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Is there a Point? Teachers' Perceptions of a Policy Incentivising the Study of Advanced Mathematics

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A growing body of international research has highlighted the importance of students studying mathematics at an advanced level. In Ireland, the subject has been assigned a special status with the introduction of an education policy called the Bonus Points Initiative (BPI) in 2012. Students are now awarded an extra 25 points in their final State examination results if they achieve ≥ 40% in advanced/ Higher Level (HL) mathematics. This incentive has had a noticeable impact and the numbers opting for HL mathematics in the final State examination have increased from 15.8% in 2011 to 32.9% in 2019. While this is undoubtedly a positive development, there has been little research about any knock-on effects regarding the teaching and learning of the subject. This article examines HL mathematics teachers' (n = 266) perceptions of the BPI. The findings reveal many mixed opinions with more teachers (46%) agreeing with the initiative than disagreeing (27%), recognising advantages such as increasing numbers and rewarding students. However, issues perceived by teachers such as questionable student motivation and the negative impact on the pace of lessons appear to be key reasons for a majority of teachers recommending a review (56%) or discontinuation (23%) of the initiative.

Keywords: education policy; mathematics education; incentives; teachers' perceptions

Introduction

In Ireland, concerns have been raised in relation to the mathematical skills and knowledge demonstrated by students upon completion of post-primary education and entry into third-level education education (Gill, O'Donoghue, Faulkner, & Hannigan, 2010; Treacy & Faulkner, 2015). Commonly cited characteristics of such concerns include a fragmented understanding of key concepts, inadequate subject knowledge, and inability to successfully solve mathematical problems (Treacy, Faulkner, & Prendergast, 2016). These issues are discouraging especially given almost all students who enter third level have studied mathematics throughout their time in post-primary education

(ages 12 – 18). While mathematics is not compulsory in Irish post-primary schools, virtually all students study the subject for both the Junior Cycle (lower post-primary level; ages 12 – 15) and the Senior Cycle (upper post-primary level; ages 16 – 18). For example, in 2019, 98% of students sat the Leaving Certificate (LC) mathematics examination (State Examinations Commission (SEC), 2019). This is a summative State examination at the end of the Senior Cycle. Unlike the majority of subjects, mathematics consists of three levels from which students can choose to study. The most challenging level is Higher Level (HL - often referred to as Honours), the next level down is Ordinary Level (OL - often referred to as Pass), and the lowest level that can be taken is called Foundation Level. While nearly all students study the subject at some level, several of the concerns around students mathematical skills and knowledge have been attributed, in-part, to the low numbers opting to study the subject at Higher Level (Expert Group on Future Skills and Needed (EGFSN), 2008; Prendergast & O'Donoghue, 2014). For example, in 2011, only 16% of the LC cohort opted for the HL mathematics examination (SEC, 2019).

In order to address this issue, the last decade has seen the introduction of an incentive to study advanced mathematics (i.e. HL) at Senior Cycle in Ireland. The overall aim of this incentive, known locally as the Bonus Points Initiative (BPI), was to increase the proportion of students opting to study HL mathematics for the LC to 30% by 2020 (Department of Education and Skills (DES), 2011). This aim was achieved ahead of schedule in 2017 when 29.99% opted for the HL paper. This number increased to 32.9% in 2019. However, while these figures are very encouraging, the introduction of the BPI has not been without issue. The 2015 LC mathematics Chief Examiner's Report (SEC, 2015) indicated that the substantial change in the number of candidates attempting the HL examination may be causing some issues with grade distribution.

Furthermore, Treacy (2018) determined that the difficulty of the LC HL mathematics examination may have decreased as a result of the BPI. Thus, while the importance of studying mathematics at an advanced level is recognised by many, the impact of incentives such as the BPI have yet to be fully determined.

The Importance of studying Mathematics at an Advanced Level

There is a large body of growing research which highlights the importance of students studying mathematics at an advanced level (Attridge & Inglis, 2013; Hodgen, Pepper, Sturman, & Ruddock, 2010; Matthews & Pepper, 2005; Noyes & Adkins, 2017). Several rationales for this assertion are prevalent in the literature. For example, Chinnappan, Dinham, Herrington, and Scott (2008) determined that higher-level mathematics facilitates the development of a variety of skills that underpin a scientifically literate workforce. Kennedy, Lyons and Quinn (2014) added 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 various real-life issues. The literature also highlights the importance of advanced mathematics for developing students' logical thinking and reasoning abilities. For example, in a year-long study of students in the U.K., Attridge and Inglis (2013) recorded differences in the conditional reasoning abilities of advanced mathematics students compared with non-mathematics students.

The Irish LC HL mathematics syllabus places particular emphasis "on the development of powers of abstraction and generalisation and on the idea of rigorous proof" (DES, 2013, p.11). With this in mind, many researchers hypothesise that there is a correlation between participation rates in HL mathematics and participation in other science subjects such as physics (Chinnappan et al., 2008; Kennedy et al., 2014) and chemistry (Donovan & Wheland, 2009). While the LC syllabus acknowledges that "not

all learners are future specialists or even future users of academic mathematics", it also acknowledges that "HL is geared to the needs of learners who may proceed with their study of mathematics to third level" (DES, 2013, p.11). Indeed, many science, engineering, and technology Level 8-degree courses have minimum requirements for attainment in LC HL mathematics. Thus, as recognised by the EGFSN (2008), increasing participation in mathematics at upper secondary level will boost the potential supply of graduate recruits for third-level science, technology, engineering, and mathematics (STEM) courses. This is particularly important in Ireland where the Government have set a goal that the country will become a leader in Europe with regards to developing and deploying STEM talent by 2026 (DES, 2017). It may also go some way in alleviating several of the concerns that have been raised in relation to the mathematical skills and knowledge demonstrated by students upon completion of post-primary education and entry into third-level education.

Proportion of Students opting to Study Advanced Mathematics

Despite much literature ascertaining the importance of studying advanced mathematics, the numbers opting to do so have been an issue of concern, both nationally and internationally (Brown, Brown, & Bibby, 2008; Hine, 2019; Prendergast & O'Donoghue, 2014). For example, in Ireland the percentages of the Junior and Senior Cycle cohorts who opted for each level in the 2011 State examinations are outlined in Table 1.

