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National Centre for STEM Education

Time in Mathematics Education (TiME):

A National Study Analysing the Time Allocated to Mathematics at Second Level in Ireland

A Research Report

By

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October 2017

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ABSTRACT

The national STEM report (2016) recommended that STEM education research become a national priority. This report, which investigates the quantum of time allocated to mathematics, seeks to address this recommendation. Many researchers agree that time is a fundamental ingredient of learning (Judson, 2013; Ruiz-Gallardo et al., 2016). Carroll (1963; 1989) described how academic achievement is dependent on variables representing the amount of time available to learn, the time needed to learn, and the time a student is willing to spend learning. However, as in countries such as the UK and the Netherlands, post-primary schools in Ireland are free to decide how to allocate instruction time among curriculum subjects. There is anecdotal evidence to suggest that this results in variations in the quantum of time allocated to teaching mathematics across different schools and between different class groups within the same school which may advantage or disadvantage students in certain class groups or in certain schools. As such, it is important to determine the quantum of time allocated to mathematics across Irish post-primary schools. This study builds a profile for both lower post-primary (Junior Cycle) and upper post-primary (Senior Cycle) mathematics instruction time in Ireland, as well as addressing a number of time-related issues. The sampling frame consisted of a list of all 723 post primary schools in Ireland (Department of Education and Science website, April 2015). Of these schools, 52% are Secondary Schools, 35% are Vocational Schools, 11.1% are Community Schools and the remaining 1.9% are Comprehensive Schools. The study targeted 55% of the entire sampling frame and so a stratified random sample of 400 schools was selected for this study. A total of 182 deputy principal surveys (46%) were returned along with 540 completed mathematics teacher questionnaires (34%). Overall, the results of the study highlight that although the proportion of time allocated to mathematics in Ireland is on par with the OECD average, there are still some issues of concern. These issues, brought to light via the deputy principal and mathematics teacher questionnaires, are discussed at length in this report.

SUMMARY OF THE STUDY

Introduction

A key recommendation contained within the national STEM report, published in 2016, was the establishment of STEM education research as a national priority. This study is an example of such research. It investigates a key aspect of any education programme - the quantum of time. It focuses on mathematics but offers a mechanism for all other STEM disciplines to investigate the time allocated to the different STEM subjects. It is critical that such information is gathered before many of the action points outlined in the STEM report can be acted upon.

Research into the provision of time for mathematics commenced in the 1960s with the work of Caroll (1963). Since then many researchers have agreed that time is a fundamental ingredient for learning (Judson, 2013; Ruiz-Gallardo et al., 2016). Carroll (1963; 1989) described how academic achievement is dependent on variables representing the amount of time available to learn, the time needed to learn, and the time a student is willing to spend learning. In more recent years, a large body of literature has demonstrated strong, positive correlations between instruction time and student achievement (Benavot & Amadi, 2004; Smith, 2000). These studies, along with the PISA and TIMSS reports, have found that the number of hours, days and years that students are formally required to take instruction in a subject impacts upon their academic success (Smith, 2000). Sufficient instruction time facilitates greater exposure to knowledge and skill development and helps foster higher levels of achievement (Smith, 2000).

Aim of the Study

This study evolved after the authors discovered anecdotal evidence that suggested that there were discrepancies in the quantum of time allocated to mathematics across schools, and across class groups within schools, in Ireland, and that these differences were resulting in some students being placed at a disadvantage. This issue needed to be investigated and quantified. As such, the aim of this study is to build an accurate profile for both lower post-primary (Junior Cycle[1]) and upper post-primary (Senior Cycle[2]) mathematics instruction time in Ireland. The profile was constructed by determining the amount of mathematics instruction time allocated to different year groups in a large sample of Irish post-primary schools. Furthermore, it involves exploring a number of related issues such as variations in assigned time and the provision of voluntary classes.

Methodology

This investigation adopted a mixed-methods approach. Two questionnaires were designed - one for post-primary mathematics teachers and one for the deputy principal of each school. The questionnaire for teachers was designed to ascertain their opinions and insights into the instruction time available for mathematics in post-primary schools. The questionnaire for the deputy principals sought to establish a time profile for mathematics education in Ireland and to determine what factors influenced decisions in relation to the time made available for mathematics in post-primary schools. The sampling frame for this study was a list of all 723 post-primary schools in Ireland (Department of Education [DES] website, April 2015), with a targeted sample size of 400 deputy principals and 1600 mathematics teachers. Using an estimate of an average of one deputy principal and four qualified mathematics teachers per school, a stratified random sample of 400 schools was selected.

Key Findings

1. The overarching finding to emerge from this study is that current arrangements relating to the time allocated to mathematics mask a significant inequity in the treatment of students studying mathematics at all levels and across all years.
2. The time allocated to mathematics instruction ranged from 120 to 300 minutes per week in first year; from 145 to 240 minutes per week in second year; from 145 to 249 minutes per week in third year; from 175 to 290 minutes per week in fifth year; and from 180 to 290 minutes per week in sixth year.

1 In Ireland, Junior Cycle refers to the first three years of post-primary education. It is a three-year cycle consisting of first year, second year and third year. Students enter the cycle between the ages of 12 and 13.
2 In Ireland, Senior Cycle refers to the last two years of post-primary education. It is a two-year cycle consisting of fifth year and sixth year. Students enter the cycle between the ages of 15 and 16.

3. Timetabling constraints, the availability of mathematics teachers and the perceived importance of the subject were deemed to be the most influential factors by deputy principals when making decisions regarding the time available for mathematics instruction.
4. 62% of teachers surveyed disagreed/strongly disagreed that there was sufficient time available to teach mathematics at Junior Cycle, while the corresponding figure for Senior Cycle was 82%.
5. 91% of teachers reported that there was no double period scheduled for their Junior Cycle classes, while 43% of teachers reported a similar scenario at Senior Cycle.
6. 88% of Junior Cycle teachers and 79% of Senior Cycle teachers stated that the time allocated to mathematics had not changed since the introduction of the new mathematics curriculum (known locally as Project Maths) in 2010. This was despite the fact that 89% of Junior Cycle and 92% of Senior Cycle teachers believed that Project Maths had impacted on the time required to teach the post-primary mathematics curriculum.
7. 23% of Junior Cycle ordinary level teachers disclosed that they offered voluntary mathematics classes in their own time, outside of school hours. The corresponding figure for Junior Cycle higher level teachers was 55%; for Senior Cycle ordinary level teachers it was 49% and for Senior Cycle higher level teachers it was 69%.
8. 9% of timetabled mathematics classes in third year and 8% of those in sixth year do not take place each year as a result of school events, including mock examinations[3].
9. In both first and second years, the majority of teachers expected their students to spend between 11 and 20 minutes per night on their mathematics homework. This increased to between 21 and 30 minutes per night for third- and fifth-year students, and to between 31 and 40 minutes per night for sixth-year students.
10. 49% of teachers surveyed stated that it was their school's policy to teach the Senior Cycle mathematics syllabus during Transition Year[4] (TY) despite the DES regulations recommending otherwise.

Recommendations

- Students should receive equal amounts of mathematics instruction time regardless of factors such as school, teacher, class group, etc.
- The recommended time allocation outlined in official syllabus documentation needs to be revised and more realistic guidelines need to be offered.
- The practice of providing of voluntary classes needs to be further investigated and measures put in place to ensure such classes are not essential.
- National guidelines should also recommend the amount of time that students are expected to spend on homework per night.
- The number of subjects that Irish students study for both Junior and Leaving Certificate examinations should be reduced so that they are in line with their international counterparts.
- All schools should be encouraged to introduce a double period per week for lower post-primary students and two double periods per week for upper post-primary students.
- Continuous professional development in the effective and efficient use of instruction time should be made available to all teachers.
- Further research should be conducted into the value of the mock examinations as they can result in a substantial number of classes being missed at a critical time of the school year.
- Mathematics teaching hours in TY need to be increased in line with recent national reports, and TY should not be seen as an opportunity to engage with the Leaving Certificate mathematics syllabus over three years instead of two.
- There is a need for a renewed and sustained effort to increase the number of qualified teachers available in mathematics and other STEM subjects.

3 Mock examinations are practice examinations that third- and sixth-year students take in early spring. These are modelled on the State Examinations, which students are required to sit at the end of Junior and Senior Cycles, and are seen as a mechanism to prepare students for these State Examinations.

4 Between the Junior and Senior Cycles, the majority of post-primary schools offer Irish students the opportunity to enrol in a one-year Transition Year programme. This is a non-academic, optional 'gap' year aimed at promoting students' social and personal development.

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PREFACE

Over the past 50 years and more the interest and progress internationally in identifying and understanding the key variables underpinning the quality of schooling has been significant. In that context, since the early research on teaching on the 1960s, time has been advanced for over that period as a key factor in the quality of teaching in schools. As such, given the government's recent national STEM policy report in 2016 and its recommendation that STEM education research become a national priority, this report by Dr. Niamh O'Meara (UL) and Dr. Mark Prendergast (TCD) sheds light on time as an important and consequential variable in understanding post-primary mathematics education in Ireland.

A report such as this also reflects the benefits of having a critical mass of researchers in a centre such as EPI-STEM, National Centre for STEM Education, University of Limerick. In part because of such centres (e.g. CASTEL in DCU, STEM-ERC in Trinity), in recent years in Ireland, a cadre of mathematics education researchers has emerged and is contributing to a growing body of literature on the dynamics of both primary and post-primary mathematics learning in classrooms. This emergence is evident in the volume of mathematics education research now available to inform both policy review and research debates. The study underpinning this report on time in post-primary mathematics has already contributed to the research literature with a number of published journals articles to date. Crucially, though a report, such as this one, fulfils an important role in reaching a wider readership, especially nationally, in terms of the complexities underpinning progress in mathematics education reform.

Prof. Paul Conway
School of Education,
University of Limerick

I remember when Mark (Prendergast) first told me about the idea for this research. I was delighted to hear that the time allocated for mathematics in Irish schools was the topic, especially as the anecdotal experience of major discrepancies between different post-primary schools was strong. It was also timely, due to the introduction of Project Maths, which was bound to demand more teaching time due to its practical nature. This report is also timely in that it addresses a key recommendation of the STEM Review Group's report (2016) to establish STEM education research as a national priority.

The report, apart from being timely, reveals significant inequalities that exist between schools in relation to the amount time students receive mathematics instruction (including voluntary classes outside the timetable) despite the fact that all schools follow the same subject specifications and prepare for the same state examinations. Many teachers also felt that there was not enough time to cover the requirements for teaching Project Maths.

TIME in Mathematics Education also provides a template for extending this study to other post-primary STEM subjects, in order to provide a blueprint for policy makers to work from in addressing the issue of inequalities that exist in various structural elements within and between schools, including the time allocated to STEM classes. Such a collaborative STEM education research project would help to realise the STEM Review Group's vision, to provide students in Ireland with "a STEM educational experience of the highest international quality...and excellent performance in STEM disciplines".

Prof. Colette Murphy
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INTRODUCTION

A key recommendation contained within the national STEM report, published in 2016, was the establishment of STEM education research as a national priority. This study is an example of such research. It investigates a key aspect of any education programme - the quantum of time. It focuses on mathematics but offers a mechanism for all other STEM disciplines to investigate the time allocated to the different STEM subjects. It is critical that such information is gathered before many of the action points outlined in the STEM report can be acted upon.

Many researchers agree that time is a fundamental ingredient for learning (Judson, 2013; Ruiz-Gallardo et al., 2016). This was recognised by Carroll (1989, p.27) who referred to time as an 'exceedingly obvious variable'. Carroll described how academic achievement is dependent on variables representing the amount of time available to learn, the time needed to learn, and the time a student is willing to spend learning. In more recent years, a large body of literature has demonstrated strong, positive correlations between instruction time and student achievement (Benavot & Amadi, 2004; Smith, 2000). During the last three decades, several highly publicised surveys of mathematics achievement (the Trends in Mathematics and Science Study [TIMSS] and Programme for International Student Assessment [PISA]) have heightened public awareness about the presumed importance of mathematical knowledge and competencies. These studies have found a positive relationship between achievement and the number of hours, days and years students are formally required to take instruction in a subject (Smith, 2000). Sufficient instruction time facilitates greater exposure to knowledge and skill development and helps foster higher levels of achievement (Smith, 2000). However, it is important to note that time alone is not a reliable predictor of achievement (Judson, 2013) and focusing on increasing the amount of instruction time cannot be the sole target for improvement (Phelps et al., 2012). Although having time to teach and learn is a critical condition, policy makers, and teachers in particular, must also attend to the quality of instruction (Phelps et al., 2012). Increasing instruction time can improve academic performance only if the extra time is allocated and used effectively (Harn et al., 2008; Rock & Thread, 2009).

AIM OF THE STUDY

There is anecdotal evidence to suggest that there are variations in the quantum of time allocated to teaching mathematics across different schools and between different class groups within the same school, which may advantage or disadvantage students in certain class groups or in certain schools. As such, it is important to determine the quantum of time allocated to mathematics across Irish post-primary schools. The aim of this study is to build an accurate profile for both lower post-primary (Junior Cycle) and upper post-primary (Senior Cycle) mathematics instruction time in Ireland. This will involve determining the amount of mathematics instruction time allocated to different year groups in a large sample of Irish post-primary schools. Furthermore, it will involve exploring a number of the issues outlined, such as the variations in assigned time and the provision of voluntary classes.

OBJECTIVES

The key objectives of this research are to:

- Determine the time allocated to mathematics in Ireland and to investigate differences in time allocation between schools and between class groups in the same school.
- Ascertain practising teachers' opinions in relation to the time allocated to mathematics.
- Examine the change, if any, in the time assigned to mathematics since the introduction of Project Maths.
- Investigate issues surrounding time afforded to mathematics education in Ireland, such as missed mathematics classes, the provision of voluntary classes, the factors affecting deputy principals' decisions when assigning time to mathematics and the time spent on mathematics homework.
- Produce a report on this representative national study for distribution through a collaboration between EPI•STEM, University of Limerick, and STEM-ERC, University of Dublin, Trinity College.

RELEVANT LITERATURE

Overview of Time Allocated to Mathematics in an Irish Context

In Ireland, the quantum of time allocated to each subject at post-primary level is not specifically set out by the Department of Education and Skills [DES]. In a recent OECD report (2014a) it is outlined that, on average, Irish Junior Cycle students are exposed to 111 hours of mathematics per annum (OECD, 2014a). This works out at 11.87% of the overall post-primary time being allocated to the subject in Ireland, which is similar to the OECD average of 12% (OECD, 2014a). This substantially exceeds the time recommended by official syllabus documentation, which states that the Junior Cycle curriculum should be taught as a 240-hour course of study, the equivalent of 80 hours per annum. While there are no OECD averages available for Senior Cycle, the official syllabus documentation recommends that the curriculum be taught over 180 hours, the equivalent of 90 hours per annum. Hence, while it appears that the amount of time allocated to mathematics in Ireland is on par with the European average and appears to exceed the time recommended in official syllabus documentation, anecdotal evidence, along with evidence from a number of national reports, has identified numerous outstanding issues in relation to the time allocated to mathematics.

Issues Surrounding the Time Allocated to Mathematics in Ireland

While few countries in international comparison reports spend significantly more time on mathematics than Ireland on a weekly basis, there are a number of issues surrounding the time allocated to the subject:

- Short Length of the Irish School Year

Starting at the end of August and continuing until the end of May, the minimum length of the post-primary academic year in Ireland is 167 days (Beggy & O'Meara, 2014). Most other countries have longer school years. For example, there are 180 days per year in USA schools, 200 in Australia, 240 in Germany and Japan and 280 days per year in Singapore schools (OECD, 2014a). Hence, while the percentage of time allocated to mathematics in Ireland is in line with the OECD average, 12% of 167 days results in less time compared to other countries who have longer school years.

