urgently:

### Examination paper structure

A lot of dissatisfaction exists with the present exam structure and the style of the exam questions. A radical change in the exam papers is called for by the IMTA. Teachers are particularly opposed to inclusion of overly-extended exam questions with many parts. There seems to be too many marks awarded for these long continued questions. Such questions are more suited to use in the classroom and are not suited to the exam. The layout of the Project Maths paper and the fact that there is not necessarily any set number of questions or a linking of specific questions to specific topics makes it difficult for teachers and students to develop strategies for tackling the paper.

### **Examinations should not be such a devastating experience for students.**

This opinion was voiced to the SEC previously but the devastation is still being experienced. The unpredictability regarding how an excessively difficult question will be marked can be very damaging to morale at exam-time. This can impact on the students' answers to the other questions on the same paper, the second paper and on their preparation for other exams. In addition, students' lack of confidence in their expected results can influence their CAO choices. They may decide to change their preferences prior to the results becoming available.

A strong belief exists that assessment at LCHL is not reflective of the current syllabus. There is a feeling that exam questions are unbalanced in terms of the time taken to do a question, the comparative level of difficulty of the questions, and the distribution of marks within a question. Large parts of the syllabus are not examined. This results in the exam being a very negative experience for many students.

Teachers have been largely unaware that there are a set number of questions at Leaving Certificate but not at Junior Certificate. Not knowing how many questions to expect or how the marks will be distributed leads to problems allocating time to each question. This is a bigger issue at Junior Certificate.

- Every effort should be made to ensure that the papers have a more intelligible structure with a more consistent format and content. Weaker students really need this.

- Students need to be able to access all parts of a question; i.e. if they fail on part (a) then they should still be able to attempt ALL of the parts (b) through (g). Each part should “start fresh”.
- A radical change should be considered. For example, Paper 1 (which could be held earlier than June) could examine only basic skills. It may have say 30 short questions of which the students might choose 25 or so to answer. This paper could carry 40% of the overall marks available. Paper 2 would then examine “in context” questions, while also incorporating choice.
- The Chief Examiner’s reports should be published annually.

### **Inconsistency in marking**

Part (a) may be 5, 10 or 15 marks. Students have no idea of how to divide their time currently. A part that requires a lot of work may only be worth 5 marks. For example in 2012, Q3, on Paper 2 Ordinary Level Leaving Certificate required students to plot 4 points in part (a) which was worth 15 marks, while part (c) which required significantly more work was only worth 5 marks. This is raising questions as to the integrity of the examinations.

The Junior Certificate papers have indications of suggested time-allocation but these do not reflect the allocation of marks; i.e. questions may have the same time allocation but still not receive the same marks.

- Guidelines should be provided as to the weighting of the marks.
- Alternative methods and proofs should be accepted wherever possible.
- The marks awarded should reflect: (i) the teaching time required, (ii) the exam time required to do the question and (iii) the difficulty of the exam question.
- Marks per question-part need to be shown on the exam paper for the integrity of the exam.

### **Issue of literacy**

There is a lot of concern at the level of linguistic skills required and also the time required to read the questions. Students at Leaving Certificate Ordinary Level are struggling with the text-heavy nature of the exam questions. It is noted that students with a good reasoning ability will do better at Project Maths than those that may have better calculating skills. Questions can be very “word-heavy”: a lot of language being used to describe something very simple. The language being employed is too difficult or elaborate: students feel that there is a trick built into such questions. For example, 2012 P2 Ord. Level Leaving Certificate Q5 (a) asks the student to write down a geometrical result that can be used to construct a tangent to a circle at a point.

- Consideration should be given to the amount of time that these questions require of students and the pressure that trying to complete them puts on candidates.

### **Lack of choice**

The absence of choice in Project Maths at Leaving Cert has been heavily criticised by teachers. No other subject lacks choice and lack of choice is seen as unfair to more able students. This is because an inability to do one particular question can see an able student lose out on an A1, whereas a choice would allow students in such situations to choose another question. There appears to be no good reason not to offer choice on the paper.

- A choice of 6 out of 8 in “concepts and skills” sections would be better.
- Questions in “Contexts and Applications” are far too long and a student who struggles with the first couple of parts will find it difficult to continue and perhaps to break it into three 50-mark questions, or do 3 questions out of 4. If a choice is to be offered, then the questions should not be so “word-heavy” as to require a lot of time to read through all the choices.

### **Time of examination**

The scheduling of a mathematics examination on an afternoon, particularly a Friday afternoon, represents a lack of understanding of the psychological issues involved in answering a mathematics paper of the Project Maths type.

- All mathematics papers should be morning papers.

### **Sample papers**

The Association is very disappointed at the late issue of the sample papers in relation to the 2013 examinations. This is particularly so as the Calculus part is not what some teachers had expected. The late issue also resulted in a delay in the publication of examination papers by the usual commercial publishers and unnecessary stress for examination students. The Irish Mathematics Teachers Association is dismayed at the level of recycling of questions from previous sample papers.

- Sample papers should be issued at the end of August at the latest.
- One sample paper per examination is insufficient, far more original sample questions are required and suggested solutions for questions should also be provided. A marking scheme to accompany the sample papers is also necessary to give guidance as to how the new topics would be marked.

## Summary

In summary, it is the opinion of the IMTA, representing the opinion of its fifteen branches from all regions of the country, that

- a. A more detailed syllabus is required.
- b. The present syllabus should be shortened by removing some aspects from strands 1 and 2 and some of the Financial Mathematics.
- c. To achieve the aspiration of the new methodologies, to move from a deductive to an inductive paradigm, considerably greater class-time needs to be devoted to mathematics and this will need to be implemented at a policy level by the DES.
- d. Any rigorous and syllabus-derived proof of a Geometry theorem should be acceptable, even if such a proof is not explicitly prescribed by syllabus.
- e. Future in-service training should target particular levels.
- f. More resources such as sample papers with contextualized problems should be prepared in a timely fashion.
- g.
  - i. In examinations of Project Maths syllabi, students do not have a chance to demonstrate the width nor in some cases depth of their understanding. Some questions are too trivial and others are too long winded, and are difficult to follow in terms of English usage, and early mistakes make later work impossible.
  - ii. The examination is a very negative experience for students. This is demonstrated by the media coverage over the last few years and by IMTA members' own students' feedback on leaving the examinations.
  - iii. The need to adjust marking schemes artificially, and in the gross way that this has been done in the last few years is bringing the examination into disrepute. The integrity and validity of the examination is being questioned by teachers, and this concern will grow among the general public if not addressed.
  - iv. It is felt that Friday afternoon is a bad time for a mathematics paper especially if the examinee has had to sit a Geography paper that morning, as was the case in 2012.