Table 1. Statistics from 2011 State Examinations in Mathematics (SEC 2019)

	Higher Level (%)	Ordinary Level (%)	Foundation Level (%)
Junior Certificate	45.6	46.5	7.9
Leaving Certificate	15.8	72.1	12.1

As evidenced from Table 1, 16% of the 2011 LC cohort opted for HL mathematics. This was very low in comparison to the percentage of students opting for HL in a sample of other LC subjects in the same year (see Figure 1).

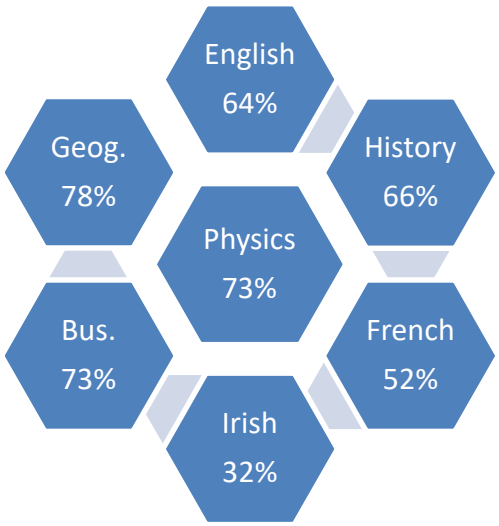


Figure 1. Percentage of students who opted for HL examination in a given subject in 2011 LC examination (SEC 2019)

However, these concerns are not just confined to Ireland. Research in countries such as England (Hodgen et al., 2010; Matthews & Pepper, 2005), Australia (Chinnappan et al., 2008; Hine, 2019) and Wales (Jones, 2008) have all expressed concern around the issue of low participation in advanced mathematics. A large scale study (sample of over 1500 students from seventeen schools in England and Wales) conducted by Brown et al. (2008) identified factors such as perceived difficulty, a lack of confidence, boredom, and a lack of relevance as the main reasons for students not continuing with the subject to an advanced level. In their study, it was observed that even students who trusted their abilities to achieve a high grade, often preferred to discontinue after the compulsory stage due to a lack of interest. In Ireland, HL mathematics is also perceived as a difficult subject (Smyth, Banks, & Calvert, 2011)

and one which requires much time and effort (Malone & McCullagh, 2018). Fuelled by the concerns of low uptake of the subject at HL, the BPI was introduced in 2012 in an effort to increase the proportion opting to study advanced mathematics at Senior Cycle.

The Bonus Points Initiative

In Ireland, the LC examination acts as a gatekeeper to third level education as a student's entry relies almost entirely on their performance in these summative State examinations. Students are awarded points based on their six best graded subjects and using the accumulated sum of these points, they can apply through the Central Applications Office (CAO) for entry onto a third level undergraduate course of their choice. Entry to these courses is competitive and the points required for entry can vary from year to year depending on a number of factors including the number of places available on a particular course together with the level of demand for the course in a given year. Different points are awarded pending the final grade in each subject and also the level at which each subject is studied (see Table 2 for breakdown). For example, if a student achieves 72% in a subject at HL, they are awarded 77 points, compared to 37 points for the same result at OL.

Table 2. Points Awarded for Grades Achieved in Leaving Certificate Examination

Grade Band	HL Grade	HL Points		OL Grade	OL Points
90% - 100%	H1	100		O1	56
80% - 89%	H2	88		O2	46
70% - 79%	H3	77		O3	37
60% - 69%	H4	66		O4	28
50% - 59%	H5	56		O5	20

40% - 49%	H6	46		O6	12
30% - 39%	H7	37		O7	0
0% - 29%	H8	0		O8	0

Prior to the introduction of the BPI, if a student achieved top grades in six HL subjects, the maximum number of points they could have been awarded was 600. However, since its introduction in 2012, any student who opts to study HL mathematics now receives an additional 25 points if they achieve a H6 grade or above (≥ 40%) in the subject. This means that the maximum number of LC points possible has increased to 625.

There is no doubting the high stakes nature of the LC examination in Irish students' lives. A study carried out by Smyth and Banks (2012, p. 302) determined that students' performance in the LC has "*very significant consequences for young people's future life chances*". With such high stakes, students are very strategic when making choices about the subjects they choose and the level at which they study each subject. Rather than being led by their interests and ability, these choices are often based on an effort to reward trade-off (Malone & McCullagh, 2018). For example, Malone and McCullagh refer to anecdotal evidence of capable students dropping from HL to OL mathematics in order to boost their performance in other subjects. With this in mind, the incentive of an extra 25 points for scoring ≥ 40% in HL cannot be underestimated.

As mentioned in the Introduction, the BPI has already succeeded in its intended aim to increase the proportion of students opting to study LC HL mathematics to 30% by 2020. The statistics from the 2019 State examinations in mathematics are outlined in Figure 2. In comparison to the same statistics from 2011, the numbers taking LC HL mathematics have increased from 15.8% to 32.9%. This is an increase of 9,918 students

in 2019 compared to 2011 (SEC, 2019). The proportion of students opting to take HL mathematics at Junior Cycle have also increased from 45.6% in 2011 to 58.8% in 2019.