- Division of School Time among Many Subjects

In Ireland, for the Junior Cycle, there are 28 subjects in total to choose from. Of the 28 subjects, students must study a minimum of ten subjects for the Junior Certificate examination. For the Leaving Certificate, students must study the compulsory subject of Irish and then select a minimum of four other subjects. However, in order to maximise their grading points in a system which acts as a gatekeeper to third-level education, students generally choose between six and eight subjects from a possible 34 which a school may offer. This is higher than their counterparts in other countries (National Council for Curriculum and Assessment [NCCA], 2005; DES, 2010). A consequence of the high number of subjects being taken by students is a lack of specialisation and the division of school time among many subjects.

- A Reformed Curriculum which Demands More Time

The Irish post-primary mathematics curriculum has undergone a major reform since the introduction of a revised curriculum known locally as 'Project Maths' to all schools nationally, on a phased basis, in September 2010. The overall aim of this new mathematics curriculum is to teach the subject in a way which leads to real understanding (DES, 2010). It involves changes to what students learn in mathematics, how they learn it and how they are assessed. There is a much greater emphasis placed on students' understanding of mathematical concepts, with increased use of contexts and applications that will enable students to relate mathematics to their everyday experiences. Despite emerging evidence of the positive impact on students' experiences of learning mathematics (Jeffes et al., 2013), many challenges remain for the implementation of the revised curriculum. The reform has prompted a number of reports and studies to suggest that, despite being in line with the OECD average, there is an insufficient amount of time currently allocated to teaching mathematics in Ireland (DES, 2010; Jeffes et al., 2013; Cosgrove et al., 2012).

Cosgrove et al. conducted a survey in 2012 in which teachers were asked about the challenges of implementing Project Maths. The most common response referred to the time available to teach the new syllabus. Teachers indicated that they encountered considerable problems in covering a course that they believe to be too long and too broad. Similarly,

the Irish Mathematics Teachers Association [IMTA] (2012) and Prendergast and Treacy (2017) found that the syllabus is seen as too long, with time becoming an issue due to the volume of content: 'Time is a big thing, you have to just move on and there's so much to cover'; 'The amount of material that has to be covered with the timeframe involved makes it very difficult' (Teachers' responses in Prendergast & Treacy, 2017, p. 11). In addition to the long syllabus, the new teaching methodologies, assessment methods and learning experiences being promoted by Project Maths are much more time-consuming than the methodologies which teachers engaged with in the past (Cosgrove et al., 2012).

- Lack of Double Classes

Following on from the previous issue, there have been calls to introduce double periods to facilitate the successful implementation of the new approaches being promoted by the reformed curriculum (Beggy & O'Meara, 2014). The IMTA argue that in order for meaningful learning to occur, longer periods than the generic 40-minute single classes are needed. This is emphasised in the report published by the IMTA (2012, p. 7) which states that: 'To facilitate problem solving, it is felt that longer time periods, greater than 40 minute blocks, are now required... [They recommend] five or six 40-minute class periods to complete the Junior Cycle course and seven 40-minute class periods at Senior Cycle'. Six or seven classes over five school days would/should, of course, include at least one double period per week for both Junior and Senior Cycle classes.

This is similar to the situation in the United States where there has been a strong call for the scheduling of double periods on schools' mathematics timetables (Flynn et al., 2005). In line with the curriculum changes resulting from the National Council of Teachers of Mathematics [NCTM] publication (2000), researchers are of the opinion that this revised form of scheduling would allow teachers to move away from the typical lecture/didactic style of teaching. Furthermore, it would facilitate the incorporation of a variety of teaching strategies (Veal & Flinders, 2001; Canady & Rettig, 1995; National Commission on Time and Learning, 1994).

- Variations in Assigned Time

Although there are Government recommendations available, the decisions regarding the amount of time individual schools allocate to different subjects are generally taken by the school principal and deputy principal, who have responsibility for the day-to-day management of the school. The deputy principal is generally allocated the timetabling responsibilities in Irish schools. While the Government recommendations may act as guidelines, the ethos of the school and the individual decisions of school management determine the amount of marginal mathematics time that students experience throughout their post-primary education. This is similar to the situation in both the UK and the Netherlands. Such policy results in variations between the times allocated to teaching mathematics in different schools and also between different class groups within the same school.

- Provision of Voluntary Classes Outside of School Time

To combat such inequities and variations in instruction time, anecdotal evidence suggests that there are a high number of teachers offering voluntary, additional mathematics classes outside of school hours in an attempt to complete the mathematics syllabus. This is not just an Irish issue. In 2013 the OECD conducted an analysis of the responses of 510,000 students who completed the PISA survey in 2012. In this report 37.9% of students said that extra mathematics lessons were offered by schools outside of scheduled class time (OECD, 2013). However, this figure was significantly higher in countries such as Japan, China (Shanghai) and Vietnam where 69.8%, 70.7% and 82.8% of students, respectively, stated that they attended such classes. On the other hand, the percentages reported for countries such as Ireland, Norway and Liechtenstein (24.1%, 22.7% and 26.1%, respectively) were lower than the OECD average (OECD, 2013).

- Issues Regarding the Provision of Mathematics in Transition Year

One of the main challenges facing the Transition Year [TY] programme in Ireland is striking a balance between the emphasis on personal and social development and the maintenance of a focus on academic development (Jeffers, 2007; Moran et al., 2013; Smyth et al., 2004). The flexible nature of the programme means it is susceptible to being taken over by the values and practices of the Leaving Certificate (Jeffers, 2007). For example, a recent Irish report from the Education Research Centre entitled Mathematics in Transition Year: Insights of Teachers from PISA 2012 found that many schools expected teachers to use TY to begin covering Leaving Certificate mathematics material (Moran et

al., 2013). This is despite the guidelines issued to schools in 1994 clearly stating that 'A Transition Year Programme is not part of the Leaving Certificate Programme and should not be seen as an opportunity for spending three years rather than two studying Leaving Certificate material' (Department of Education, 1996, p. 1).

On the other hand, some schools do not place enough emphasis on mathematics in TY. The National Strategy to Improve Literacy and Numeracy Among Young People (DES, 2011) has recommended that mathematics be taught regularly during the programme. An Education Research Centre [ERC] report found that on average TY students are timetabled to receive 83 hours of mathematics instruction per year (Moran et al., 2013). However, of the 83 hours timetabled, students receive just 84.1% of those hours on average (Moran et al., 2013). This disparity between hours timetabled and taught may be due to student participation in multi-day activities that typically take place during TY (Department of Education, 1996).

- Number of Cancelled Classes

Disparity between the hours timetabled and those taught is not just a TY issue. In each year group, many scheduled mathematics classes are cancelled over the course of a school year due to school events such as sports, shows and excursions, in-house examinations or award ceremonies taking place. The in-house examinations refer to end-of-term (Christmas and summer) examinations that are held during class time, as well as mock examinations.

- Variations in Time Assigned to Homework

One way teachers may compensate for the shortages in class time is to load their students with homework. There has been much debate in recent years regarding the advantages and disadvantages of homework and research has yielded mixed results. In the United States, Cooper et al. (2006) found that the relationship between the amount of homework students do and their achievement outcomes was positive and statistically significant. On the other hand, Farrow et al.'s (1999) work casts a shadow over such findings as they note that students who only completed homework once a month in the core areas of mathematics, English and science had higher test scores than those who reported doing homework more frequently. The time allocated to homework appears to vary between countries. Denmark has piloted 'homework-free' schools, resulting in a reported fall in dropout rates and rise in overall grades (Kryger & Ravn, 2009). At the other end of the spectrum, Chinese students who consistently score in the top band in mathematics international comparison tests (OECD, 2014b) do hours of extra study at home and in after-school tutorials (Ferreras & Olson, 2010). In Australia, national homework guidelines suggest that Year 9 students (generally aged 14-15 and equivalent to third year in Ireland) should spend between 45 minutes and 1.5 hours per night on their homework (Department of Education and Training, 2015). In the UK, national homework guidelines suggested that their comparable Year 11 students (generally aged 15 and equivalent to third year in Ireland) should spend between 1.5 and 2.5 hours per night on their homework (Hinds, 1995). However, these guidelines were scrapped in 2012 due to complaints from parents that it was impacting on family time. In Ireland there are no national guidelines for schools in relation to the provision of homework but individual schools are advised to have a policy on the matter (Jackson & Harbison, 2014).

The aim of this national report is to build a time profile for both Junior Cycle and Senior Cycle mathematics in Ireland. This will involve determining the amount of mathematics instruction time allocated to different year groups in a large sample of Irish post-primary schools. This is in response to the anecdotal evidence that suggests there are currently discrepancies in the time allocated to mathematics across schools and across class groups within schools. Furthermore, the study involves exploring a number of the issues outlined in this literature review, such as the variations in assigned time and the provision of voluntary classes. This research is unique in an Irish context as it is the first study of its kind to look systematically at the amount of time allocated to mathematics instruction in post-primary schools using a nationally representative sample.

METHODOLOGY

This investigation adopted a mixed-method approach. Two questionnaires were designed - one for teachers of mathematics and one for the deputy principal of each of the schools in the sample. In the deputy principal questionnaire, the respondents were asked to provide a detailed breakdown of the class time for each of the following year groups:

- First year Common Introductory Course
- Second year ordinary level
- Second year higher level
- Third year ordinary level
- Third year higher level
- Transition Year
- Fifth year ordinary level
- Fifth year higher level
- Sixth year ordinary level
- Sixth year higher level.

This provided an insight into the total number of minutes per week spent on mathematics, the number of mathematics classes provided per week and also a specific breakdown of these classes for each year group. Furthermore, the deputy principal questionnaire sought information from deputy principals on the factors which they felt were most influential in assigning instruction time to mathematics in their school. On the other hand, the teacher questionnaire sought to ascertain if the time assigned to mathematics in Irish schools is reasonable; to determine if there has been an increase in the time assigned to mathematics since the introduction of Project Maths; to investigate the type of class periods (double or single) that are assigned to mathematics; to examine the prevalence of voluntary classes which take place outside of school time; and to establish the number of mathematics classes that are foregone on a weekly basis for reasons outside of a teacher's control. The open-ended questions included on the teacher questionnaires also allowed the teachers to elaborate on their feelings towards the time allocated to mathematics in their school and their reasons for providing or not providing mathematics classes on a voluntary basis outside of school time.

Sampling Frame

The sampling frame for this study was a list of all 723 post-primary schools in Ireland (DES website, April, 2015). Of these schools, 52% are Secondary Schools, 35% are Vocational Schools, 11.1% are Community Schools and the remaining 1.9% are Comprehensive Schools. The study targeted 55% of the entire sampling frame and so 400 schools were selected for this study. Initially the authors wished to cover the full sample of 723 schools. However, this proved to be very demanding in terms of logistics and thus a coverage of over half of all post-primary schools was decided on.

This allowed the authors to target 400 deputy principals and approximately 1600 qualified mathematics teachers.

Data Collection and Response Rate

Each of the deputy principals of the 400 schools was sent a questionnaire to be completed and returned in a stamped, addressed envelope. The deputy principals were also sent the teacher questionnaires and were given the responsibility of distributing these questionnaires to the mathematics teachers in their schools. Each deputy principal received four teacher questionnaires and four stamped, addressed envelopes for returning the teacher questionnaires. Information sheets were also provided for all participants along with each questionnaire. These information sheets outlined the background and aims of the study, along with instructions for the completion and return of the questionnaires. Instructions for the deputy principals stated that if more than four qualified mathematics teachers were teaching mathematics in their schools then copies of the questionnaire should be made and more than one questionnaire could be returned in each of the envelopes. Each stamped, addressed envelope included was given a number corresponding to the school selected so the researchers could identify the schools that had not returned the completed questionnaires.

Two weeks after sending the questionnaires, follow-up telephone calls to each of these schools were undertaken by a research assistant so as to increase the response rate to both questionnaires.

Deputy principals from 182 schools (45.5% of the targeted sample) responded to the survey. The percentage of each type of school in the deputy principal sample was very similar to the national percentages, as evidenced in Table 1.

Table 1. Types of school that responded to deputy principal questionnaire

	Secondary	Vocational	Community	Comprehensive
National Figures	52%	35%	11%	2%
Schools that responded	58%	29%	10%	3%

Teachers from 229 schools (57.25% of the targeted sample) responded to the survey. Altogether, 540 questionnaires were returned from teachers teaching mathematics in these schools. The number of teachers who returned the questionnaire in each school ranged from one to six teachers, with the modal value being two (n = 71). As was the case with the deputy principal questionnaires, the percentage of each type of school in the teacher sample was very similar to the national percentages. This is demonstrated in Table 2.

Table 2. Types of school that responded to teacher questionnaire

	Secondary	Vocational	Community	Comprehensive
National Figures	52%	35%	11%	2%
Schools that responded	57%	31%	10%	2%

FINDINGS

A statistical analysis of the quantitative data was undertaken using the statistical software package SPSS for Windows (Version 20), while the qualitative data was analysed using the software package NVivo. The findings are discussed in the following subsections.

Time Profile

The deputy principal questionnaire was the research instrument used by the authors to arrive at a profile of the time allocated to mathematics across all year groups in Irish post-primary schools. The results are summarised in Table 3 below, while Figures 1-5 show the percentage of schools which allocated varying amounts of times to each year groups.

Table 3: Overview of minimum, maximum, mean and median time allocated to mathematics across Irish post-primary schools per week (in minutes) and per annum (in hours)

	Minutes per Week				Hours per Annum[5]		
Group	Min. Time	Max. Time	Mean Time	Median Time	Min. Time	Max. Time	Mean Time
First Year	120	300	191.09	200	66.8	167	106.4
Second Year OL	145	240	194.07	200	80.7	133.6	108.0
Second Year HL	145	240	194.26	200	80.7	133.6	108.1
Third Year OL	145	249	196.30	200	80.7	138.6	109.3
Third Year HL	145	249	196.52	200	80.7	138.6	109.4
Fifth Year OL	175	280	219.46	223.5	97.4	155.9	122.2
Fifth Year HL	175	290	222.16	225	97.4	161.4	123.7
Sixth Year OL	180	280	227.64	237.5	100.2	155.9	126.7
Sixth Year HL	180	290	230.60	240	100.2	161.4	128.4

5 This figure is calculated based on OECD (2016) statistics which state that post primary schools in Ireland open for 167 days per annum – the equivalent of 33.4 weeks.

Table 3 highlights the variations in the time allocated to mathematics in schools across Ireland. The cumulative time highlights the effect that this can have over a full academic year. For example, a student studying first-year mathematics in a school that allocates the maximum amount of time to mathematics will experience 100.2 more hours of mathematics in his first year of post-primary education than a student studying first-year mathematics in a school offering the minimum amount of time. This student will also spend considerably more time (an additional 60.6 hours) than the average student studying mathematics in first year. When these figures are considered over the entire Junior Cycle and Senior Cycle programmes, the variation is further exacerbated. For example, the minimum time allocated to mathematics over the three-year Junior Cycle programme is 228.2 hours, compared with a maximum time of 439.2 and a mean time of 323.7 hours at ordinary level and 323.9 hours at higher level. At Senior Cycle, the minimum time for ordinary-level students is 197.6 hours, compared with a maximum of 311.8 and a mean of 248.9. The comparative figures for higher level are a minimum of 197.6 hours, a maximum of 322.8 hours and a mean of 252.1 hours.

In Ireland, the number of hours of tuition for mathematics is not prescribed but instead there are recommendations offered in the syllabus documentation. According to the Junior Cycle syllabus, the time recommended for mathematics is 80 hours per annum, which is the equivalent of 144 minutes per week. From Figures 1, 2 and 3 it is evident that, in first, second and third year, across both higher and ordinary level, the vast majority of schools are reaching or exceeding these recommendations. Likewise, the Senior Cycle syllabus recommends allocating 90 hours per annum to teach the Senior Cycle curriculum. This equates to 162 minutes per week. Figures 4 and 5 show that every school surveyed exceeds this recommendation.

