WHAT'S THE POINT: EVALUATING THE IMPACT OF THE BONUS POINTS INITIATIVE FOR MATHEMATICS

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Since 2012 mathematics has been assigned a special status within Irish post-primary education with the introduction of a Bonus Points initiative (BPI). Students are now awarded an extra 25 CAO points in their upper post-primary school state examination results if they achieve a passing grade at higher-level. These extra points will increase the likelihood of these students getting a place on the course of their choice at third level. This incentive was introduced to encourage students to study the subject at higher-level. Anecdotally there have been many mixed reviews about the success of the BPI. While the numbers taking HL mathematics have steadily increased, there have been concerns expressed that many students who are not mathematically capable of performing up to the standard required are now opting for the HL paper and that the difficulty of this examination and the marking schemes have been adjusted accordingly (Treacy, 2018). This paper reports on a national study, the first of its kind in Ireland, that was conducted to investigate teachers' perspectives (n = 266) on the BPI. The authors will investigate if the increase in the number of students studying higher-level mathematics in Ireland has occurred in tandem with an increase in the mathematical proficiency of post-primary students and will ascertain the impact of the BPI on the profile of higher-level mathematics classes. It will report on findings from a national study.

INTRODUCTION

The benefits of studying advanced/higher-level mathematics, henceforth referred to as higher-level mathematics, have been well documented in the literature. According to Chinnappan, Dinham, Herrington and Scott (2008) higher-level mathematics facilitates the development of a variety of skills that underpin a scientifically literate workforce. Kennedy, Lyons and Quinn (2014, p. 35) add that higher-level mathematics courses in high school are critical if we are to produce graduates who are capable and confident in making informed decisions about "…issues such as renewable energy production…or climate change". Furthermore, a study by Wolfe (2002) found that mathematics is the only A-level subject in the UK that positively influences potential future earnings. Many researchers also hypothesise that there is a correlation between participation rates in higher-level mathematics and participation rates in other science subjects such as physics (Chinnappan et al., 2008; Kennedy et al., 2014). This is a cause of concern due to the low participation rates reported in physics in the Western world (De Witt, Archer & Moot, 2018).

Despite the importance of mathematics and the necessity for a mathematically literate workforce for economic growth, many countries worldwide report low numbers of students studying higher-level mathematics at upper secondary level. In Australia, Goodrum, Druhan and Abbs (2011) found that all high school science subjects, mathematics included, were experiencing dramatic declines. Similarly, in the UK participation in higher-level mathematics, that is mathematics post GCSE level (age 16), has been a cause of concern for many years. According to Noyes (2012) only 10-15% of 16-year-old students choose to continue their study of mathematics and he reports that this figure is low when compared with other developed countries. Similar problems have been reported internationally, in the USA (National Commission on Mathematics and Science Teaching, 2000); India (Garg & Gupta, 2003); and France (Charbonnier & Vayssettes, 2009). In Ireland, mathematics is not strictly a compulsory subject for the Leaving Certificate examinations, however it is treated as such by schools since it is a gatekeeper for the vast majority of third-level courses. Thus, studying mathematics for Senior Cycle[1] is typically expected of all students and this is reflected in the numbers completing these examinations each year (SEC, 2018).

Due to the importance of higher-level mathematics and the issues in relation to uptake that the authors have just discussed, it is unsurprising that improving mathematics participation and achievement at upper secondary level is an area of considerable focus amongst education systems and policy makers worldwide (Hodgen, Foster, Marks & Brown, 2013; Noyes, 2013). According to Brown, Brown and Bibby (2008, p.3) "Improving participation rates in specialist mathematics after the subject ceases to be compulsory at age 16 is part of government policy in England". Internationally, although advocated for, it appears as though very few policies or strategies have been introduced to increase participation rates in higher-level mathematics and Noyes (2013) outlines how there is currently very little consensus about how to tackle the issue of low participation rates in certain subjects. However, in recent years, Ireland has adopted a policy which is hoped will address the shortage of students studying higher-level mathematics.