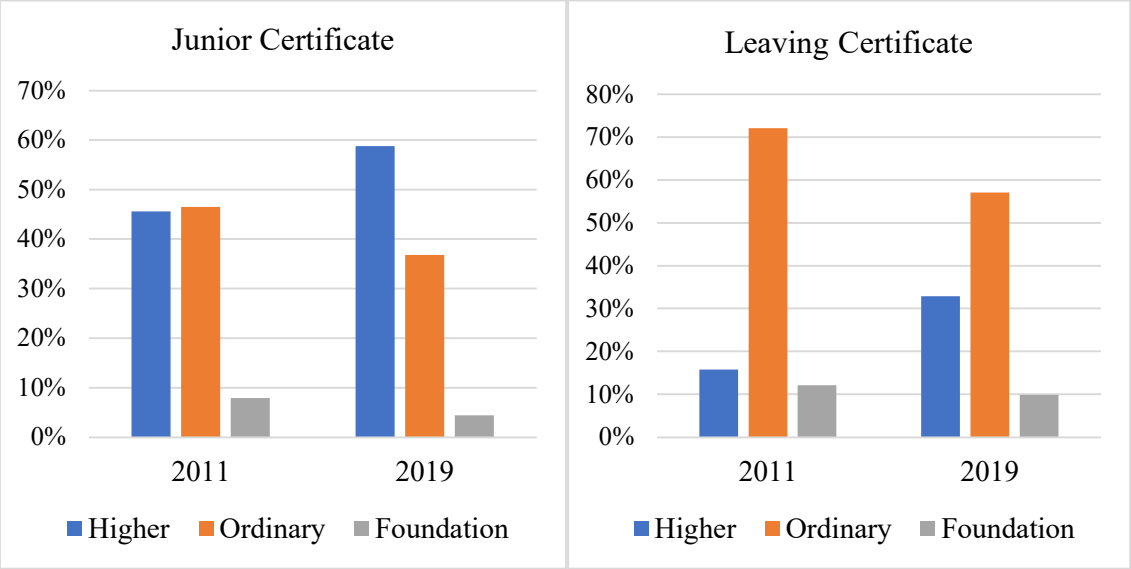


Figure 2: Statistics from State Examinations in Mathematics (SEC, 2019)

However, while these figures are undoubtedly encouraging, the introduction of the BPI has not been without issue. As mentioned in the Introduction, there have been some concerns around grade distribution. The student cohort perhaps most influenced by the BPI are those who would have traditionally opted for the LC OL mathematics paper and achieved an O1 (90%-100%) grade worth 56 points. Prior to the BPI, this was the same number of points that a student would have been awarded had they achieved a H5 (50%-59%) at HL. These 56 points at HL would have been hard earned in terms of the time and workload involved. However, through the BPI there is now much more of an incentive for a student who may have typically done OL, to attempt the HL paper. For example, a H6 (40 – 49 %) at HL is now worth 15 more points compared to an O1 at OL. With this in mind, it is likely that a greater proportion of students that would have typically attempted the OL examination are now attempting HL. As a result, there has been an increase in those achieving low grades at HL (SEC, 2015). This is evident in the jump in figures (15% to 24% - see Figure 3) for those who achieved a HL D

grade (≥ 40 and < 55%) between 2011 and 2016 (the grade band system evident in Table 2 was only introduced in 2017 and so more recent comparisons cannot be made).

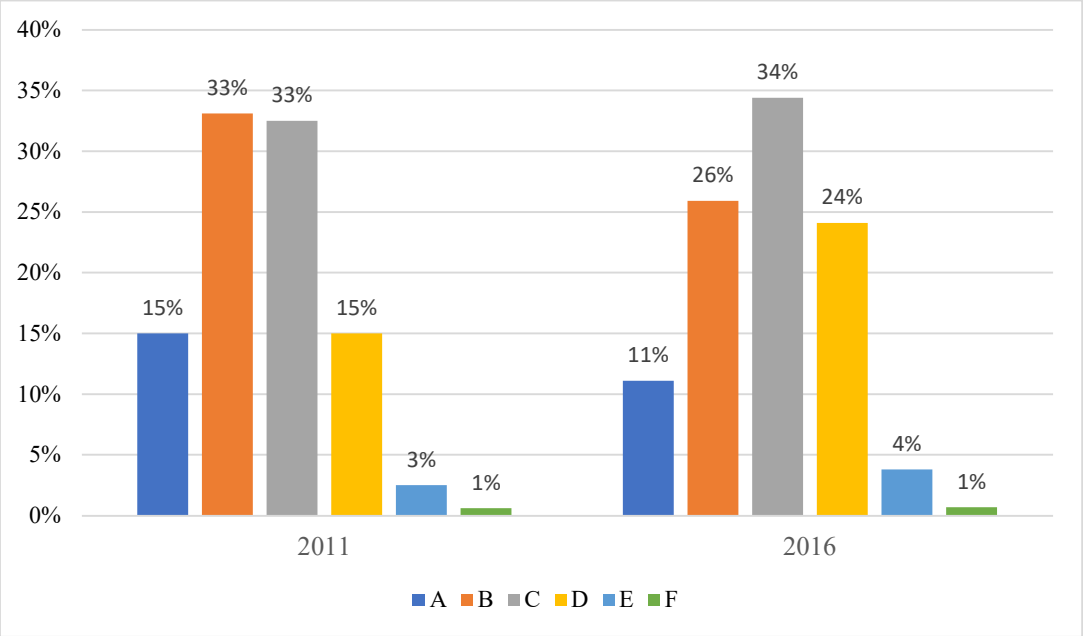


Figure 3. LC HL Maths Grades 2011 – 2016 (SEC, 2019)

In addition to this concern around grade distribution, a study conducted by Treacy (2018) determined it is likely that the difficulty of the LC HL mathematics examination has decreased as a result of the BPI. In Treacy's study, experienced LC HL mathematics examiners indicated that the difficulty of the examination has been adjusted to cater for the influx of students who are not mathematically capable of performing up to the standard required at HL.

So, while the aim of the BPI in increasing the numbers studying mathematics at an advanced level has been realised, there have been some unwarranted consequences. Furthermore, while it was initially designed to be a temporary measure (for four years), there are currently no indications that the BPI will be discontinued or altered in any manner. In fact, expansion of this initiative to other subjects is being considered. The DES (2017, p. 19) indicated in their 'STEM Education Policy Statement 2017-2026'

that they will "*explore the provision of bonus points in STEM-related Higher Level Leaving Certificate subjects (in cases where students apply for higher education courses in STEM-related areas)*". This indicates that the BPI for mathematics is perceived to be a success by policy makers. However, outside of the raw numbers now taking HL, there has been a dearth of research carried out to assess the impact of the BPI, particularly from the perspective of one of the main stakeholders, mathematics teachers. Accordingly, the aim of this study is to investigate mathematics teachers' perceptions of the BPI and to address the following research questions:

1. What are mathematics teachers' perceptions of the BPI?
2. What would mathematics teachers like to see happen to the BPI in the future?