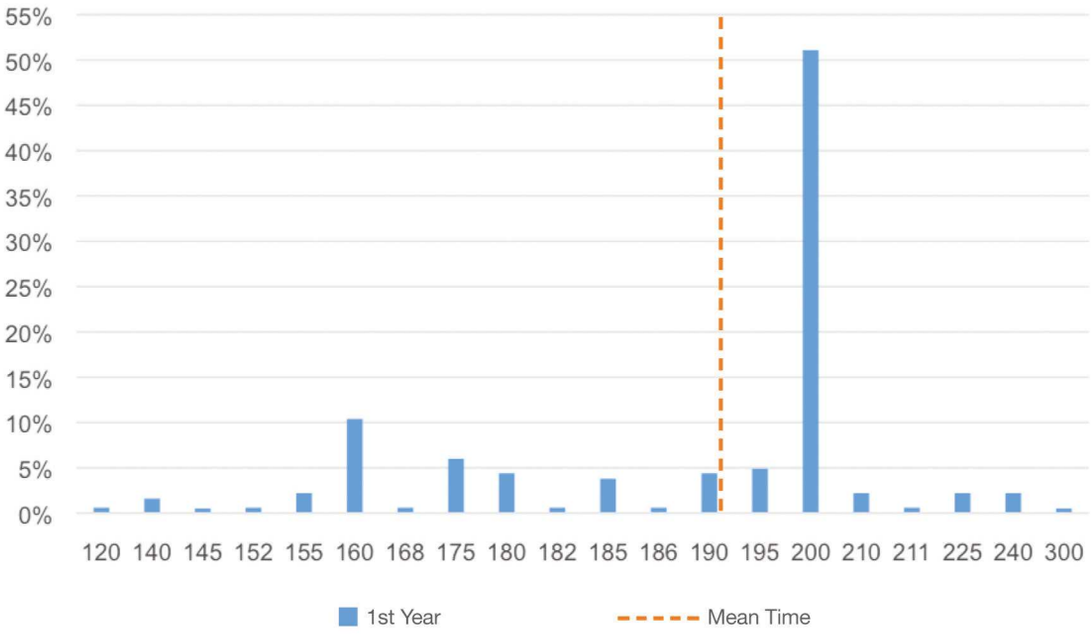


Figure 1: Percentage of first-year mathematics minutes per week

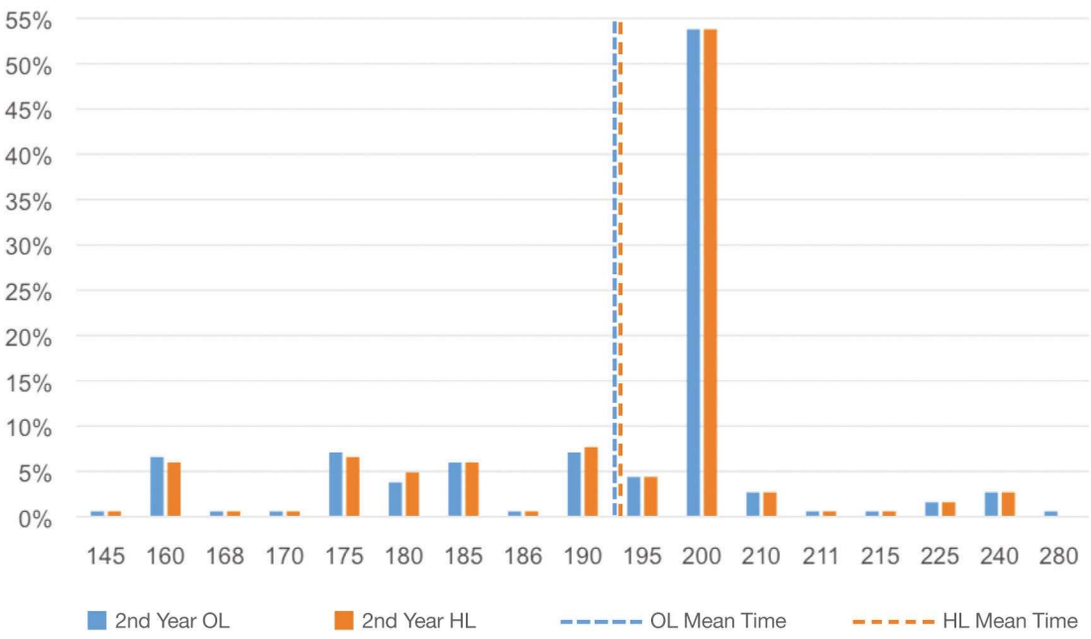


Figure 2: Percentage of second-year higher and ordinary level (HL & OL) mathematics minutes per week

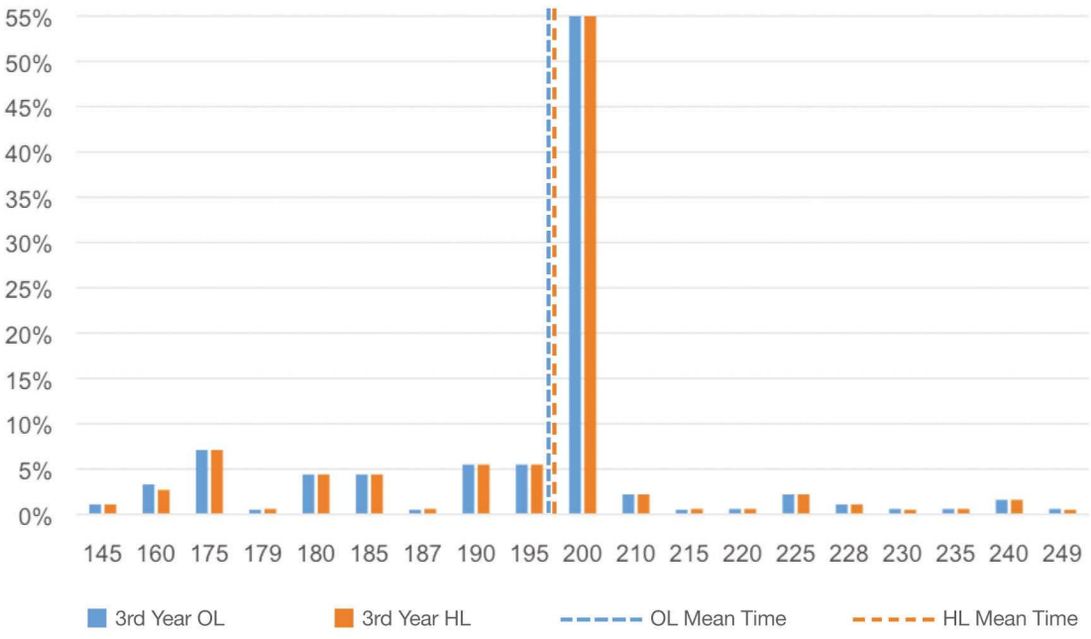


Figure 3: Percentage of third-year higher and ordinary level (HL & OL) mathematics minutes per week

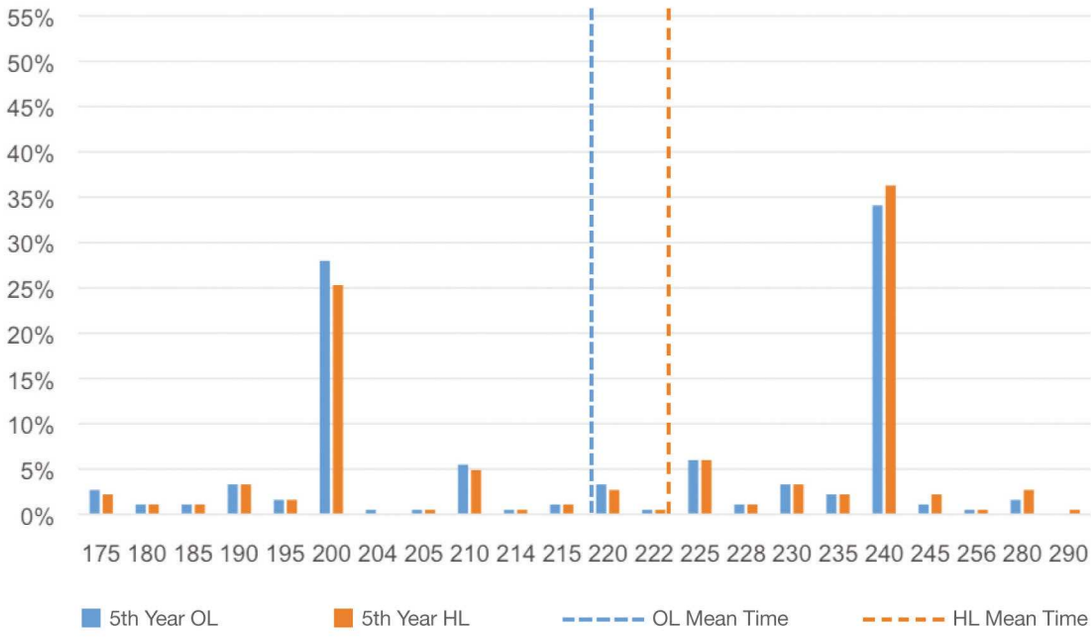


Figure 4: Percentage of fifth-year higher and ordinary level (HL & OL) mathematics minutes per week

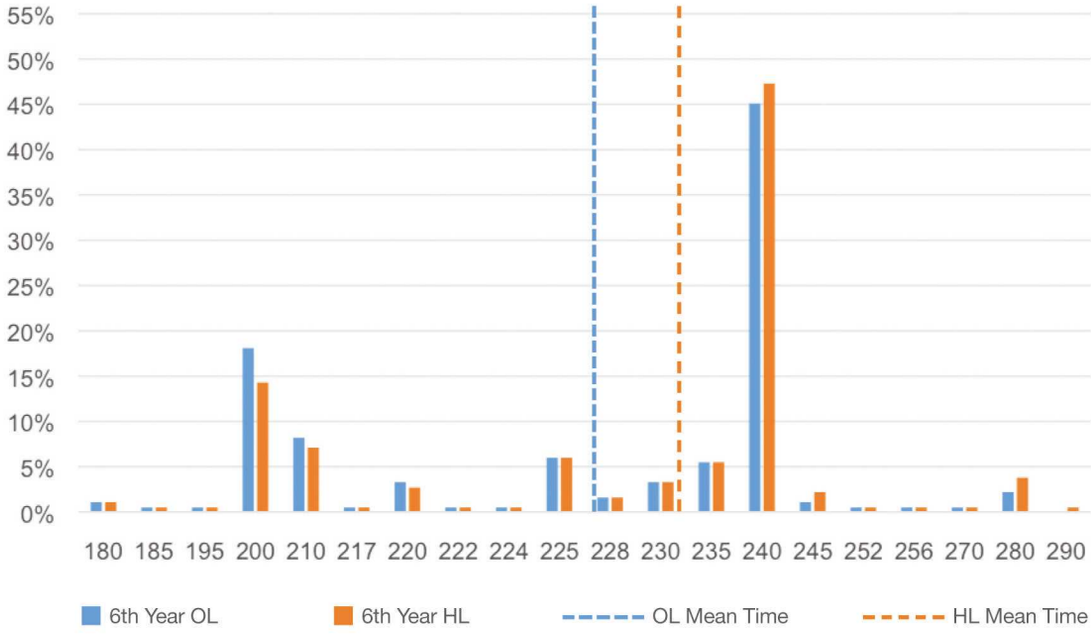


Figure 5: Percentage of sixth-year higher and ordinary level (HL & OL) mathematics minutes per week

Influential Factors

With the help of a Deputy Principal Research Advisory Group, established by the researchers, which consisted of a number of deputy principals from around Ireland, and the extensive literature review conducted by the researchers, the authors were able to identify seven key factors that influenced deputy principals when they were deciding on the time they allocated to mathematics for their students (Prendergast & O'Meara, 2016c). The seven factors are listed below, unranked:

- Ability Level of the Class Group
- Availability of Classroom Resources
- Availability of Mathematics Teachers
- Parental Pressure
- Perceived Importance of the Subject
- Timetabling Constraints
- Year of the Class Group

Figure 6 outlines the most prominent factors from the perspective of the deputy principals surveyed, while Figure 7 shows the proportion of deputy principals who considered the remaining four factors to be central to their decision.

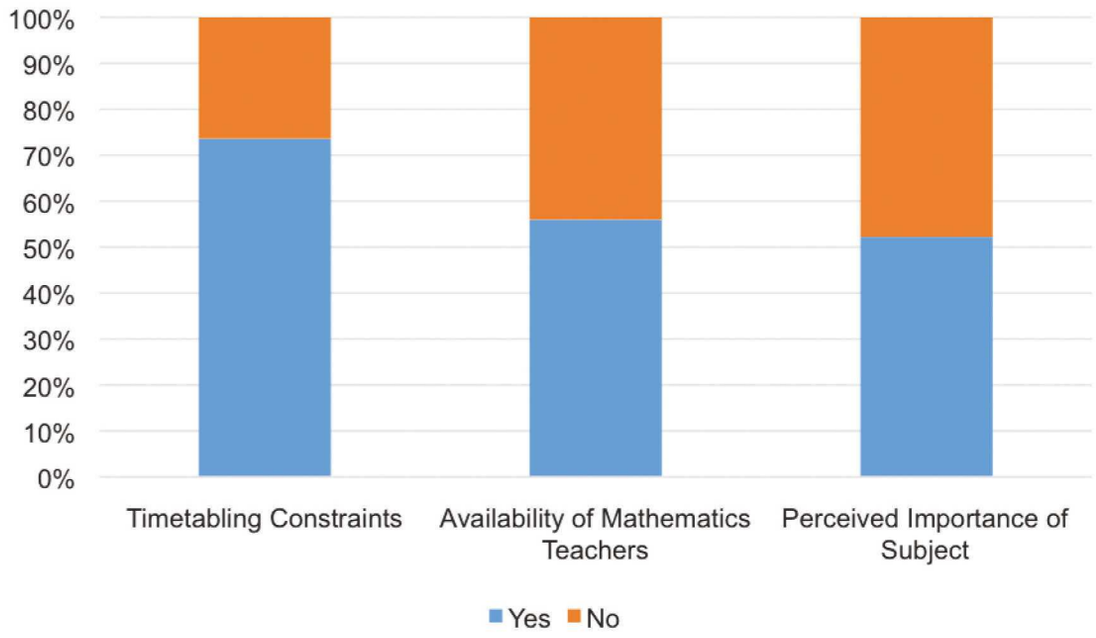


Figure 6: Three main factors influencing deputy principals when deciding on the time to allocate to mathematics

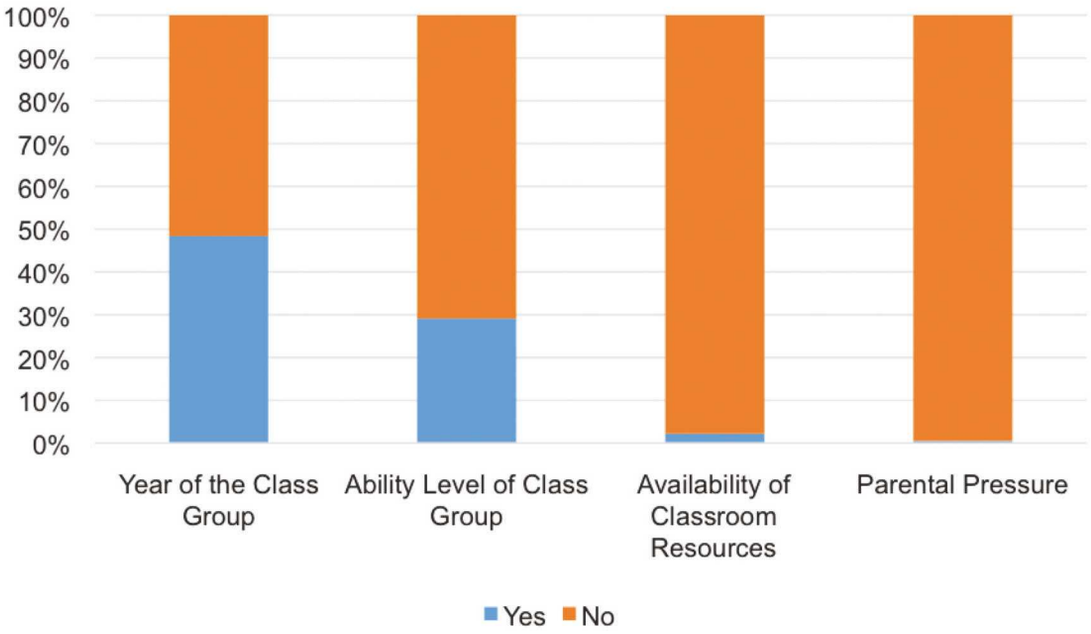


Figure 7: Other factors influencing deputy principals when deciding on the time to allocate to mathematics

Figures 6 and 7 show that timetabling constraints, the availability of mathematics teachers and the perceived importance of the subject are the prominent variables considered by deputy principals when assigning class time.