In 2011, the proportion of students studying higher-level mathematics in their final two years of secondary schooling was 15.8%. In 2012, the Government of Ireland introduced the Bonus Points Initiative [BPI], which sought to encourage more students to opt to study mathematics at higher-level for Senior Cycle during their secondary education (Treacy, 2017). In Ireland, students must sit a summative examination, known as the Leaving Certificate at the end of upper secondary school. The Leaving Certificate acts as a gatekeeper to tertiary education with students awarded points based on their six best subjects. Prior to 2012, the maximum points that could be awarded for the top grade in a subject studied in its most advanced form (higher-level) was 100. Since 2012, mathematics has been assigned a special status within Irish schools with the introduction of the BPI. Students are now awarded an additional 25 points if they achieve a pass grade at higher-level ($\geq$ 40%) in their mathematics Leaving Certificate examination. Many people have cited that the perceived level of difficulty is one of the principal causes for poor uptake of higher-level mathematics (Brown et al., 2008) and the additional points offered is seen as a way of acknowledging the level of difficulty associated with higher-level mathematics while simultaneously increasing the uptake of higher-level mathematics. The DES (2017) are now considering expanding this initiative to other subjects but prior to this the authors believe it is critical that the BPI is critiqued and this paper will

[1] In Ireland, post-primary education is divided into two cycles. Junior Cycle is made up of the first three years of post-priamry education when students are aged between 12/13 and 15/16. Senior Cycle is a two year cycle that follows the Junior Cycle, with an optional "gap year", known locally as Transition Year, offered to students between Junior and Senior Cycle.

present findings in relation to teachers' perspectives on the BPI and the impact it has had on the profile of higher-level mathematics classes and students' proficiency in mathematics.

RESEARCH QUESTIONS

Following on from the extensive literature review, the authors derived the following research questions that will underpin this study:

1. Since the introduction of the BPI, do teachers believe there has been a notable improvement in the mathematical capabilities of post-primary students?
2. What are teachers' experiences of the impact of the BPI on the student profile in higher-level mathematics classes?

METHODOLOGY

To address these research questions a mixed method approach was adopted. Such an approach combines both qualitative and quantitative methods of data collection. It was important to get a high response rate and the authors felt that the response rate would be increased if they used a research tool that would be easy to distribute and collect and one that the participants did not find too time consuming to complete. As a result, all data within this study was gathered through a questionnaire. The questionnaires were designed with the help of a Teacher Research Advisory Group (TRAG), which consisted of five teachers. The teachers involved in this group were experienced in their positions and were recruited using a purposive sampling method. Members of the TRAG were invited to participate on the basis of the expertise they could bring to the research and the contemporary experiences they have in similar peer groups to the research participants (Murphy, Lundy, Emerson & Kerr, 2013). Their remit was to assist the authors in refining the items on the questionnaire and providing initial insights into expected responses to each item.

The sampling frame for the study was a list of all 723 post primary schools in Ireland (DES website, February 2015) and stratified sampling was used. Around 11.1% of these schools are community schools, 35% are vocational schools, 1.9% are comprehensive schools and the remaining 52% are secondary schools. These school types were the four strata used when selecting the sample. The targeted sample size was 800 teachers. Based on advice from the TRAG, a stratified random sample of 400 schools was selected: 44 schools (11.1%) were community schools; 140 (35%) were vocational schools; 8 schools (1.9%) were comprehensive schools; and 208 (52%) were secondary schools.

The questionnaires were distributed in April 2018 via post and were addressed to the Head of Mathematics at each school. It was requested in the accompanying information sheet that the two copies of the questionnaire enclosed should be completed by two teachers of higher-level senior cycle mathematics in the school and returned in the stamped addressed envelopes. 266 teachers completed and returned the surveys, a response rate of 33.3% which is within the 20%–30% range recommended by Veal and Flinders (2001) for mailed surveys. The quantitative data was recorded, summarized and analysed using the computer package SPSS. The open-ended questionnaire responses were transcribed and analysed using NVivo. The authors employed thematic content analysis. A coding scheme was generated based on a mixed deductive and inductive approach. On the one hand, codes were derived theoretically, taking into account the research questions, the literature review and the results emanating from the quantitative analysis. On the other hand, themes were identified from the open-ended questions, providing the basis for generating new codes or modifying the existing codes. Each of the authors worked separately on the data, to derive their own codes. The coding allocated by each researcher was then compared and any discrepancies were discussed and resolved by the authors before the coding scheme was finalized.

RESULTS

Statistics, released by the State Examinations Commission, show that the proportion of students opting to study higher-level mathematics for their Leaving Certificate has increased from 15.8% in 2012 to 31.5% in 2019. In this study teachers were asked if they believed that this 15.7 percentage point increase was as a direct result of the BPI or whether other factors such as the introduction of a revised curriculum, which was introduced around the same time as the BPI, played a role. The results are presented in Figure 1.