Methodology

The methodology for this study involved the distribution of a questionnaire to a representative sample of Senior Cycle HL mathematics teachers in Irish post-primary schools. The questionnaire was designed specifically for this study and it was developed by the authors with the assistance of an advisory group involving five experienced post-primary mathematics teachers. Their role was to help with the design and piloting of the questionnaire and to help the authors in relation to sampling issues. These five teachers were experienced in their positions and were recruited using a purposive sampling method (each teacher was known in a professional capacity by at least one of the researchers). They 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.

The questionnaire was originally drafted by the authors and comprised of four main sections. Section 1 sought basic demographic information. Section 2 and 3 sought teachers' views on how they felt the BPI had impacted on the student profile in their

class and as a result, their teaching approaches. Section 4, which is the focus of this paper, inquired of teachers' perceptions of the BPI through a series of multiple-choice questions (see Appendix 1). Prior to distribution, the questionnaire was piloted with the five members of the advisory group who offered advice regarding its layout and structure and the wording of some questions. They advised that the questionnaire be kept short (maximum of four pages) and that respondents should also be given the opportunity to provide some qualitative feedback in relation to their opinion on the BPI. This opportunity was provided through the inclusion of two open-ended questions in Section 4 of the final research instrument, specifically enquiring as to the main advantages and disadvantages of the BPI.

The sampling frame for the study was a list of all 723 post-primary schools in Ireland. Having consulted with the teacher advisory group, it was established that on average there are two Senior Cycle HL mathematics teachers in each school in Ireland. Hence using this estimate, a stratified random sample of 400 post-primary schools around Ireland was selected. This sampling technique ensured that an accurate representation of each type of school (secondary (51%), vocational (36%), community (11%) and comprehensive (2%)) was included in the sample.

The questionnaires were distributed (two to each of the 400 post-primary schools) in early April 2018. They were sent to the Head of Mathematics in each of the 400 schools and they were asked to distribute them to Senior Cycle HL mathematics teachers. The packs sent to the schools included information sheets for all involved, the questionnaires, and stamped addressed envelops for them to be returned in. The information sheets issued to the Department Heads invited the recipients to make copies of the questionnaires for additional HL teachers in their schools, if necessary. Each stamped addressed envelope was also given a number corresponding to the particular

school 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 so as to increase the response rate.

The response rate was 266 Senior Cycle HL mathematics teachers (approx. 33%) across 173 post-primary schools. Upon receipt of the completed questionnaires the quantitative data was entered and saved into the computer programme SPSS (Version 22.0). The data from any open-ended questions was transcribed into a Microsoft Word document and an inductive 'bottom up' thematic content analysis was performed on the teachers' responses in relation to the advantages and disadvantages, and the future of the BPI. The work of Bruan and Clarke (2006) provided a framework for this analysis. It was a flexible and recursive process, with repeated movement back and forth as initial codes were generated, and themes were reviewed. The coding process was thorough and comprehensive, and all themes were checked against each other and back to the original data set. While the initial analysis was completed by the first author, it was reviewed by the second author to ensure reliability. Overall, there were no major discrepancies with regard to the themes that emerged. Any disagreements in coding were discussed until both coders fully agreed with each other. Perhaps the most difficult part of the process was clearly defining and naming each theme so that there were no overlaps and ensuring each theme was internally coherent and distinctive. In one instance, this resulted in the formation of a sub-theme so that the full story of the data could be accurately portrayed. The specifics of this main theme concerned how the BPI 'increases the number of students opting for and continuing LC HL mathematics'. However, within this theme there was also a sub-narrative of how the BPI 'increases the number of girls opting for LC HL mathematics'. The statements from this sub-theme were double coded and were also counted as part of the main theme.

Once we had a set of fully worked-out themes, the coding frameworks were summarised using a frequency/percentage analysis and supported by direct quotations from participants' responses where relevant.

In the Findings section these coding frameworks are illustrated in a series of tables. In each of these (Table 4, 5, 7, 8, 9), *f* refers to the number of teachers who mentioned a particular theme. Themes repeated by the same teacher (T) were not counted twice. However, participants sometimes mentioned more than one theme, explaining why *f* often exceeds the total number of teachers who responded to the particular question (*n)*.

Findings

At the outset, teachers were asked through two multiple-choice questions, whether they agreed with the BPI ($n = 266$) and whether the BPI had raised the standard of mathematics in their school ($n = 265$). While 46% of respondents indicated that they agreed with the BPI, 27% did not, and a further 27% signalled that they were unsure. This is a relatively high percentage of mathematics teachers who were undecided about the BPI and it highlights the mixed opinions that many stakeholders have about the initiative.

In relation to the second question, the majority (59%) of respondents felt that the incentive had not resulted in an improvement in the standard of mathematics in their school. While 19% felt that it had, a considerable number (23%) indicated that they were unsure. There may be several reasons why so many mathematics teachers (61) were again unsure in this case. Over the past number of years there have been many changes to the Irish post-primary mathematics curriculum with the national roll-out of a large-scale reform in 2010. The phased implementation of this reform meant that from 2012 until 2017 there were incremental levels of the new mathematics curriculum being

examined in the LC each year. This timeframe also coincided with the new grade band system (see Table 2) which was introduced in 2017. Both of these changes may have made it difficult for responding teachers to make comparisons regarding the standard of mathematics in their schools, pre and post the introduction of the BPI in 2012. Furthermore, as noted previously, the SEC Chief Examiners Report (2015) indicated that the growing numbers attempting the HL examination may be causing some issues with grade distribution. This, along with Treacy's (2018) claim that the difficulty of the LC HL mathematics examination may have decreased, might have further contributed to responding teachers being 'unsure' of standards. In any case, a cross tabulation was employed to determine the relationship, if any, between the responses to both of these initial questions.