Teachers' Opinions on the Time Allocated to Mathematics

At both Junior and Senior Cycles, the statement 'There is a sufficient amount of time allocated to mathematics' was applicable to 516 teachers, and of these 509 responded. At Junior Cycle, 62.3% of teachers either disagreed or strongly disagreed with the statement, while 29.1% either agreed or strongly agreed. At Senior Cycle, 82.1% either disagreed or strongly disagreed with the statement, while 13.0% agreed or strongly agreed.

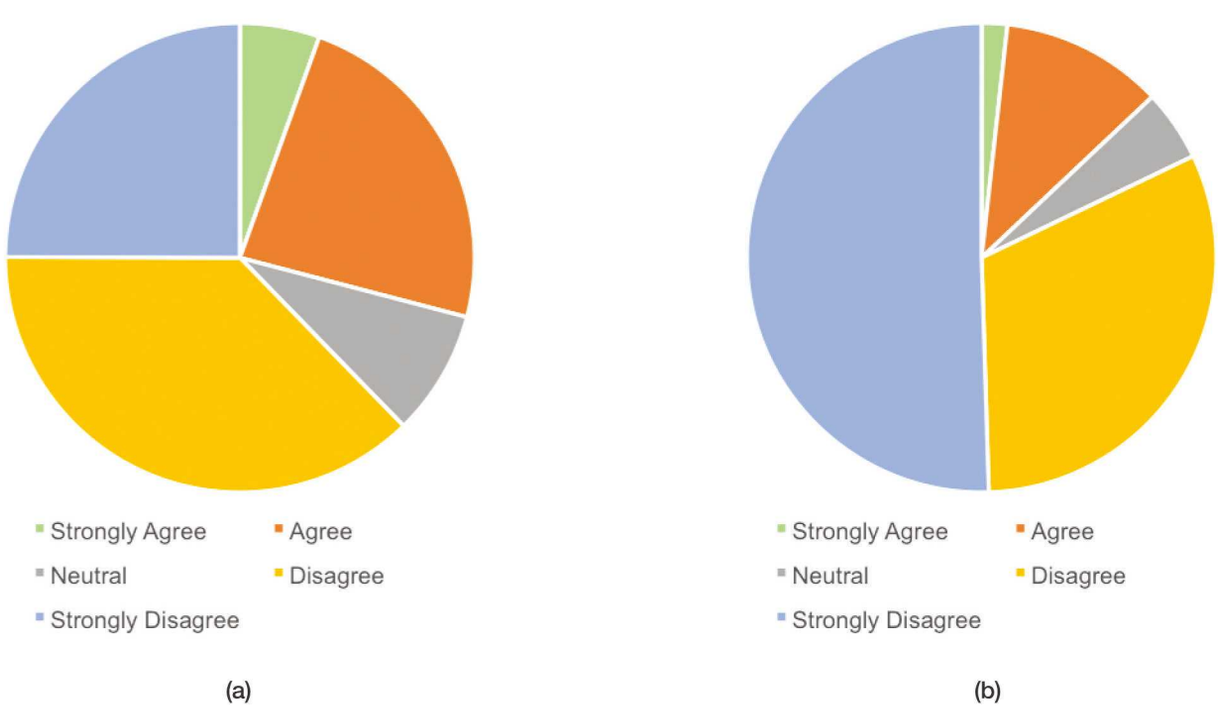


Figure 8: Pie chart of teachers' responses to the statement 'There is a sufficient amount of time allocated to mathematics at (a) Junior Cycle; (b) Senior Cycle'

Teachers were also asked if they felt the aims and objectives of Project Maths could be achieved within the current time available to them. This question was applicable to 526 teachers at Junior Cycle and 516 offered a response. Of these teachers, 14.7% felt that it was feasible to achieve the aims and objectives of Project Maths within the given timeframe, while the remaining 85.3% felt that this was not the case. At Senior Cycle, the question was applicable to 527 teachers and 508 offered a response. Of those teachers, 5.1% felt that is was possible to achieve the aims and objectives of Project Maths within the allocated time, while the remaining 94.9% believed the opposite to be true.

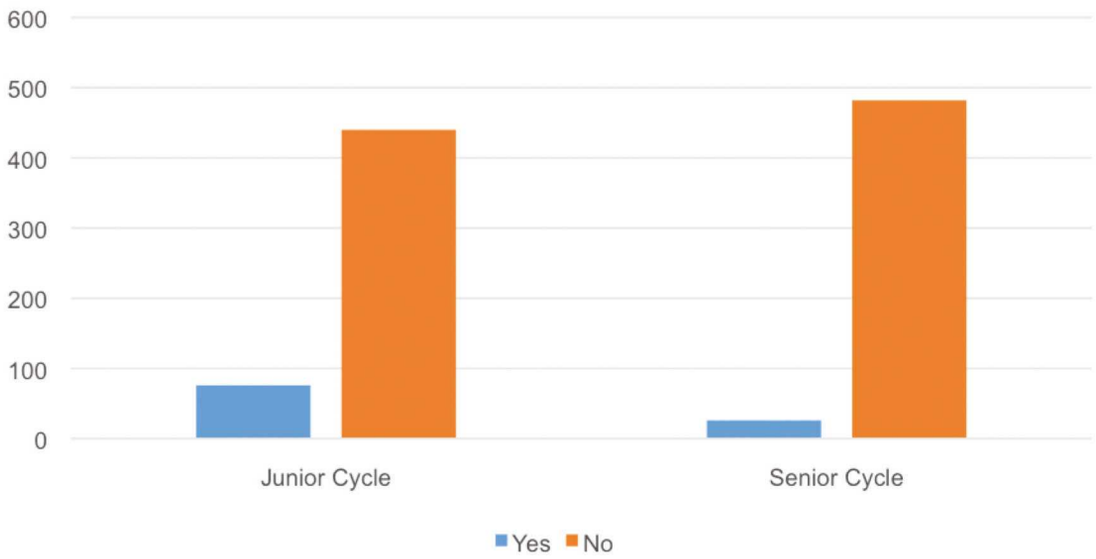


Figure 9: Bar chart of teachers' responses when asked if the aims and objectives of Project Maths can be achieved under the current time provisions at Junior and Senior Cycle

The findings presented in Figure 9 were supported by the responses given to the open-ended questions that asked teachers to give a general comment as to their opinion on the time allocated to mathematics at both Junior and Senior Cycle. Responses to this question were received from 494 Junior Cycle teachers. While some of them used this as an opportunity to detail the breakdown of classes in their school, a large proportion did use it to outline their perspective on the time allocated to mathematics. Of the 494 teachers, 51.2% (n = 253) expressed the opinion that there was insufficient time allocated to mathematics at Junior Cycle:

> T133: 4 periods x 40 minutes is not enough to cover first year Common Introductory Course. 5 x 40 minutes in second and third year is not enough time to cover the higher-level course. Maths teachers are under huge pressure.

> T283: Not enough time to do the course if teaching in a school with moderately bright students (higher-level) - not even speaking about teaching for understanding, practical work etc. Barely enough time to finish the books.

> T368: Not enough time to get Junior Cert course completed. Ridiculous amount of material to get covered in the time allocated. Crazy!

On the other hand, 21.7% of teachers who responded (*n* = 107) said that there was a sufficient amount of time allocated to Junior Cycle mathematics:

> T218: There is enough time to complete the course at Junior Cycle.

> T232: 5 x 40 minute periods is sufficient to cover the course with about 5 or 6 weeks of revision. However, if you want to ensure a deeper understanding more time is needed.

Many teachers who stated that the time allocation was sufficient were of a similar opinion to that expressed by respondent T232. They believed the time was sufficient but only if certain objectives of Project Maths, such as teaching for understanding or problem solving, were overlooked. Furthermore, it must be noted that 27 of the 107 teachers who indicated that time was sufficient said that this was the case for ordinary level but not so for higher level:

> T317: Enough at ordinary level but not nearly enough at higher level. No comparison.

> T459: Probably sufficient for foundation and ordinary level but more time (classes) required at higher level.

Responses were received from 483 Senior Cycle teachers to this open-ended question. Upon analysis, three main themes emerged relating to the adequacy of the time allocated to mathematics at Senior Cycle and the depth of treatment required for the Senior Cycle curriculum. Of those who responded, 58.8% (*n* = 284) stated that there was insufficient time allocated to mathematics or that they needed more time at Senior Cycle:

> T5: Insufficient time to teach the course at both higher and ordinary level. To be honest, if I taught the course in the way proposed by the Project Maths team, I wouldn't get 60% of the course covered in the two years.

> T102: More hours needed per week for both higher level and ordinary level. Very rushed to finish syllabi and always end up giving extra classes, outside of school time.

> T122: We have five periods per week to teach in fifth and sixth year. This is not sufficient. I used to give an extra class every week to sixth years, but stopped doing it because the school expected me to do it instead of giving us an extra period (and paying me for it!). Now we still only have five periods so we try to cover some of the material in Transition Year.

Among Senior Cycle teachers, 14.9% (*n* = 72) stated that they felt the time was sufficient. However, as was the case at Junior Cycle, 18 of these respondents said that such sentiments only applied to the ordinary-level course and not the higher-level course, while a further 11 teachers who said time was sufficient noted that their concern was not with the time allocation but rather the length of the course:

> T220: More class time required for Honours Level. Ordinary Level, where we have 6 x 40 minutes, is adequate.

> T330: [Time allocation] is very satisfactory in comparison to other subjects and other schools. I can complete the course.

> T439: Time allocation for maths at Senior Cycle is quite good in my school with 6 class periods of 35/40 minutes each. However, the curriculum itself is so long it is very difficult to complete the course.

Finally, 7.3% of respondents (*n* = 34) did not use this open-ended question to express their opinion of the time allocated to mathematics but instead used it to outline their feelings towards the scope of the curriculum. All 34 respondents in this category made no reference to time but instead said that the Leaving Certificate course was simply too broad. This may be an implicit acknowledgement that the time allocated to mathematics is insufficient or simply an assertion that no amount of time would be suitable given the breadth of the curriculum:

T4: ... there is too much material. The jump from Junior Cert ordinary level to Leaving Cert ordinary level is ridiculous.

T397: The course is far too long to cover. Leaving Cert [students] are given 6 class periods per week, however it is still a major struggle to cover the course.

T518: Course is too long. Unfair amount of course content. Impossible to cover the full course. If the new style of teaching was fully implemented the course just wouldn't get covered.

Changes in the Time Allocated to Mathematics since the Introduction of Project Maths

Asked if the time allocated to mathematics in their school had changed since the introduction of Project Maths, 508 teachers at Junior Cycle offered a response. The majority (88.0%) said that there had been no change in the time allocated to mathematics, while 8.5% said they had been assigned more time and 3.5% said the time allocated to mathematics had been reduced. At Senior Cycle, 508 teachers responded and the majority (79.3%) stated that there had been no change in the time provided for mathematics in their school. A further 17.5% reported an increase in the time allocated to mathematics, while the remaining 3.2% reported a decrease.

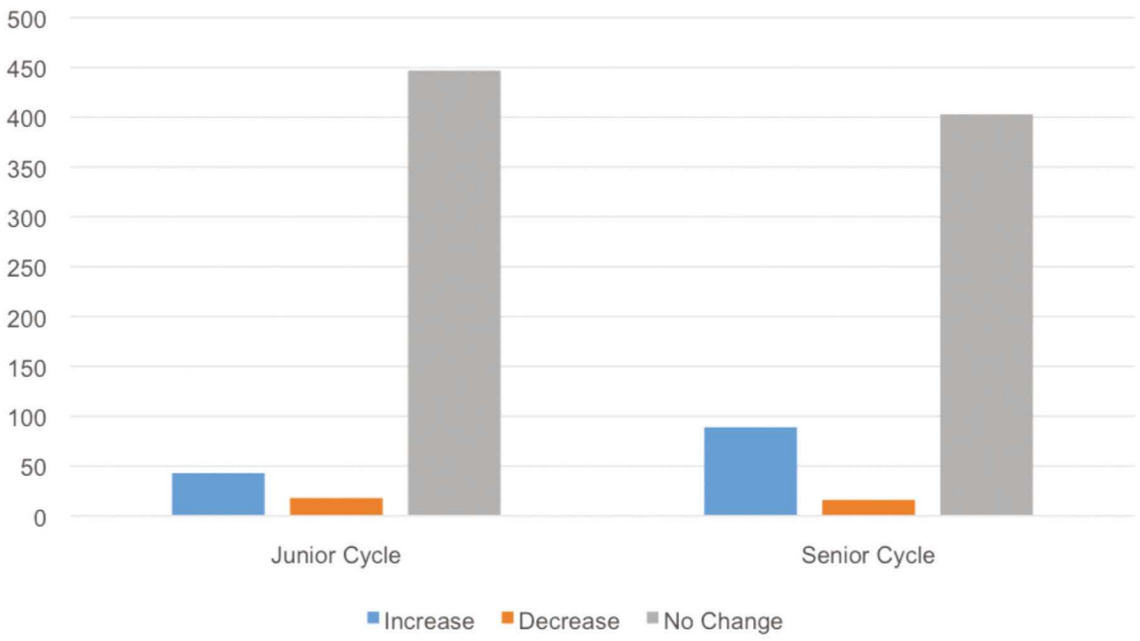


Figure 10: Bar chart showing teachers responses when asked if the time allocated to mathematics has changed since the introduction of Project Maths

At Junior Cycle, the statement 'Project Maths has impacted on the time required to teach mathematics' was applicable to 506 teachers and 495 offered a response. Of these, 88.9% either strongly agreed or agreed with the statement, while 4.4% disagreed or strongly disagreed. At Senior Cycle, the question was applicable to 503 teachers and 495 responded. Of these, 92.5% of teachers strongly agreed or agreed with the statement and a large proportion of them (n = 325) selected the strongly-agree option. On the other hand, 3.6% of teachers disagreed or strongly disagreed with the statement.