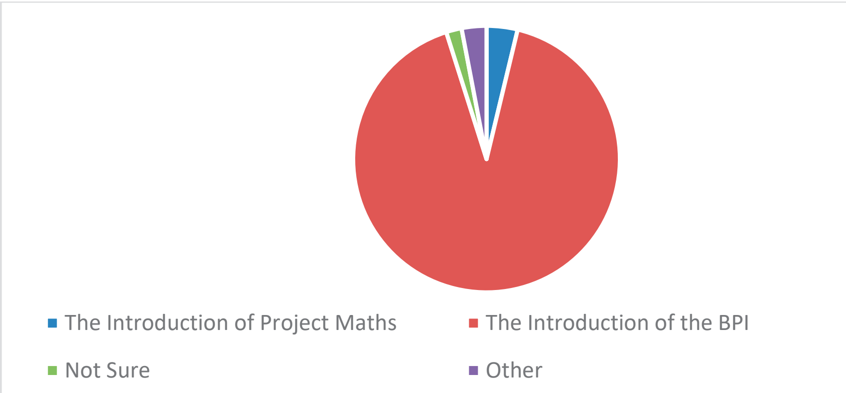

Figure 1. Teachers' perceptions of factors influencing the increased uptake of higher-level mathematics

In total 266 teachers responded when asked which initiative they believed was most influential in increasing the numbers taking the higher-level mathematics exam. Figure 1 shows that the vast majority of these teachers (n = 243) believed that the BPI was responsible for the increased uptake while only 10 teachers believed the new curriculum to be a factor. In addition to this, teachers were also asked to rate their level of agreement with the statement *"More students are now studying higher-level mathematics at Junior Cycle as a direct result of the Bonus Points Initiative."*. As shown in Figure 2, a vast number of teachers (57.4%) agree or strongly that the BPI has an impact on the uptake of higher-level at Junior Cycle, while only 16.0% disagreed or strongly disagreed with this viewpoint. This highlights the impact of the BPI beyond Senior Cycle mathematics.

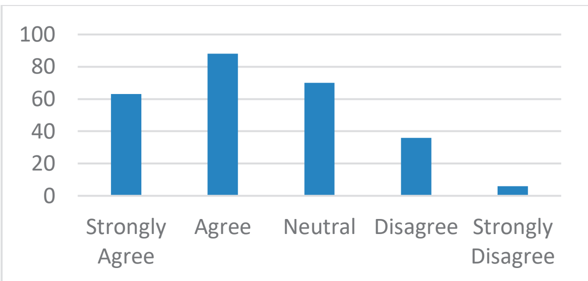

Figure 2. Teachers' perceptions of the influence of BPI at Junior Cycle

Given that the BPI is perceived to have had such an influence on the uptake of higher-level mathematics, the authors were keen to investigate whether teachers believe there has been a corresponding improvement in students' mathematical aptitude. Teachers in this study did not believe this to be the case. When asked if they believed that the increased number taking higher-level resulted in improved standards in mathematics among post-primary graduates 265 teachers offered a response with 155 (58.5%) believing this not to be the case. On the other hand, 50 teachers (18.9%) did see an improvement in students' mathematical competencies while 60 teachers (22.6%) were unsure.

The second research question underpinning this study required the authors to analyse both quantitative and qualitative data. First, the authors conducted thematic analysis on the responses offered by teachers to the question *"What impact (if any) has the Bonus Points Initiative had on the student profile of your Senior Cycle mathematics groupings?"* All 266 teachers in the study offered a response to this question and the majority believed that the BPI had a significant impact on the student profile in their classroom with only 8 teachers (3.0%) reporting that the BPI had no impact on the student profile in their classroom. The most common change reported by teachers was that the BPI resulted in people not suited to higher-level mathematics now persevering with it to the detriment of some.

> T152: "Higher numbers trying higher [level] though [they] are not at all suited and many of these struggle from the outset."

> T391: "More of the students who struggle with higher-level mathematics stay and do the exam. They stay purely to earn bonus points. Many stay who would be better served at ordinary level. Our failure rate has increased at higher-level because of this"

> T168: "Bonus points have encouraged more students to try higher-level maths which is great. However, some of the students deciding to do higher-level do not have the required standard of maths to enable them to do so. It is putting enormous pressure on teachers."

A total of 81 teachers (30.5%) alluded to this type of change in student profile. This finding was echoed in the quantitative literature when 266 teachers ranked their level of agreement with the statement *"Many students who are struggling at higher-level persist due to the provision of Bonus Points."* 199 teachers (74.8%) strongly agreed with this statement while a further 62 (23.3%) agreed.

Another change in student profile, possibly a direct consequence of previous findings, reported by a number of teachers (n = 61) was in relation to more mixed ability classes. The large number of less able students doing higher-level mathematics has resulted in a much wider range of abilities than would have been the case prior to 2012.

> T431: "The range in abilities is far too great. There are students attempting [higher-level] for the sake of trying to achieve more points, when they are simply not capable and end up doing poorly in their exams."