Table 3. Teachers level of agreement with BPI and whether it has raised the standard of mathematics

	BPI has raised the standard of mathematics	**BPI has not raised the standard of mathematics**	**Unsure whether BPI has raised the standard**	**Total**
Agree with BPI	41	52	28	121
Disagree with BPI	3	63	6	72
Unsure whether I agree or disagree	6	40	26	72
Total	50	155	60	265

Unsurprisingly, as evidenced in Table 3 the vast majority of those who didn't agree with the BPI, felt that it had not raised the standard of mathematics in their school (n = 63; 87.5%). Also, unsurprisingly, very few of those who disagreed or who were unsure about the BPI, agreed that it had raised the standard (n = 3; 4.2% and n = 6;

8.3% respectively). The data is a little more inconclusive for those who agreed with the BPI. 43% (n = 52) of those who agreed with the initiative felt that it had not raised the standard of mathematics in their school and a further 23% (n = 28) were unsure. This may indicate that there are other reasons as to why these teachers agree with the BPI. Further information around such reasons was sought in two subsequent open-ended questions in which teachers were asked for their opinions regarding the main advantages and disadvantages of the BPI. The main themes which emerged from the responses to these questions are outlined in Tables 4 and 5.

Table 4. Advantages of the BPI (n = 252; f = 298)

Theme	Total f*(%)	Sample Responses
Increases number of students opting for and continuing LC HL maths	104 (34.9%)	T216: A few strong students do higher level that may have strategically dropped it. T112: It definitely made more students stay in 'H' level who should have stayed where previously they would just have opted out to concentrate on other subjects.
* Increases number of girls opting for LC HL maths	4 (1.3%)	T265: Greater uptake of HL amongst female students.
Rewards students for the time and effort required for LC HL	68 (22.8%)	T20: Recognises that honours maths require more time/attention for students than some other subjects at higher level. T195: Reflective of the extra effort + time needed for the candidates.
No advantages	29 (9.7%)	T2: I don't see any advantages. T88: I get that it is trying to promote HL maths but to me I don't really see any advantages.
Motivates students to work harder at maths	27 (9.1%)	T93: It is encouraging students to push themselves at maths. T222: Students are likely to work harder knowing there is a greater reward.
Raises profile and recognises importance of subject	25 (8.4%)	T63: Highlights the importance of maths in the curriculum. T68: Recognition of the subject's importance.
Extra points and increases access to courses	25 (8.4%)	T3: The only advantage in my opinion is the obvious one – 25 bonus points. T148: Students are given a broader range of courses in college with 25 extra points.

Increases uptake of JC HL maths	12 (4%)	T50: It has encouraged an uptake of HL maths at JC level.
Exposes students to a higher standard of maths	8 (2.7%)	T146: More mainstream students are being exposed to a higher standard of mathematics.

*Sub-theme – These four statements are double coded and are also counted as part of the main theme

Table 5. Disadvantages of the BPI (n = 250; f = 372)

Theme	Total f*(%)	Sample Responses
Encourages students who are not up to the standard to stay at LC HL maths or drop to OL very late	131 (35.2%)	T103: Students who are not capable of doing H.L are now doing it and sticking with it, even though they FAIL every class assessment from start of 5th year! T163: Students continue with HL maths in 6th year for longer than previously before dropping to OL.
Puts the focus of maths on LC points rather than on knowledge, understanding and enjoyment of subject	57 (15.3%)	T2: Maths is reduced to a vehicle for points… it is merely currency in the CAO marketplace. T18: Too many students are gambling with the system instead of making a well-reasoned decision because of their ability.
Slows down the pace of HL class & holds back more able students	50 (13.4%)	T4: Well able students been "held back" not getting attention/pace they need. T46: Students of a stronger mathematics ability may not be extended to the same degree.
Increases levels of pressure, stress and anxiety on struggling students	42 (11.3%)	T12: Students who should be placed at OL – undergoing mental torture to try and complete the HL course. T13: Students who would be happy, strong OL students are overwhelmed and stressed at HL.
Increases pressure on teachers	16 (4.3%)	T62: Pressure on teacher to bring OL students through the HL course successfully. T244: Added pressure on teachers due to a greater spread of ability in the class.
Increases parental demand and expectations on students to study HL	16 (4.3%)	T16: Parents put pressure on students to do HL where they are often not able to. T67: Pressure from parents being placed on students to achieve a level they are not capable of.
Increases risk of students failing LC maths	13 (4.8%)	T147: More students are risking failing maths.
Leads to oversized HL maths classes	8 (2.2%)	T136: HL class sizes are too big.

Promotes grind culture	7 (1.9%)	T82: It promotes a grinds culture where if a parent throws enough money at the problem the problem will be solved....

In terms of advantages, the main theme which was noted by 35% of respondents was that the BPI increases the number of students opting for and continuing LC HL mathematics. Related to this, the main disadvantage (also noted by 35%) was that it encourages students who are not up to the standard to persist at LC HL maths or drop to OL very late. These two leading themes in both data sets, although somewhat conflicting, were at the heart of the narrative that emerged from the thematic analysis. There was a sense from teachers' responses that the main advantage of the BPI is very much linked to the initiative's main disadvantage. This contradiction may also shed some light on why many respondents (27%) were unsure when asked whether they agreed or disagreed with the BPI. In general, some participating teachers recognised that increasing the numbers studying LC HL mathematics is desirable. As noted previously, the high stakes nature of the LC examination means that some students who are capable of studying HL mathematics, strategically drop to OL so that they can exert more time and effort towards other 'point friendly' subjects. The introduction of the BPI has undoubtedly resulted in many of these students opting for and continuing in the HL course. Some participating teachers also felt that the BPI has motivated students to work harder, has rewarded them for the extra time and effort, and through all of this, has exposed them to a higher standard of mathematics. However, other participating teachers also recognised that the BPI has had some unintended consequences. On the flip side of the coin, the initiative has encouraged some students who were well-placed in terms of ability at OL, to now attempt HL mathematics. The fact that a H6 at HL is

now worth 15 more points than an O1 at OL means that in many cases the reward offsets the risk. In such instances "*mathematics is reduced to a vehicle for points*" with little focus on knowledge or enjoyment of the subject. Although struggling, a portion of these students bid to persevere at HL for the duration of the two-year Senior Cycle programme, or else they end up finally succumbing, and dropping to OL very late. However, some teachers felt that their time at HL will have been marred by increased levels of pressure and anxiety, and an overhanging fear of failing LC mathematics. They also recognised that there is also increased pressure on teachers who must cater for more mixed ability groups in oversized HL mathematics classes. Inevitably, this may lead to the pace of the class slowing down with the knock-on effect of holding back more-able students. This conflicting narrative is derived from the main themes which emerged from the participating teachers' responses, and these positive and negative perceptions will be examined and interpreted further in the Discussion section.