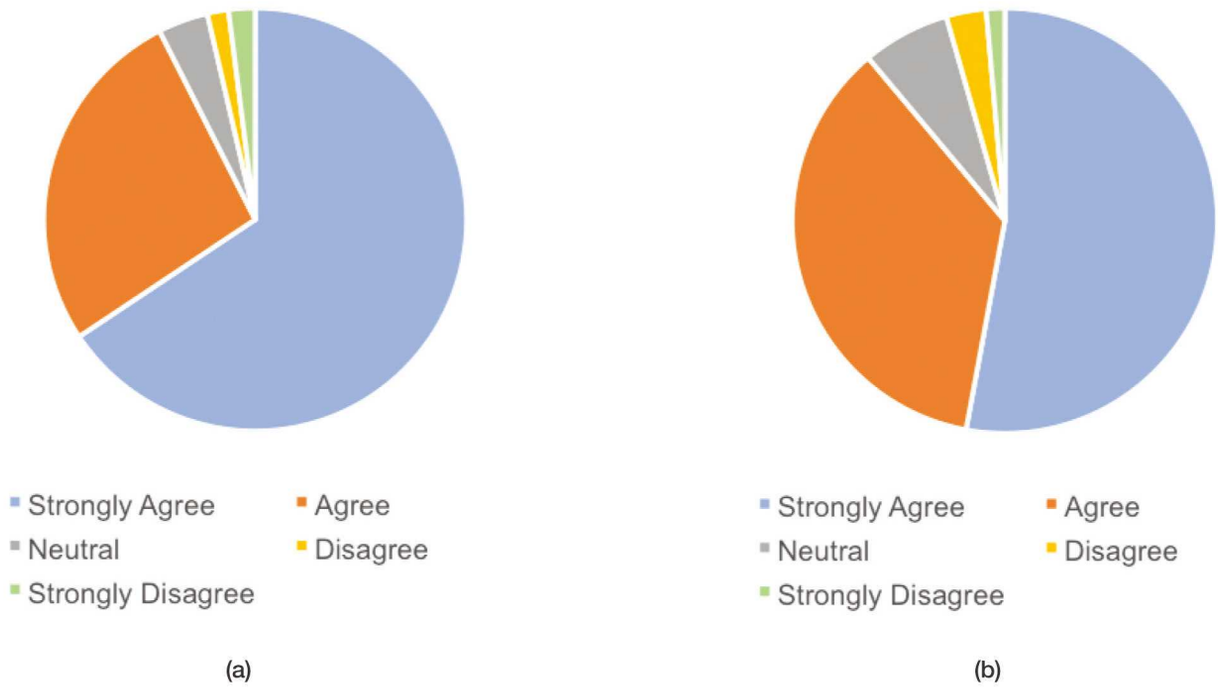


Figure 11: Pie chart of teachers' responses to the statement 'Project Maths has impacted on the time required to teach mathematics at (a) Junior Cycle; (b) Senior Cycle'

Double Class Periods

In the questionnaire, teachers were asked to state if a double mathematics period was scheduled for every Junior and Senior Cycle class they taught. At Junior Cycle the question was applicable to 525 teachers and 514 of these provided a response. At Senior Cycle the question was applicable to 523 teachers and 508 provided the researchers with a response. Of these, 8.9% of teachers said that a double period was scheduled every week with every Junior Cycle class group they taught, compared to 56.9% at Senior Cycle. On the other hand, 91.1% of Junior Cycle teachers reported not having a double period scheduled with each class group every week, compared to 43.1% at Senior Cycle.

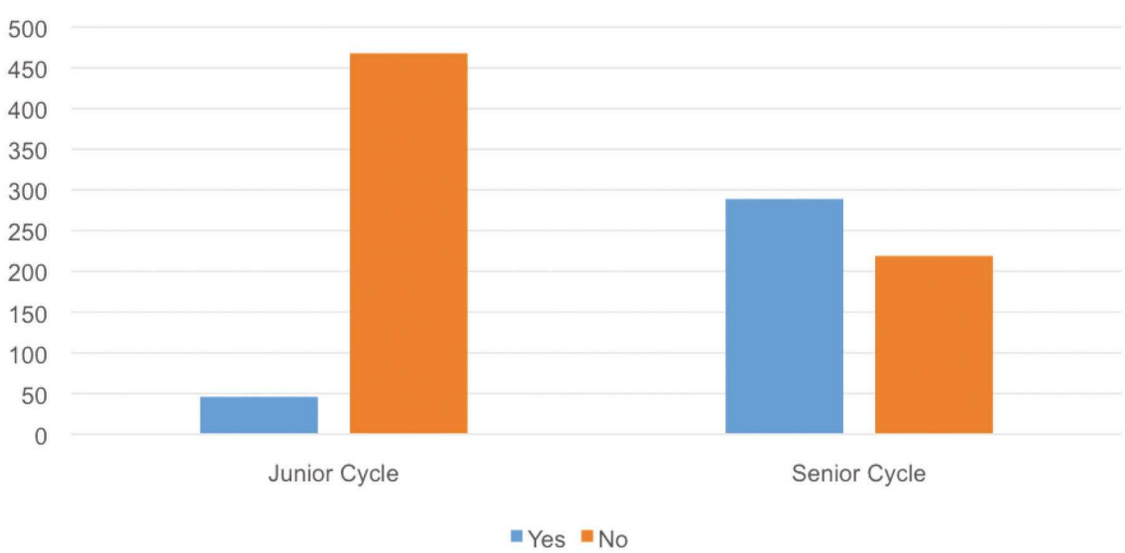


Figure 12: The provision of double periods at Junior and Senior Cycles

In order to determine if there was a relationship between the provision of double periods and school type, the authors conducted a cross-tabulation between the two variables. The results of this, presented in Table 4, show that at Junior Cycle, Secondary Schools were least likely to include double periods on the timetable, with 7.6% of respondents from this school type indicating that a weekly double mathematics period was scheduled. At Senior Cycle, Comprehensive Schools were least likely to include double periods on the timetable, with 44.4% of valid responses from this school type indicating that a weekly double mathematics period was scheduled. On the other hand, Community Colleges were the most likely to include double mathematics periods on the timetable at both levels, with 13.5% and 60.4% of respondents from this school type indicating that a weekly double mathematics period was scheduled at Junior and Senior Cycle respectively.

Table 4: Comparing the provision of double periods across school type

Type of School	Double Mathematics Period Per Week at Junior Cycle?		Double Mathematics Period Per Week at Senior Cycle?	
	Yes	No	Yes	No
Secondary	22	268	168	117
Vocational	16	139	82	77
Community	7	45	29	19
Comprehensive	1	10	4	5

A chi-square test for independence was carried out to ascertain if there was a significant difference between school types. At Junior Cycle, χ^2 was found to be 0.488 and so the authors failed to reject the null hypothesis indicating that there is no significant difference between the types of school in terms of their provision of double periods at Junior Cycle. At Senior Cycle χ^2 was found to be 0.446 and so again the authors failed to reject the null hypothesis regarding the provision of double periods at Senior Cycle, meaning there was no significant differences across school types.

Cross-tabulation was also the mechanism used to determine if there was a correlation between the provision of double periods and teachers' level of satisfaction. The results of this are presented in Tables 5 and 6, below.

Table 5: Comparing the provision of double periods and teachers' level of satisfaction at junior cycle

		Are double mathematics periods scheduled weekly with your Junior Cycle mathematics classes?	
		Yes	No
There is a sufficient amount of time allocated to mathematics at Junior Cycle	Strongly Agree	5	23
	Agree	14	103
	Neutral	3	39
	Disagree	16	171
	Strongly Disagree	6	121

Table 6: Comparing the provision of double periods and teachers' level of satisfaction at senior cycle

		Are double mathematics periods scheduled weekly with your Senior Cycle mathematics classes?	
		Yes	No
There is a sufficient amount of time allocated to mathematics at Senior Cycle	Strongly Agree	4	5
	Agree	41	15
	Neutral	15	9
	Disagree	95	63
	Strongly Disagree	132	118

Table 5 indicates that of the 44 teachers who reported having a weekly double period of mathematics scheduled on their timetable, 19 (43.2%) either agreed or strongly agreed that there is a sufficient amount of time allocated to mathematics at Junior Cycle. On the other hand, of the 457 teachers who reported that there was no double period scheduled for mathematics at Junior Cycle in their school, 126 (27.6%) either agreed or strongly agreed with the aforementioned statement. In relation to Senior Cycle, Table 6 shows that of the 287 teachers who reported having a double period included on their timetable, 45 (15.7%) agreed or strongly agreed that there is a sufficient amount of time allocated to mathematics at Senior Cycle. Of the 210 teachers who reported not having a double period, 20 (9.5%) were of this opinion. Further statistical analysis was conducted to see if the correlation between the levels of satisfaction with the time allocated to mathematics and the provision of double periods was significant. At Junior Cycle the correlation was not found to be significant ($p > 0.05$) but the opposite was true at Senior Cycle. Hence, this analysis indicates that at Senior Cycle the correlation between teachers' levels of satisfaction and the provision of double periods was significant ($p < 0.05$).

Provision of Voluntary Classes

For the purpose of this study, voluntary classes are defined as mathematics classes that are provided by mathematics teachers outside of regular school time, on a weekly basis and without any form of payment in return (O'Meara & Prendergast, Under Review).

Table 7 shows that the majority of teachers at Junior Cycle higher level (54.8%) and Senior Cycle higher level (68.8%) offered voluntary classes, while almost half (49.1%) of teachers of Senior Cycle ordinary-level students also provided such classes.

Table 7: The provision of voluntary mathematics classes across Junior and Senior Cycles

	N	Yes	No
Junior Cycle Ordinary Level	418	96	322
Junior Cycle Higher Level	463	254	209
Senior Cycle Ordinary Level	440	216	224
Senior Cycle Higher Level	388	267	121

Furthermore, many of the teachers who stated that they did not provide classes on a weekly basis did report, in their responses to the open-ended questions, that they provided voluntary classes on an ad hoc basis. At Junior Cycle, 24 of the 463 teachers (5.2%) to whom the question was applicable stated that, while they did not give weekly classes throughout the school year, they did provide voluntary mathematics classes at certain times in the school year. Likewise, at Senior Cycle 24 of the 388 teachers (6.2%) to whom the question was applicable stated that they provide the classes on an ad hoc basis as opposed to on a weekly basis. Some sample responses in this regard are given below:

> T155: I provide additional classes to Junior Cert students during Easter break. It is mostly as a response to panic for mock exams and I give a day during the holidays for students to come in and ask/do questions.
>
> T454: Coming close to the Leaving Cert exam I feel I have to give extra classes (from Christmas onwards).

All teachers who said that they provided voluntary classes on a weekly basis were then asked to outline how many classes they provided per week. Across all levels, the majority of teachers reported providing one additional class per week. A large proportion of higher-level teachers at Junior Cycle (20.5%) and Senior Cycle (34.8%) also reported providing two additional classes. However, very few teachers across all four levels (a maximum of 9.4% at Senior Cycle higher level) reported giving any more than an additional two extra classes per week.

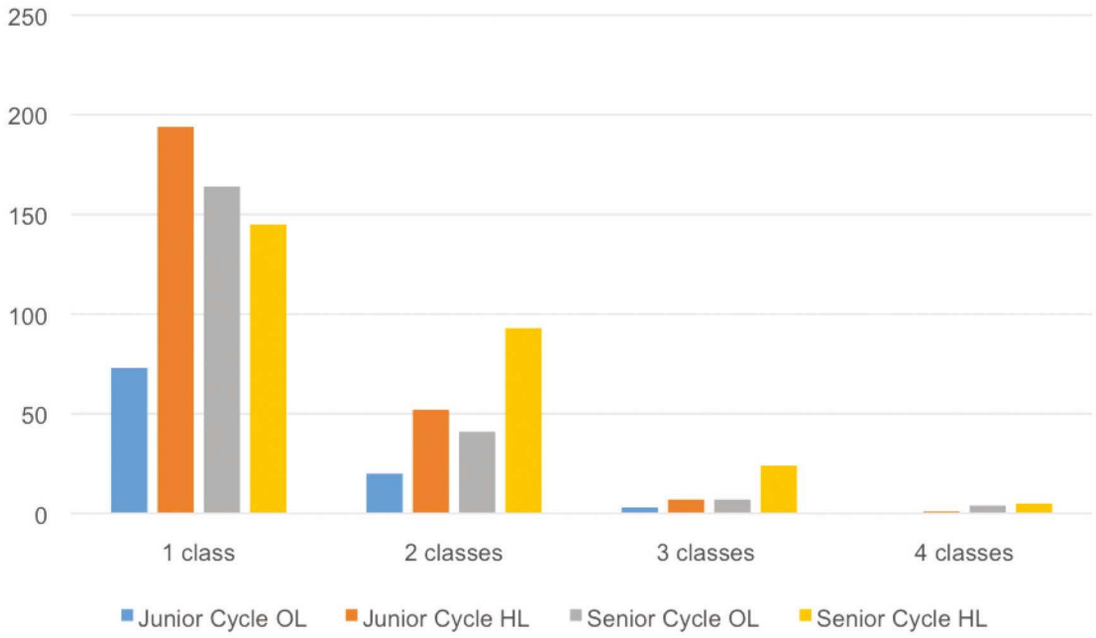


Figure 13: Number of additional classes provided by teachers per week

The teachers who provided additional classes were also asked to detail when the classes commenced and how many extra minutes the weekly classes equated to. Again, all teachers who provided additional classes responded. At both Junior and Senior Cycles, the majority of teachers reported commencing the classes at the beginning of the final year of the cycle (see Figure 14). At Junior Cycle ordinary level, 81.25% of teachers commenced the classes in third year, while the corresponding figure for Junior Cycle higher level was 88.9%. Likewise, at Senior Cycle ordinary level 86.6% of teachers reported beginning the classes at the start of sixth year and 65.2% of Senior Cycle higher level teachers reported the same. Teachers were also asked how many additional minutes per week these voluntary classes afforded them. The responses to this question are detailed in Figure 15. The modal time reported by Junior Cycle teachers at both levels and Senior Cycle ordinary level teachers was 21-40 minutes per week: 46.9% of Junior Cycle ordinary level teachers, 42.1% of Junior Cycle higher level teachers and 40.3% of Senior Cycle ordinary level teachers reported spending this much time in voluntary classes per week. At Senior Cycle higher level the modal time, reported by 31.8% of teachers, was 41-60 minutes per week. However, at this level and Junior Cycle higher level a large proportion of teachers, 33.5% and 22.8% respectively, reported spending between 61 and 80 additional minutes on mathematics per week as a result of these additional classes.

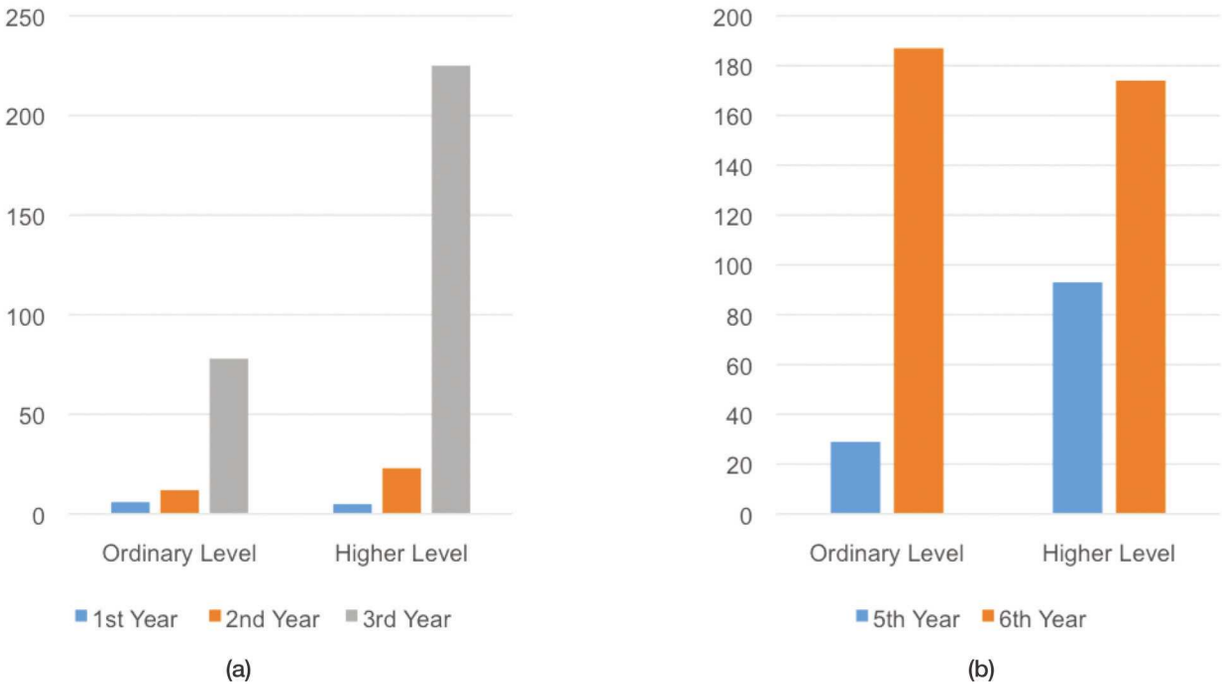


Figure 14: When do teachers commence the additional classes at (a) Junior Cycle; (b) Senior Cycle?