> T52: "More students are doing HL and remaining in higher-level despite the lack of progress in some cases. The average ability of HL students has decreased."

This change in student profile, as these responses indicate, presents teachers a series of new challenges to contend with.

Finally, another change in student profile reported by teachers relates to less ambitious students now selecting higher-level mathematics. 35 teachers reported that students in higher-level now have lower expectations of themselves with many aiming to just reach, rather than exceed, the score required to be awarded bonus points. Teachers also report that such students are not as hardworking as those that would have selected higher-level in the past

T383: "Students are hanging on at higher-level to gain bonus points. A lot of students now have the attitude '40% will do"

T217: "Students who would have taken ordinary level prior to the introduction of BPI are now attempting the higher-level paper and are willing to settle for a low grade"

T373: "Definitely have a lot more students taking it on, that probably wouldn't have before. You also have a lot of students who hang in there and aren't willing to do the work involved and just try and pass it."

CONCLUSION

The findings of this study have shown that the BPI has achieved one of its goal, in that it increased the number of Irish students studying higher-level mathematics. There has been a significant increase, from 15.8% to 31.5%, in the seven years since the BPI was introduced. On the surface, this may appear to indicate that Ireland has found an incentive, as suggested by Brown et al. (2008), to increase the participation levels in higher-level mathematics. However, increased participation rates was only one of the aims of the BPI. An additional objective of this initiative was to enhance students' mathematical skills (Treacy, 2018). Many researchers, such as Hodgen et al. (2018), have called for a simultaneous increase in participation and attainment but this study reveals that while the BPI is successful in the former, it may not be having the desired effect on the latter. Only 18.9% of teachers surveyed believe that the BPI has resulted in an overall improvement in students' mathematical ability, despite many more students studying mathematics in its most advanced form. This belief is also reinforced when one compares students' results pre and post-BPI. In 2018, 37.7% of higher-level students attained 70% of more in their Leaving Certificate mathematics examination, compared with 47.2% in 2011. This is despite many believing that the difficulty level of the Leaving Certificate mathematics examination decreasing in this time period (Treacy, 2018). One possible reason for this is that the students now taking mathematics are doing so solely to obtain the 25 additional bonus points and not because of any renewed interest or motivation for the subject. Instead, as reported by teachers in this study, current higher-level students are happy to study higher-level mathematics without investing the time and effort required to improve their skills or excel in the subject. As such, the authors recommend that a campaign to highlight the importance of mathematics in almost every career and in a multitude of daily tasks is undertaken. Such a campaign would allow these additional students studying higher-level mathematics to see the importance of the subject, as discussed by Chinnappan et al. (2008) and Kennedy et al. (2014), and this may in turn provide an incentive to dedicate the time and effort needed to improve their mathematical skillset.

Another possible reason for the increase in participation, but not in competence may be due to the changing profile of higher-level mathematics classes. Teachers in this study reported that many students who they deem unsuitable for higher-level are now opting for this course of study and as a result, there is a much greater range of abilities in higher-level mathematics classes than was the case prior to 2012. According to Linchevski and Kutscher (1998) mathematics is one of the more difficult subjects for working with mixed ability groupings while Harem and Ireson (2003) suggest that mixed ability grouping is inappropriate for mathematics. The BPI was introduced without any consideration for the impact it may have on class profiles and as such, teachers received no training in dealing with the knock-on effects of the BPI, including guidance on how to develop teaching strategies to cater for more mixed ability students. The authors are not proposing that such mixed ability groups have a negative effect on student learning, in fact some studies have shown that such diversity can have a positive impact on student learning (e.g. Davidson & Kroll, 1991). On the other hand, Boaler, William and Brown (2000), and more recently Taylor, Francis, Archer, Hodgen, Pepper, Tereshchenko and Travers (2017), state that there is not enough conclusive evidence to make a judgement about the impact of mixed ability grouping on student learning. Instead, the authors argue that a drastic change from more streamed or tracked classes to a mixed ability setting, without any formal training was a very difficult task for teachers and something they are struggling to deal with. As such, the authors recommend that continuous professional development is made available to teachers in the immediate future that focuses on developing the skills needed to teach and assess in mixed ability settings.

Overall, the authors conclude that while the BPI has been successful in attracting more students to higher-level mathematics, such increases in uptake have not occurred in tandem with improvements in students' mathematical ability. The recommendations proposed in this paper may help to improve students' competency in mathematics and if this was the case the authors believe that the BPI could be considered a success and used as a model for improving mathematics participation and attainment internationally. However, without some additional changes and revisions the BPI will simply serve to attract students, in an exam-driven system, to study a subject that they do not value and force teachers to engage in teaching styles that they may not be familiar with or have any training in.

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