In order to address the second research question, teachers were asked what they would like to see happen to the BPI in the future, and three options were provided, namely that it is; maintained in its current form indefinitely, retained but adjusted, or discontinued and not replaced. Of the three options provided, the majority (56%) indicated that they would like to see the BPI 'retained but adjusted'. 21% said that they would like to see it 'maintained in its current form' and 23% opted for it to be 'discontinued and not replaced'. A cross tabulation was also employed here to determine the relationship, if any, between the responses of this question and the teachers' level of agreement with the BPI (see Table 6).

Table 6. Teachers level of agreement with BPI and what they would like to see happen to it in the future

	Maintained in its current form indefinitely	Retained but adjusted	Discontinued and not replaced	Total
Agree with BPI	50	69	2	121
Disagree with BPI	1	18	52	71
Unsure whether I agree or disagree	4	61	6	71
Total	55	148	60	263

Of the 46% who agreed with the BPI, there were mixed opinions on whether it should be 'maintained in its current form' (n = 50; 41%) or 'retained but adjusted' (n = 69; 57%). However, it is clear that the vast majority of the 27% who were unsure about the BPI would like to see it 'retained but adjusted' (n = 61; 86%). The main reasons for all respondents choices are summarised in Tables 7, 8, and 9. As can be seen from these Tables, the themes from teachers responses in relation to the BPI being 'maintained in its current form' (see Table 7) and 'discontinued and not replaced' (see Table 8) are closely linked to the main themes that emerged from the responses to the 'advantages' and disadvantages' of the BPI, respectively. However, the most noteworthy finding may be in relation to the three themes which emerged from the responses of those majority of teachers (56%) who felt the BPI should be 'retained but adjusted'. In terms of future education policy on the BPI, these three themes outlined in Table 9 are worthy of further consideration.

Table 7. Maintained in its Current Form (n = 44; f = 53)

Theme	Total f*(%)	Sample Responses
Rewards students for the time and effort required for LC HL	21 (39.6%)	T92: I am glad the undoubted extra time & effort HL maths requires is being rewarded. T431: The bonus points reward students for a subject that generally takes proportionately 25% more time and effort than other subjects.

Increases number of students opting for and continuing LC HL maths	14 (26.4%)	T373: Before the bonus points system students were too quick to give up on HL Maths in my opinion. T49: Bonus points are key incentive for students to pursue the most demanding course for LC.
Raises profile and recognises importance of subject	6 (11.3%)	T45: I believe we should maintain that emphasis on the importance of mathematics. T20: Gives maths a higher profile.
Motivates students to work harder at maths	5 (9.4%)	T432: More students will make a better effort and this raises the overall standard T431: it makes life a bit easier as students try harder in maths as it is worth more to them.

Table 8. Discontinued and Not Replaced (n = 50; f = 59)

Theme	Total f*(%)	Sample Responses
Encourages students who are not up to the standard to stay at LC HL maths	16 (27.1%)	T232: Encourages students who find maths very difficult to stay in HL maths and risk failing the subject T108: Students who are very weak at Maths and should not be doing Higher Level are choosing to do so.
Unfair to prioritise one subject over another	11 (18.6%)	T229: I don't believe that making a subject "more important" is the right approach. T76: Leaving Cert is about many subjects, not just one. Maths should be of equal importance.
Slows down the pace of HL class & holds back more able students	8 (13.5%)	T152: Makes teaching more difficult as catering for the weaker student & strong ones are ignored to a degree T406: Exam questions are becoming easier to answer, stronger students are not being sufficiently challenged and standards have dropped. This must change.
Increases levels of pressure, stress and anxiety on struggling students	6 (10.1%)	T136: Too many students get so stressed about maths as they are hardly passing tests… T168: it is a cause of distress and worry to an increasing number of students who do not have the ability or discipline to achieve in higher level maths…

Table 9. Retained but Adjusted (n = 137; f = 156)

Theme	Total f*(%)	Sample Responses
Points should be awarded on a scale which is dependent on result	56 (35.9%)	T67: Different bonus points depending on grade. Unfair to give a H1 & H5 student same points. T8: the 25 bonus points for a H6 is too tempting for a student who hovers at H6/H7. They stay at H.L. in the hopes of getting over the line & getting the 25 points. If

		the points were scaled, it would continue to reward high-achievers, reduce the incentive for less able students who do not really grasp the material
Points should only be awarded for higher grades	35 (22.4%)	T217: No bonus points awarded for scraping a pass. T171: Bonus points on offer from H5 upwards. This will eliminate students that are just in the class to get H6 and these students get majority of teachers attention & time which could be focused on students with higher levels of ability.
Points should only be awarded for courses that require maths at 3rd level	23 (14.7%)	T39: Bonus points should only be rewarded to those who are taking maths related third level courses. T225: Bonus Points could be given only if you applying to a degree course with a substantial Maths content.

To sum up the findings, overall, more teachers (46%) agree with the BPI than disagree (27%), recognising advantages such as increasing numbers studying HL mathematics and rewarding students. However, issues perceived by teachers such as questionable student motivation for studying HL mathematics and negative impact on the pace of lessons appear to be key reasons for a majority of teachers recommending a review (56%) or discontinuation (23%) of the initiative. This is similarly reflected in the proportion (59%) indicating that the BPI has not raised standards of mathematics amongst students in their schools. These findings will be further examined and interpreted in the Discussion section.

Discussion

Research Question 1: What are mathematics teachers' perceptions of the BPI?

Findings from both the qualitative and quantitative data in this study suggest that teachers hold many mixed opinions regarding the BPI. In order to address Research Question 1, both the positive and negative perceptions will be further discussed in more depth.