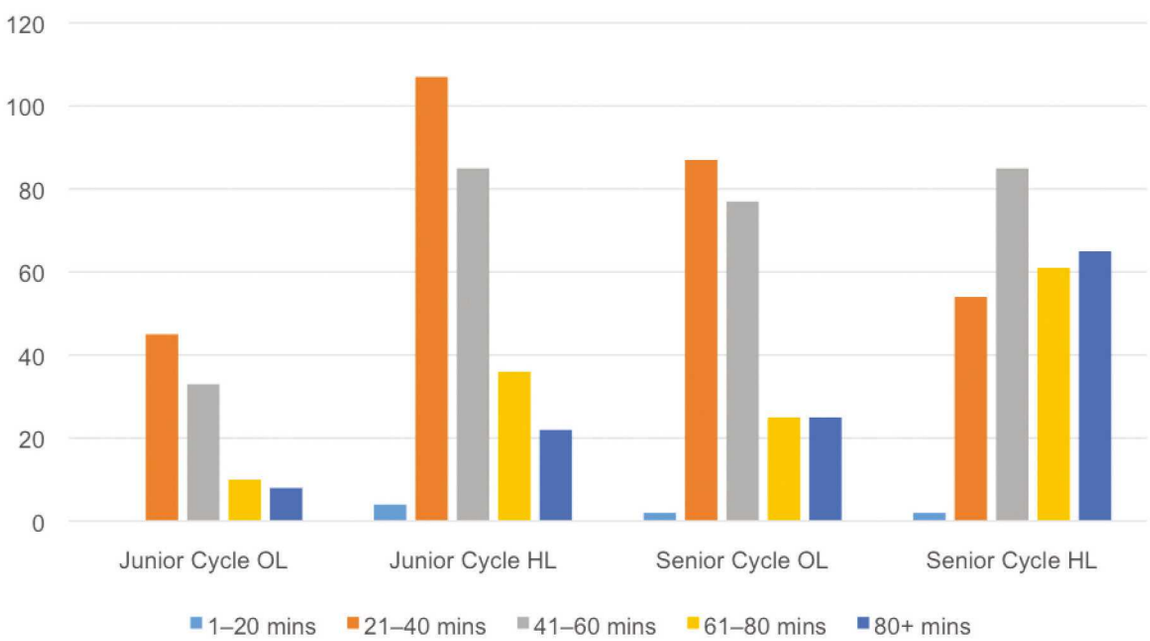


Figure 15: Typical duration of time spent in voluntary classes per week

Finally, in order to get a deeper insight into this phenomenon, teachers were asked to give reasons why they did or did not provide additional voluntary classes. At Junior Cycle, 423 teachers responded to this question, with 252 teachers offering reasons as to why they did provide the classes and 171 teachers offering reasons as to why they did not provide these additional classes. The five most popular reasons are illustrated in Figure 16.

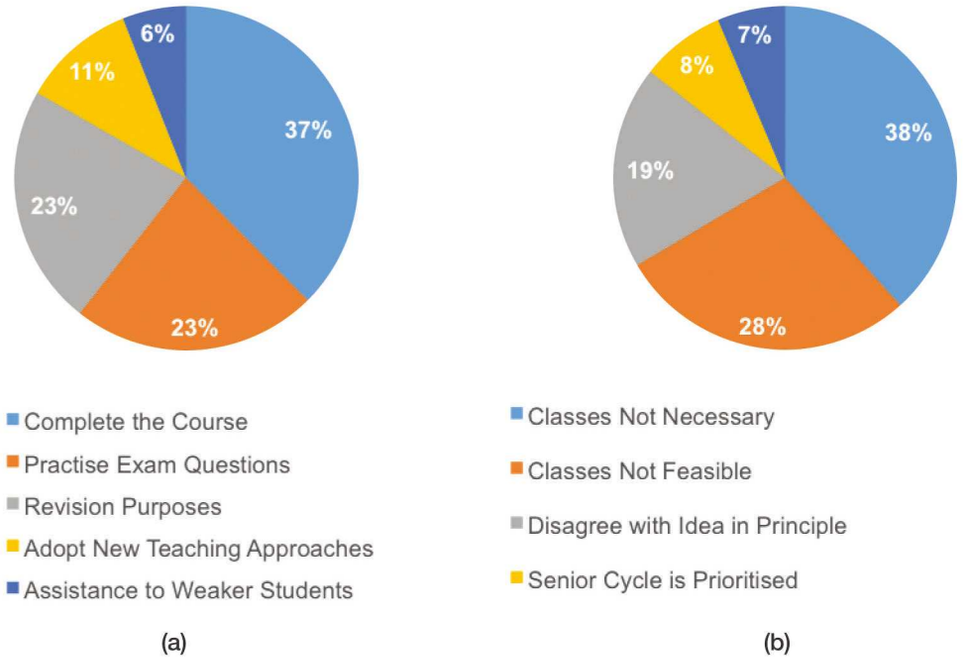


Figure 16: Reasons for (a) providing, (b) not providing additional, voluntary classes on a weekly basis at Junior Cycle

The most popular reason for providing classes at Junior Cycle, offered by 119 participants, was that they are needed in order to cover the course. For example:

> T95: ...to complete the course and give students the time they need to gain a deep understanding of the concepts.

Other popular reasons given included the opinion that the classes were necessary in order to allow time for sample exam questions; to allow for revision to be completed; and to enable teachers to adhere to the teaching methodologies promoted by Project Maths:

> T102: Not enough time in classes allocated to do exam papers and extra questions.

> T235: These additional classes are used to do revision which would not be completed otherwise.

> T342: We have 5 class periods a week (40 minute or 35 minute). Could definitely have 6-7 classes to do justice to approach to teaching for understanding and use all various approaches...

On the other hand, the most popular reason (given by 72 teachers) as to why they did not provide additional classes at Junior Cycle was because they felt the classes were not necessary:

> T83: Not required for Junior Cert ordinary level or higher level as all is covered in class.

Of those 72 teachers, 24 (33.3%) who cited this as a reason for not providing additional classes reported teaching the ordinary-level course. In addition to this, other popular reasons given included the opinion that the classes were not feasible due to other commitments; that the teachers disagreed with these classes in principle; and that some teachers reported that they could only give additional classes to one class group and so Senior Cycle was prioritised.

> T124: I have an ordinary level Junior Cert group, and while I am under pressure with the syllabus, I don't have the time to give an extra class in my own time, what with lunch, S + S [study and supervision], sports at lunch, etc.

T33: I have refused to do this, it is completely unacceptable. I take the textbook and the syllabus, count my 30-odd weeks' contact time and divide the course up accordingly. There are other teachers in previous schools I have worked in who have done at least one hour per week with their third and sixth years and, to be honest, it has become expected of us maths teachers. I take offence to this! The course should be coverable completely and in-depth in the time allocated. The answer may not be more contact time but possibly reduce the course, provide more tangible resources, stop taking a "cop out" attitude when teachers challenge what has been forced on us without proper consultation.

T159: If I had no Senior Cycle classes, I would definitely provide extra class time to third year higher level students. However, I just do not have the extra time to give up a second evening of my working week.

Senior Cycle teachers were also asked to provide the reasons why they did or did not provide additional, voluntary classes on a weekly basis. In total, 420 teachers responded to this question, with 318 offering reasons as to why they did provide additional classes and 102 offering reasons as to why they did not. The results are outlined in Figure 17.

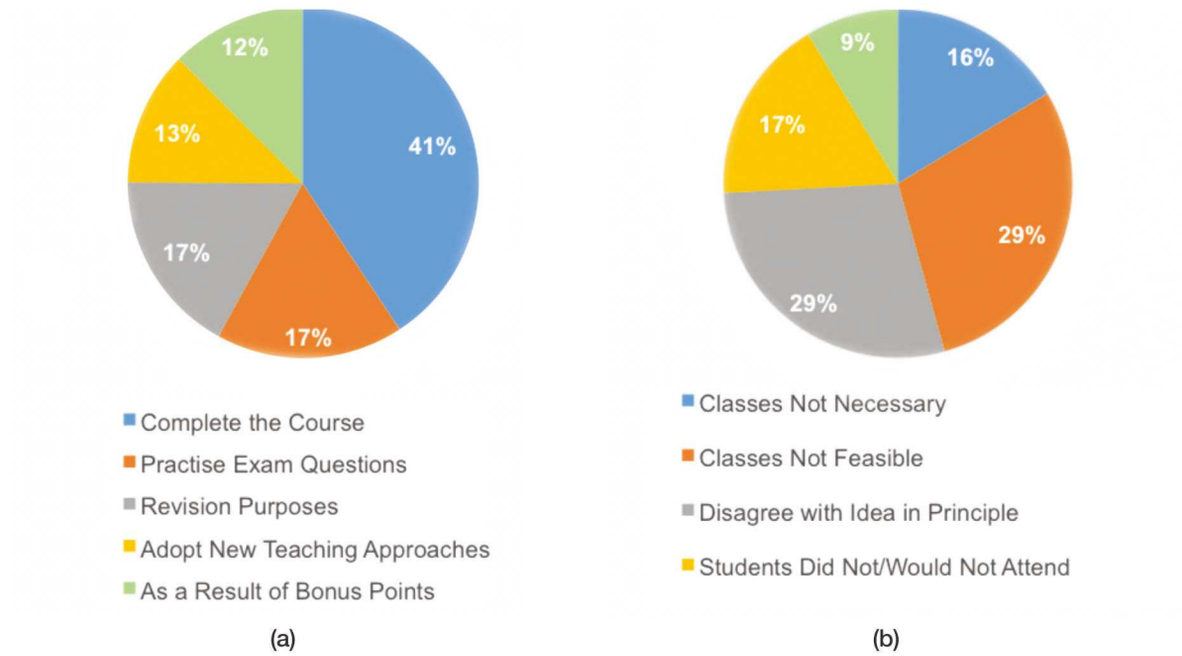


Figure 17: Reasons for (a) providing, (b) not providing additional, voluntary classes on a weekly basis at Senior Cycle

As can be seen from Figure 17, four of the five most popular reasons for both providing and not providing additional classes at Senior Cycle are the same as those offered by teachers at Junior Cycle. When outlining the reasons why they did provide additional classes at Senior Cycle, the only additional reason offered was that these classes were necessary due to the increase in mixed ability in the classroom as a result of the introduction of bonus points[6].

T110: 25 bonus points have led many to believe they can study Leaving Cert higher level maths. These same pupils would not do higher level if [the] old course still existed. Our classes have now "less able" pupils and this slows down the speed of progressing with the course.

Likewise, when offering reasons as to why they did not provide additional classes, Senior Cycle teachers only offered one reason that differed from those offered by Junior Cycle teachers. Twenty teachers who responded said that they did not offer these classes because their own experience has led them to believe that students would not attend such classes.

T20: Too many activities on after school. Children don't seem willing to participate in maths after school hours

6 In 2012 an initiative to increase the number of students studying higher-level mathematics at Senior Cycle was introduced in Ireland. Under this initiative students were offered an additional 25 CAO points if they passed the higher-level mathematics paper. This in turn increased the likelihood of a student getting the college course of his/her choice.

Classes Foregone on a Weekly Basis

Further insights into the actual time students spend engaged in mathematics in Irish post-primary schools were gained when teachers were asked to approximate how many classes they missed with each class group they taught over an academic year. All teachers were asked to approximate how many classes were foregone in a school year by taking a week to equal five mathematics classes. When approximating, teachers were asked to take into consideration events such as mock examinations, in-house exams, school shows/events, award ceremonies, sports days, school sports and excursions which led to classes not taking place. The results for Junior Cycle and Senior Cycle are presented in Figure 18 and Figure 19 respectively.

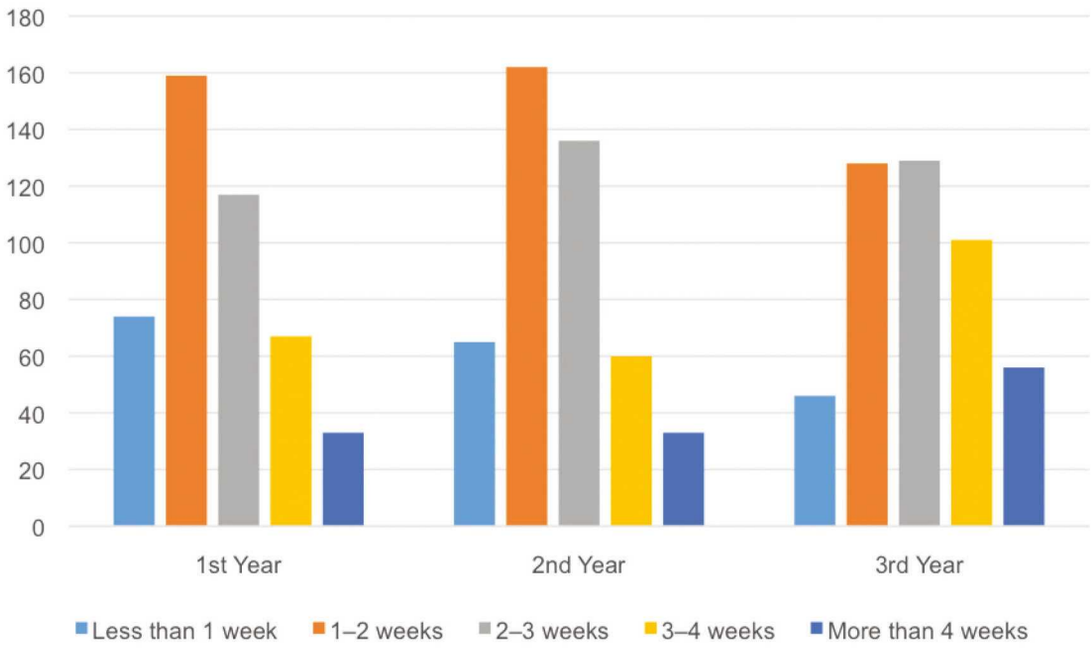


Figure 18: Bar chart showing the approximate number of Junior Cycle classes that do not take place

At Junior Cycle, the number of teachers who responded to this in relation to their first, second and third year cohorts was 489, 484 and 486 respectively. For both first- and second-year groups, the modal amount of time missed in a given year was 1-2 weeks (i.e. 5-10 classes per year). This was reported to be the case by 35.3% of first-year teachers, compared with 35.5% of second-year teachers. A large proportion of teachers of third-year students (27.8%) also reported missing 1-2 weeks, but the modal figure was 2-3 weeks (i.e. 10-15 classes per year). This was reported by 28.0% of teachers.

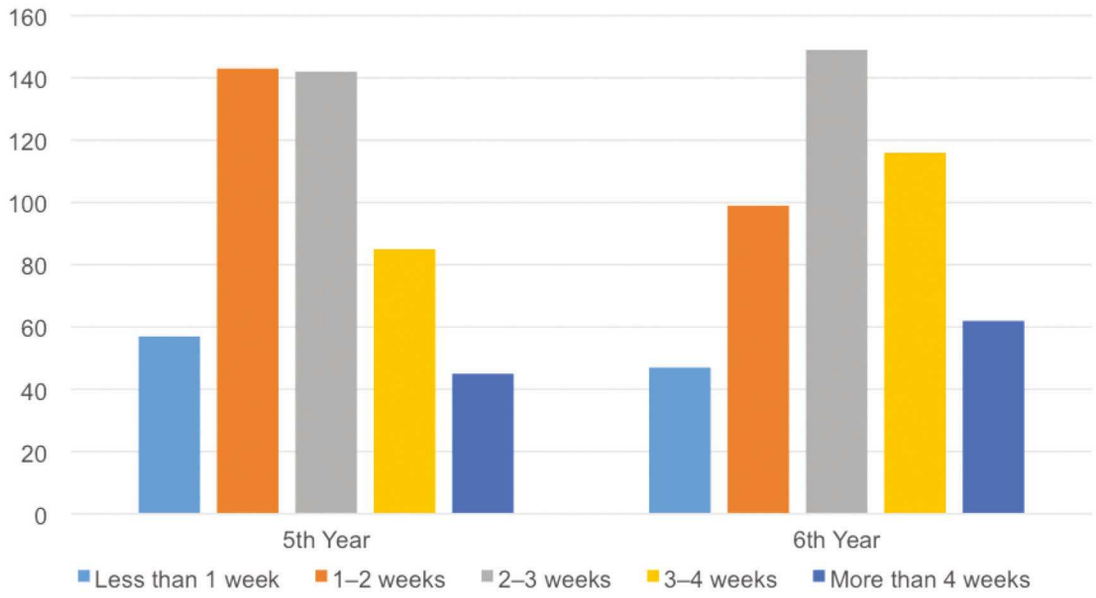


Figure 19: Bar chart showing the approximate number of Senior Cycle classes that do not take place

At Senior Cycle, the number of teachers who responded to this question in relation to their fifth- and sixth-year cohorts was 502 and 497 respectively. The modal number of classes foregone in fifth year was 1-2 weeks, with 30.3% of teachers reporting this to be the case. In sixth year, the modal number of mathematics classes that do not take place was 2-3 weeks, with 31.5% of teachers reporting this to be the case. In addition, a large proportion of sixth-year teachers (24.5%) reported missing 3-4 weeks (i.e. 15-20 classes) over the course of the year.

Assigning of Homework

One way that teachers may recover from the perceived lack of time allocated to mathematics is through the provision of homework. For this reason, the amount of time Irish students spend engaged in mathematics homework was also analysed in this study. Teachers were asked to outline how many minutes they expected their students to spend on mathematics homework every evening. The number of minutes teachers expect Junior Cycle students to spend on their mathematics homework per night is outlined in Figure 20, while Figure 21 provides the corresponding data for Senior Cycle students.

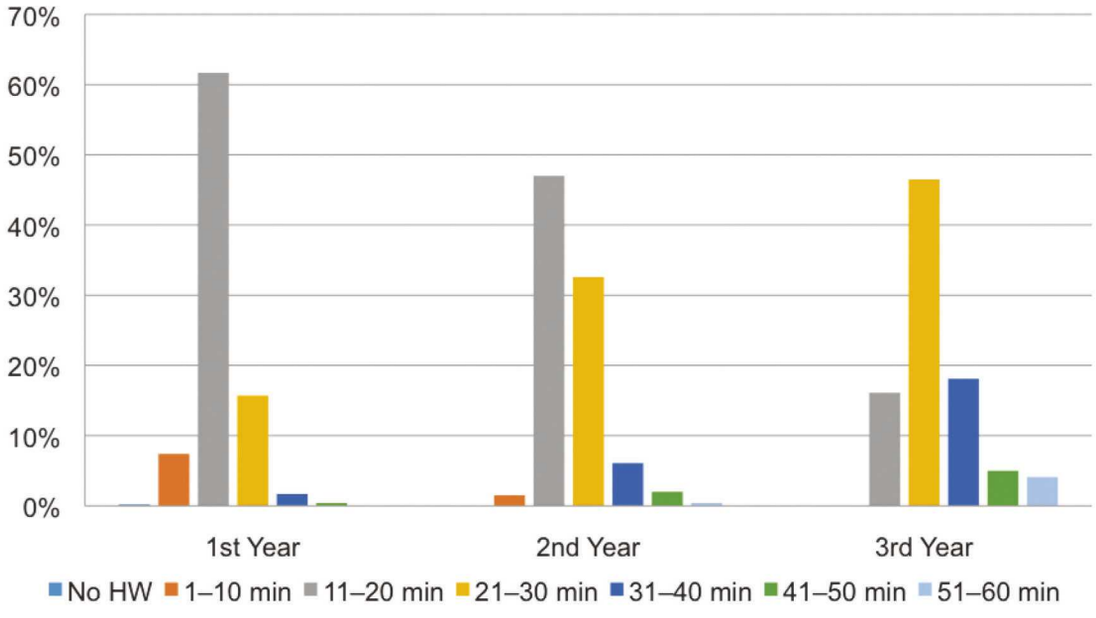


Figure 20: Expected time (in minutes) Junior Cycle students spend on mathematics homework per night

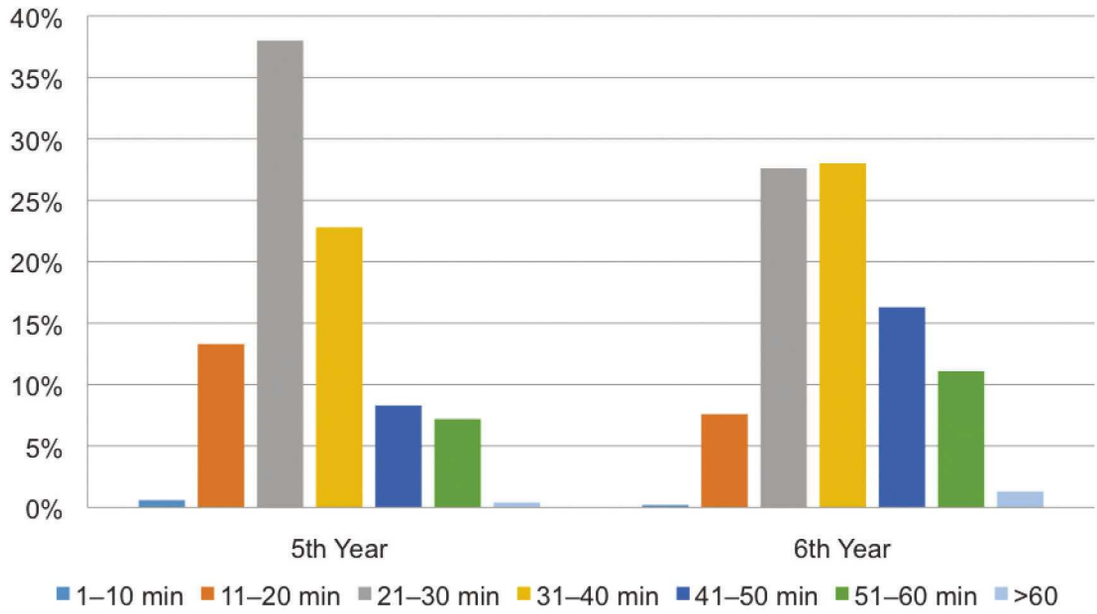


Figure 21: Expected time (in minutes) Senior Cycle students spend on mathematics homework per night

In first year (62%) and second year (47%), the majority of teachers expected their students to spend between 11 and 20 minutes on their mathematics homework. This increased to between 21 and 30 minutes per night for third-year students (47%). For fifth year, again the most common time expected for students to spend on homework per night was between 21 and 30 minutes (38%). This increased to between 31 and 40 minutes per night (28%) for sixth-year students.

Time in Transition Year

TY is an optional school year that is set aside for a transition and youth development programme that helps to bridge the gap between Junior and Senior Cycles (Prendergast & O'Meara, 2016b; Clerkin, 2012). This research report also investigated the time allocated to mathematics during this 'gap year' and investigated how TY teachers spend the time assigned to mathematics. Of the 182 deputy principals who responded to the survey, 163 reported that their school offered a TY programme and their responses are described in Figure 22.

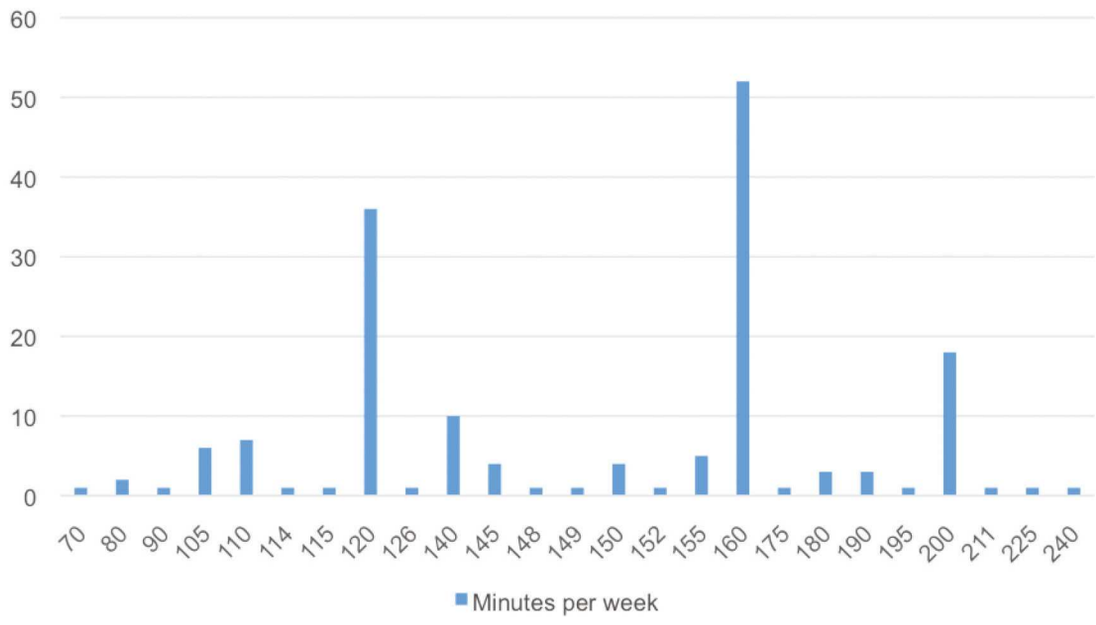


Figure 22: Minutes assigned to mathematics per week in Transition Year

Figure 22 shows that the time allocated to mathematics in TY ranges from 70 minutes per week to 240 minutes per week. Cumulatively, the amount of time allocated to mathematics over the course of this year ranges from 38.6 hours to 132.4 hours. The modal time, reported by 31.9% of deputy principals, was 160 minutes and the most common breakdown was four 40-minute classes per week. The next most popular response was 120 minutes. This was reported by 22.1% of deputy principals and the majority of these deputy principals favoured a breakdown of three 40-minute classes per week. The mean number of minutes allocated to mathematics per week in TY was 148.9 (SD: 31.18).

The authors were also interested to find out if the time allocated to TY differed according to school type. Figure 23 shows that Community Schools allocated the most time to mathematics in TY (mean = 89.2, SD = 24) while Comprehensive Schools offered the least amount of time to mathematics in TY (mean = 81, SD = 17).

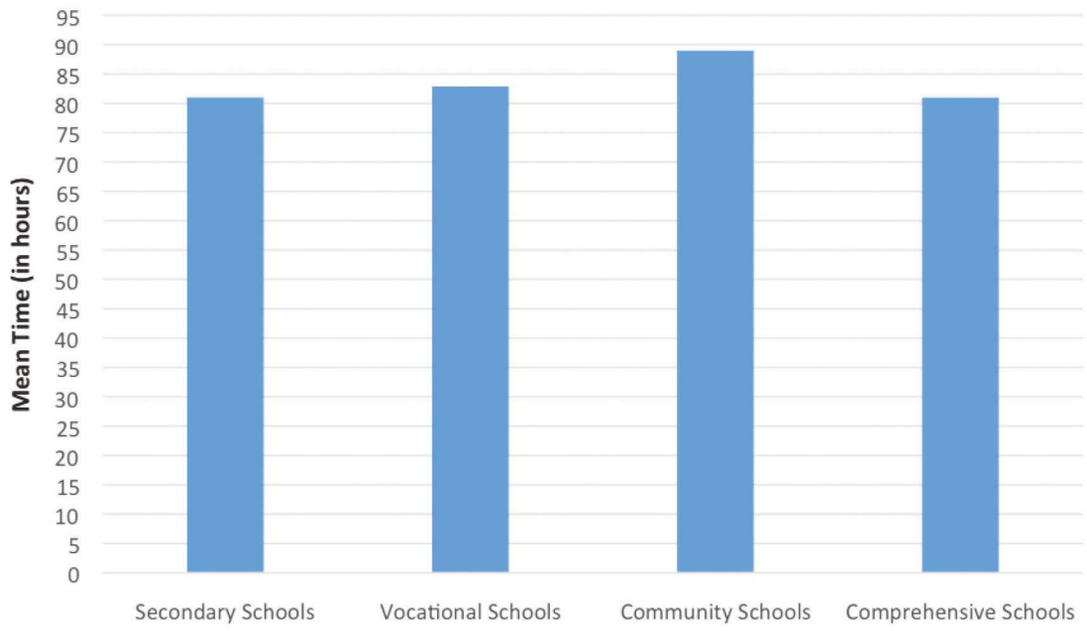


Figure 23: Mean number of hours allocated to Transition Year per year based on school type

A one-way between-groups analysis of variance was conducted and it found that the differences between the type of school and the mean time allocated to mathematics in TY were not statistically significant ($F(4, 162) = 1.838$, $p = 0.124$). As was the case with the mainstream year groups, TY teachers were also asked to approximate the number of mathematics classes foregone in a given year. This again allowed the researchers to obtain a more accurate profile of the time students in this year group spent engaged with mathematics over the course of the year. This question was applicable to 366 of the 540 teachers who completed the questionnaire. The majority of teachers (54.4%) stated that they missed in excess of four weeks per year (i.e. more than 20 classes were foregone per year).

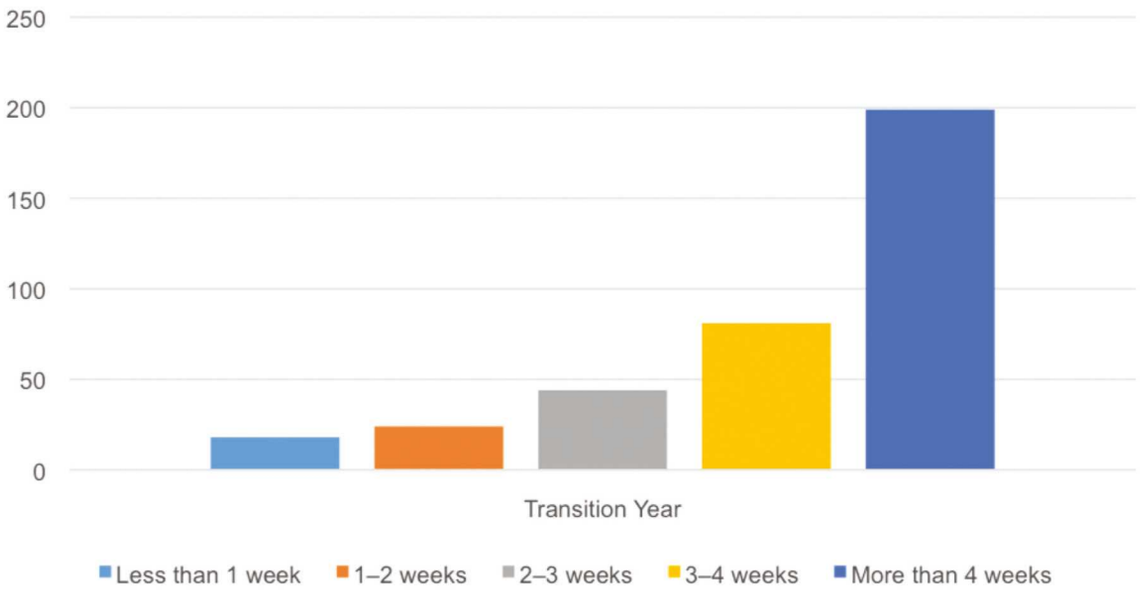


Figure 24: Classes missed over the course of Transition Year programme

Of the 540 teachers, 360 responded when questioned about the amount of mathematics homework they expected their TY students to complete each night. The modal amount of time which TY students were expected to spend on homework was 11-20 minutes per night. This was the response provided by 48.1% of teachers who responded. A further 25.6% of teachers who responded gave their students no homework during TY. Overall, the time assigned to homework ranged from 0 minutes a night to 45 minutes a night, meaning that the range over the course of the school year was from 0 hours to 124 hours of homework, as shown in Figure 25.