Positive Perceptions:

In terms of positive perceptions, the main advantage which was noted by 35% of respondents was that the BPI increases the number of students opting for and continuing LC HL mathematics (e.g. T112: "*It definitely made more students stay in 'H' level*"). This was the main objective of its introduction (DES 2011) and also aligns with key objectives outlined by the DES (2017) in terms of increasing uptake in the study of STEM subjects. However, it must be noted that while the BPI has undoubtedly increased the numbers choosing HL mathematics, it has not had the desired knock-on effect on students selecting to study other STEM subjects. This is evident from Table 10 which shows little difference in the proportion of students choosing to study different STEM subjects in 2011 compared to 2018.

Table 10: Proportion of 2011 and 2018 LC cohorts choosing STEM subjects (SEC 2019)

Subject	**% of 2011 Cohort**	**% of 2018 Cohort**
Physics	13%	14%
Chemistry	15%	17%
Engineering	10%	10%
Technology	2%	3%
Applied Mathematics	3%	4%

The second most cited benefit, mentioned by 23% of respondents, was that the BPI rewards students for the time and effort required for the HL mathematics course (e.g. T20: "*Recognises that honours maths require more time/attention for students than some other subjects at higher level*"). Concern has long been expressed at the workload and timeframe of the LC HL mathematics curriculum in Ireland (Cosgrove, Perkins,

Shiel, Fish, & McGuinness, 2012; O'Meara & Prendergast, 2018; Prendergast & Treacy, 2018) and this has often deterred students from pursing the subject at its highest level (e.g. T61: "students who would have dropped despite being capable"). As noted in the review of literature, given the high stakes nature of the LC, students are very strategic when making choices about the level of subject they study. Malone and McCullagh (2018) noted that these choices are often based on an effort to reward trade-off, and many students who may have been well able for LC HL mathematics dropped to OL as the effort required could be better rewarded if spent on other subjects. In addition to the workload and timeframe, an Irish study carried out by Smyth et al. (2011) found that mathematics is considered to be among the top five most difficult LC subjects. Similarly, in the U.K., a study conducted by Coe, Searle, Barmby, Jones, and Higgins (2008) noted that the STEM subjects are generally harder than other subjects. The BPI recognises this and rewards students for their time and efforts in studying HL mathematics (e.g. T91: "*Rewards what is a long challenging course*").

The importance of young people pursing advanced mathematics was highlighted in the review of literature (Attridge & Inglis, 2013; Hodgen et al., 2010; Matthews & Pepper, 2005). In line with this, twenty-five teachers who participated in this study felt that the BPI raises the profile and recognises the importance of the subject (e.g. T92: "*It stresses the importance of Maths*"). This is indeed a positive perception and is consistent with the long established argument that "*mathematics is not just another subject*" (Mc Donagh & Quinlan, 2012, p. 4). However, on the other hand, eleven participants who were making a case for the discontinuation of the BPI felt that it is unfair to prioritise one subject over another (e.g. T76: "*Leaving Cert is about many subjects, not just one. Maths should be of equal importance*"). This was an issue highlighted in an article by Lynch and McGarr (2016) in which they raised questions

regarding the subject hierarchies that exit in Irish post-primary education. They determined that the BPI in mathematics suggests a certain preference for graduates with strong mathematical skills. Such a preference may be linked back to the DES (2017) 'STEM Education Policy Statement'. However, as previously discussed, while mathematics may be central in the study of other STEM subjects, the BPI has not had the desired knock-on effect on students choosing to study these subjects at Senior Cycle, and this is an issue which must be considered further (see McGarr & Lynch, 2017).

Another positive theme which emerged from teachers' responses was that the BPI has resulted in an increased uptake of JC HL mathematics (this was mentioned by 4% of respondents). More students are endeavouring to study HL mathematics at lower post-primary school to give themselves every opportunity of doing HL at LC and pursue the extra 25 points (e.g. T117: "*More students have greater interest in maths even at JC*"). This is backed up by figures from the SEC which show the numbers doing JC HL mathematics have increased from 45.6% in 2011 to 58.8% in 2019 (SEC 2019). While this study examined the perceptions of Senior Cycle HL mathematics teachers, future research may be warranted to examine the knock-on effects of the BPI at Junior Cycle, and whether it has positive or negative implications for the teaching and learning of mathematics at this level.

Finally, although only mentioned by four participants as a sub-theme in this study, figures from the SEC confirm and show that the uptake of girls doing HL mathematics has increased since the BPI's introduction. For example, in 2011, 45.6% (3758) of the HL cohort were female and this figure increased to 48.6% (8830) in 2019 (SEC, 2019). This is an important finding as a number of international studies have

determined that girls are less likely to enrol for advanced mathematics than boys (Mendick, 2006; Noyes & Adkins, 2017).

Negative Perceptions:

In terms of negative perceptions, while the BPI may increase uptake, 35% of teachers felt it also encourages students who are not up to the standard to stay at LC HL mathematics or to drop to OL very late (e.g. T103: *Students who are not capable of doing H.L are now doing it and sticking with it, even though they FAIL every class assessment from start of 5th year!*"). Similar concerns were raised in the LC Mathematics Chief Examiner's Report (SEC, 2015). As discussed in the review of literature, it was noted that the substantial change in the number of candidates attempting the HL examination due to the BPI may be causing some issues with grade distribution. A greater proportion of students who would have typically attempted the OL examination, were it not for the BPI, are now attempting the HL examination and thus there is an increase in those achieving low grades (SEC 2015). Hence, while the BPI has certainly increased the numbers studying HL mathematics, the question remains whether it has increased the overall mathematical proficiency of the student population. As noted by Hodgen, Marks, and Pepper (2013), incentives for studying mathematics at an advanced level must seek an increase in participation and an increase in attainment, simultaneously. This is often one of the downfalls associated with an extrinsically motivated incentive such as the BPI. For example, a U.S. study by Fryer Jr (2011) concluded that incentives attached to an output (e.g. performance in an examination) did not result in achievement gains as compared to those attached to an input (e.g. engagement with rich mathematical tasks). This concern with grade distribution was best highlighted by a quote from a LC examiner in Treacy (2018, p. 12) where they noted that *"….some of them are passing with a low grade but I think they're*

getting a false sense of security because they're passing with low partial understanding and then they come into college and they're drowning in the maths that they are being shown. So the numbers are increasing and all that, which is nice, but I think the standard isn't increasing in the same way."