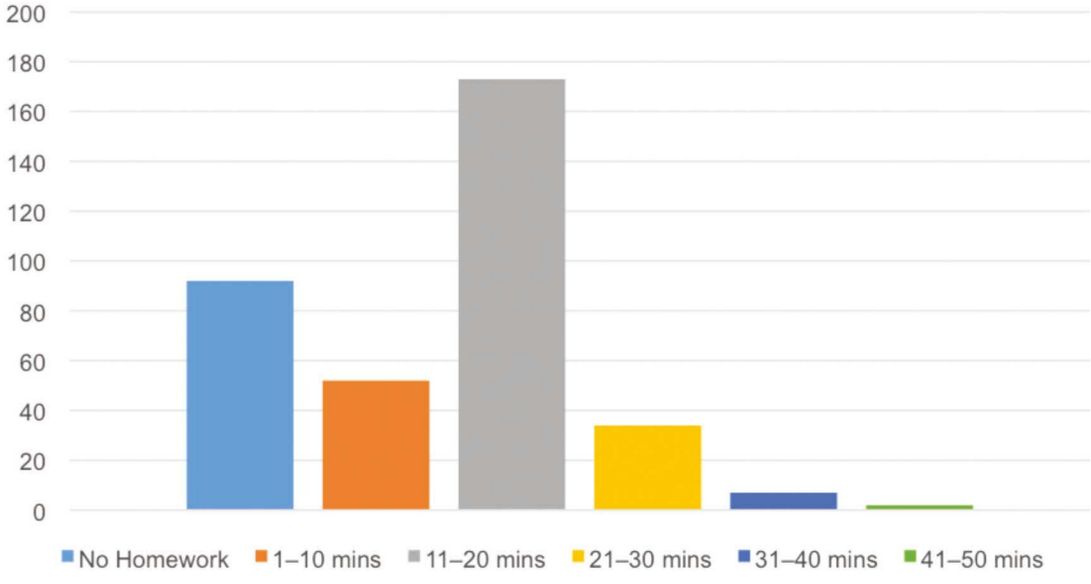


Figure 25: Expected time (in minutes) Transition Year students spend on mathematics homework per night

Finally, while investigating the time allocated to mathematics at TY the authors also investigated how this time was used during the year. Teachers in the study were asked if it was their school's policy to teach the Senior Cycle mathematics curriculum during TY. This question was applicable to 495 teachers and 244 of these teachers (49.2%) indicated that this was the case. In essence, this means that 49% of teachers in this study have the opportunity to teach the Leaving Certificate curriculum over the course of three years as opposed to the designated two.

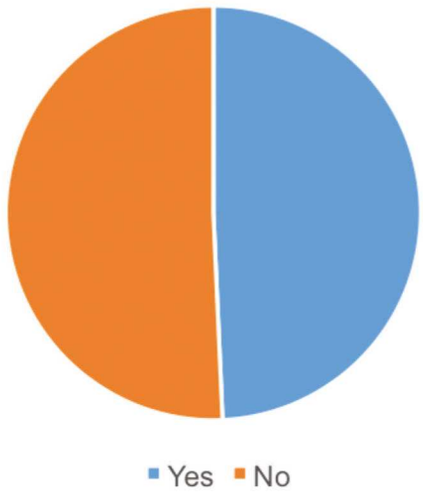


Figure 26: Pie chart showing if it was the school's policy to teach the Senior Cycle mathematics syllabus during Transition Year

DISCUSSION

The findings of this study presented for the first time a comprehensive profile of the time allocated to mathematics in Ireland. Overall, the findings showed that the mean time allocated to mathematics from first to sixth year for ordinary-level mathematics and higher-level mathematics is 114 hours per annum and 115 hours per annum, respectively. However, this was the average number of minutes assigned to mathematics and not the time that every Irish student was exposed to. In fact, a significant finding of the study was the range of time being allocated to mathematics across Irish schools. As demonstrated in Table 3, the range of time allocated to mathematics in first year varied between 67 and 167 hours per annum, while this range was between 81 and 134 hours per annum in second year and between 81 and 139 hours in third year. In fifth year, ordinary-level students experienced a range of between 97 and 156 hours, while the corresponding range for higher level was between 97 and 161 hours. Finally, in sixth year the range of time was between 100 and 156 hours per annum for ordinary-level students and between 100 and 161 hours for higher-level students. Such findings indicate significant differences in the time offered for mathematics across different schools in Ireland. This is in line with previous international research of Anderson (1981), Karweit (1984) and Hossler et al. (1988). Since it is generally accepted that there is a positive correlation between time and academic achievement (Benavot & Amadi, 2004), some students are being given more opportunities to succeed in mathematics than their peers. The issue is compounded further when the time a student is exposed to mathematics over the course of the entire Junior or Senior Cycle is considered. For example, a student who is exposed to the maximum amount of time during all three years in his/her Junior Cycle would receive 95 more hours of instruction than a student exposed to the mean amount per annum and 211 hours more than a student exposed to the minimum amount of time in each of the three years. This lack of consistency in relation to the time allocated to mathematics is something that needs to be addressed, owing to the aforementioned positive correlation between mathematics instruction time and student performance (Benavot & Amadi, 2004). Post-primary students in Ireland, regardless of school, are studying the same syllabi and preparing for the same state examinations and there is no argument to support the variation in instruction time evident in the findings of this study.

This issue is further exacerbated when another finding of the study is considered, namely the provision of voluntary classes. This practice is commonplace in a large number of Irish schools surveyed as part of this study. The study showed that 23.0% of Junior Cycle ordinary-level teachers, 54.9% of Junior Cycle higher-level teachers, 49.1% of Senior Cycle ordinary-level teachers and 68.8% of Senior Cycle higher-level teachers offered these classes, thus increasing the variation in time allocated to mathematics across Irish schools. The provision of out-of-school classes was also a phenomenon investigated by the OECD (2013). They found that, on average, 37.9% of students surveyed engaged in mathematics classes provided by their own school/teacher outside of school time, while the corresponding

figure for Ireland was 24.1%. This is significantly lower than the figures reported in this study, which was conducted from the perspective of teachers. As such, this report suggests that many students may be exposed to more additional mathematics classes per week than was reported internationally.

The OECD (2013) also sought to explain why such classes were provided to students. In the OECD study, principals were asked to state whether the classes were for remedial purposes; for remedial and enrichment purposes; for enrichment purposes only; or if they were provided without differentiation, depending on students' prior achievement. In that study, the majority of Irish principals stated that the classes were either for remedial purposes only (34%) or for both remedial and enhancement purposes (45.5%). The findings from this study were somewhat different to those reported by the OECD in 2013. Only 7.5% of Junior Cycle teachers indicated that the classes they offered were for remedial purposes, while the corresponding figure for Senior Cycle teachers was 7.2%. Instead, the primary reason offered by teachers at both Junior and Senior Cycles in this study as to why they provided such classes was so that they could complete the course. The discrepancies between the responses received in this survey and those presented in the OECD study are most likely attributable to the fact that this study sought the views of the teachers providing the classes, as opposed to the principals who facilitate the additional classes in their schools. Furthermore, in this study the reasons were ascertained through the use of open-ended questions as opposed to providing participants with a pre-determined list of options.

When discussing the reasons for providing additional classes, teachers in this study were very vocal about the perceived lack of time currently allocated to mathematics. They felt there simply was not enough time to complete the course at either level. These sentiments were also supported by the quantitative data collected as part of the study. For example, 62.3% of Junior Cycle teachers in this study disagreed that there was a sufficient amount of time currently allocated to mathematics, while 82.1% of Senior Cycle teachers were of a similar opinion. When teachers were asked to comment on the time allocated to mathematics, this issue was raised by a large proportion of teachers (51.2% of Junior Cycle teachers who responded and 58.8% of Senior Cycle teachers who responded). This was similar to the findings reported by the Irish Mathematics Teacher Association [IMTA] (2012). They reported that 'Teachers now feel that it is impossible and unmanageable to cover the content in the class time provided ... no revision time is built in to the syllabus and students are poor at taking responsibility for their own learning' (IMTA, 2012, pp. 5-6).

The dissatisfaction that teachers expressed in relation to the time allocated to mathematics could, in some part, be attributed to the fact that double periods did not feature on many teachers' timetables. In this study, 91.1% of Junior Cycle teachers and 43.1% of Senior Cycle teachers confirmed that there were no double periods included on their timetable for any of their class groups. This is very different to the situation in the United States, where a large proportion of schools in many states, such as Maryland, now offer what is referred to as 'double dose' instruction (Durwood et al., 2010). The difference between the two nations may be attributable to the fact that calls for a policy change relating to double periods really only began in Ireland with the introduction of Project Maths in 2010, while similar calls have been made in the United States since the introduction of the National Standards in 2000. The situation at Senior Cycle is analogous to the situation in the United States. Rice et al. (2002) found that across the United States, on average, 50% of schools offer or were seriously considering offering double/block periods in mathematics at 10 Grade (equivalent to the first year of Senior Cycle in Ireland). This compares with 56.8% of teachers in this study who reported having at least one double mathematics period per week at Senior Cycle. Further analysis in this study showed that the correlation between teachers' levels of satisfaction and the provision of double periods was significant at Senior Cycle, and while a correlation also existed at Junior Cycle, it was not statistically significant. Such findings were in line with those presented in the IMTA (2012) report. In this report, teachers indicated that class periods which exceeded 40 minutes in length were necessary and they called for a minimum of six 40-minute classes per week at Junior Cycle, including one double period, while two double periods were requested at Senior Cycle. This study showed that if such calls were acknowledged and acted upon there is a strong possibility that teachers' opinions in relation to the time allocated to mathematics would improve and other issues of concern, such as the provision of voluntary classes, might in turn be alleviated.

The variations in time-allocation discussed thus far were magnified when other issues examined in this study were taken into consideration. For example, issues such as classes foregone due to school events, the time spent engaged with mathematics outside of school time via the allocation of homework, and the use of the time allocated to mathematics in TY contributed to further inequities amongst students. The combination of these factors may result in some students being at an advantage in terms of the opportunities they have to succeed in mathematics owing to the positive correlation between mathematics instruction time and student performance (Benavot & Amadi, 2004).

RECOMMENDATIONS

Overall the findings of this report highlight a number of important issues concerning mathematics instruction time in Irish post-primary schools. Although there are national guidelines regarding instruction time available from the DES, the results of this study suggest that a substantial inequity exists in the time afforded to students to learn mathematics. Depending on the school they attend, the year group they are in, the teacher they are assigned and the level of mathematics they study, students can expect to receive different amounts of instruction time. To address the main issues highlighted in this report, the following recommendations have been proposed:

1. Students should receive equal amounts of mathematics instruction time regardless of factors such as school, teacher, class group, etc. (Prendergast & O'Meara, 2016a). There currently exist inequities in relation to the allocation of mathematics instruction time and the Government needs to specify a fixed amount of class time that should be allocated to all curriculum subjects across all post-primary year groups.

2. The DES needs to ensure that the time recommended for mathematics in official syllabus documentation is realistic, and it needs to work with curriculum developers to specify a time allocation that is feasible and aligned with the curriculum. This should help ensure that the provision of voluntary classes is no longer deemed essential by practising teachers.

3. National guidelines should also recommend the amount of time that students are expected to spend on homework per night. The results of this research show that teachers are expecting students to spend too much time on their homework, particularly given the high number of other subjects which are studied at both Junior and Senior Cycle levels.

4. The number of subjects that Irish students study for both Junior and Leaving Certificate examinations should be reduced in line with their international counterparts. This would allow for more time to be made available for all subjects, including mathematics, and in turn would reduce the pressure and constraints on school timetables.

5. All schools should be encouraged to introduce a double period each week for lower post-primary students and two double periods for upper post-primary students. Such inclusion of double mathematics periods on all students' timetables should not result in students' daily exposure to mathematics being reduced. Instead all timetables should include a mixture of double and single periods so that students encounter mathematics on a daily basis. These double periods in mathematics and other STEM disciplines are essential to allow for inquiry-based learning, which was a key action point in the national STEM report (2016). Furthermore they facilitate the practical application of mathematics promoted by the revised mathematics curricula.

6. Attention must be given to how teachers use the time currently available to them. Increasing the time allocated to mathematics alone will not guarantee an improvement in academic achievement. This will only materialise if the time assigned to mathematics is used efficiently and effectively. The national STEM report (2016) called for the development of a coherent policy framework for Continuous Professional Development [CPD] in STEM education, and the authors propose that, as part of this action point, teachers should receive formal training in relation to the effective use of time in the mathematics classroom. CPD which offers teachers suggestions, ideas and strategies about how best to use the time assigned to mathematics and needs to be made available.

7. Further research should be conducted into the value of the mock examinations. These can result in a substantial number of classes missed at a critical time of the school year, and as such their significance needs to be critically scrutinised.

8. Mathematics teaching hours in TY need to be increased in line with the recommendations of recent national reports (DES, 2010, 2011; Moran et al., 2013). In addition, while there are many benefits associated with the freedom schools are given to design their own programmes, policy makers need to ensure that this flexibility does not result in educational inequalities for students in different schools. TY should not be seen as an opportunity to engage with the Leaving Certificate mathematics syllabus over three years, instead of two.

9. The availability of mathematics teachers was one of the factors identified by deputy principals as being influential when assigning instruction time to mathematics. Such teacher shortage in STEM subjects was also a documented issue in the recent publication of the national STEM report. With this in mind, there is a need for a renewed and sustained effort to increase the number of qualified teachers available in mathematics and other STEM subjects.

CONCLUSION

This study is the first of its kind in Ireland, and as such it is the first report to offer insights into the allocation and distribution of mathematics instruction time at post-primary level. Until now, the time profile for mathematics instruction in Ireland has been difficult to quantify, and this study seeks to address this gap in research. The overarching finding to emerge from this study is that current arrangements relating to the time allocated to mathematics mask a significant inequity in the treatment of students studying mathematics at all levels and across all years. Furthermore, the study revealed that:

- The time allocated to mathematics instruction time ranged from 120 to 300 minutes per week in first year; from 145 to 240 minutes per week in second year; from 145 to 249 minutes per week in third year; from 175 to 290 minutes per week in fifth year; and from 180 to 290 minutes in sixth year.

- Timetabling constraints, the availability of mathematics teachers and the perceived importance of the subject were deemed to be the most influential factors by deputy principals when making decisions regarding the time available for mathematics instruction.

- 62% of teachers surveyed disagreed or strongly disagreed that there was sufficient time available to teach mathematics at Junior Cycle, while the corresponding figure for Senior Cycle was 82%.

- 91% of teachers reported that there was no double period scheduled for their Junior Cycle classes while 43% of teachers reported a similar scenario at Senior Cycle.

- 88% of Junior Cycle teachers and 79% of Senior Cycle teachers stated that the time allocated to mathematics had not changed since the introduction of Project Maths in 2010. This was despite the fact that 89% of Junior Cycle and 92% of Senior Cycle teachers believed that Project Maths had impacted on the time required to teach the post-primary mathematics curriculum.

- 23% of Junior Cycle ordinary level teachers disclosed that they offered voluntary mathematics classes in their own time, outside of school hours. The corresponding figure for Junior Cycle higher-level teachers was 55%; for Senior Cycle ordinary-level teachers it was 49% and for Senior Cycle higher-level teachers it was 69%.

- 9% of timetabled mathematics classes in third year and 8% of those in sixth year did not take place each year as a result of school events, including mock examinations.

- In both first and second years, the majority of teachers expected their students to spend between 11 and 20 minutes on their mathematics homework. This increased to between 21 and 30 minutes per night for third- and fifth-year students, and to between 31 and 40 minutes for sixth-year students.

- 49% of teachers surveyed stated that it was their school's policy to teach the Senior Cycle mathematics syllabus during TY.

These findings, along with the recommendations outlined in the previous section, provide evidence and suggestions for policy makers and others seeking to improve mathematics instruction in Ireland.

However, the authors want to emphasise that time alone should not be the sole focus of efforts to improve Irish mathematics education. Naïve policies that only concentrate on increasing the length of lessons may do little to improve student learning (Phelps et al., 2012). Instead, the purpose of this report is to generate awareness amongst all stakeholders in mathematics education of the variation in instruction time, and of the reality that students, even students in the same school, can receive different amounts of instruction in mathematics. Post-primary students in Ireland, regardless of school, are studying the same syllabi and preparing for the same state examinations and there is no argument to support the variation in instruction time evident in the results of this study (Prendergast & O'Meara, 2016a).

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