This issue is also related to the third most common negative perception, whereby 13% of respondents felt the BPI slows down the pace of the HL class and holds back more able students. For example, one respondent (T46) feared that "*students of a stronger mathematics ability may not be extended to the same degree*". This highlights the difficulties of working with mixed ability groupings, particularly in mathematics (Francis et al., 2017). The issue was explored in more detail by the authors in a separate paper related to this study which further examined the day-to-day classroom impact of the BPI for teachers (Treacy, Prendergast, & O'Meara, 2019). Key findings highlighted addition to teacher workloads, the challenges of differentiating effectively, worries that higher attaining students are being neglected, pressure to cover the syllabus, and concerns with regards to pace of instruction. If the BPI is to continue in its current guise, Treacy et al. (2019) concluded that professional development with exemplars, resources, and supports need to be put in place for teachers to further develop their practice in catering for wider ranges of student attainment in a typical Senior Cycle mathematics classroom.

The second most cited disadvantage, mentioned by 15% of respondents, was that the BPI puts the focus of mathematics on LC points rather than on knowledge, understanding and enjoyment of the subject. This theme is best summed up by the response of one teacher (T2) who remarked that "*maths is reduced to a vehicle for points… it is merely currency in the CAO marketplace*". Unfortunately, the very nature of the LC points system as it currently stands, means that students will select subjects

and levels to maximise their return (Mac Aogáin, 2005). Although students may have previously shunned HL mathematics because of the effort and workload required, the BPI is having the opposite effect. As one respondent (T18) noted "*Too many students are gambling with the system instead of making a well-reasoned decision*".

Research Question 2: What would mathematics teachers like to see happen to the BPI in the future?

While the BPI was initially designed to be a temporary measure, there are currently no indications that the policy will be discontinued or altered in any manner. The results of this study indicate that the majority (56%) of Irish mathematics teachers would like to see the BPI retained but adjusted. The most popular adjustment would be for the points to be awarded on a scale which is in line with the mathematics grade achieved (e.g. T67: "*Different bonus points depending on grade. Unfair to give a H1 & H5 student same points*"). In its current guise, the BPI gives the same reward of 25 points regardless of whether a student has scored 100% or 40% in their LC HL mathematics examination. The scaling of the points may reduce the number of borderline students willing to take the risk of narrowly passing the examination, while still rewarding those who do for the extra time and effort required for HL LC mathematics. For example, before the introduction of the BPI in 2012, the University of Limerick (UL) offered bonus points for several years. However, these were offered on a scaled basis (e.g. 40 points were awarded for the top grade and this decreased by 5 points for every subsequent grade band). Furthermore, under the UL model, bonus points were only awarded to students who achieved at least a C3 (≥ 55%) in LC HL mathematics. This is also related to the second most common adjustment mentioned by teachers, in that bonus points should only be awarded for higher grades (e.g. T217: "*No bonus points awarded for scraping a pass*"). The current system sees points awarded when students

achieve at least 40% at HL. This has certainly incentivised students who would have typically sat the OL examination into taking a 'calculated risk'. As mentioned previously, a H6 grade at HL is now worth 15 points more than an O1 at OL. Both of these suggestions would certainly entice high achieving students who know they can be successful, as well as reducing the number of students who are solely targeting 40% in order to get 25 extra points. However, there is little incentive here for the marginal students who, through extra time and effort, may be capable of achieving a H5 or H6 and in doing so would be exposed to a higher level of mathematics.

The third and final adjustment that was proposed by teachers was that bonus points should only be awarded for courses that require mathematics at third level. This is a suggestion that was indicated by the DES (2017) in their 'STEM Education Policy Statement' when considering the provision of bonus points in other STEM-related areas. The CAO points system operates on a demand and supply based system, and under its current guise the BPI can have a knock-on effect of raising course entry requirements. For example, when the BPI was first introduced in 2012 it was reported that 56% of higher degree university courses registered an increase in CAO points (Irish Examiner, 2012). More recently, in 2019 CAO entry points for a college course in Ireland rose above 600 for the first time, meaning that the 25 extra bonus points were central in the selection process. This potential impact on CAO points across the board may push reluctant students who find mathematics difficult and have no intention of studying a mathematics related course at third level to study the subject at LC HL. To prevent this happening, respondents felt that "*bonus points should only be rewarded to those who are taking maths related third level courses*". This adjustment could still encourage and reward mathematically capable students who opt for the HL course. However, on the other hand, it may also discourage from HL a cohort of mathematically

capable students who do not intend studying a mathematics related course at third level. Furthermore, to the wider public, the hidden message that mathematics is more important than all other disciplines would remain (Lynch & McGarr, 2016).

Alternatively, 23% of respondents felt that the BPI should be discontinued and not replaced (e.g. T70: "*No logical reason for them - get rid of Bonus Points*"). In considering this option, one of the possible concerns is that the number of students opting for LC HL mathematics may again fall below 20% as was the case before the introduction of the BPI. In such a scenario, it may be worth considering other initiatives which could incentivise students to study HL mathematics. For example, an Australian government-funded media campaign "Maths multiplies your choices" took place in Victoria during the 1980's. This public awareness campaign, which also leveraged prime time television advertisements, aimed to encourage female participation in mathematics. The campaign targeted students as well as parents and was hugely successful (Leder & Forgasz, 2010; McAnalley, 1991). The marked success of this programme induced a proposal for its re-implementation in the 1990's to combat the decreasing participation of students in advanced level mathematics courses (Thomas, 2000). More recently, as one of the Australian policy measures to improve mathematics uptake, a five-year national awareness campaign for mathematics and statistics targeted at both the school and Higher Education sectors has been recommended (AMSI, 2018). Similarly, in New Zealand, Hodgen et al. (2013) found that the country's success in encouraging students to study advanced mathematics seems to be built on providing students with greater choice through the provision of more than one high-status route for the study of mathematics. Providing Irish students with the option to tailor their study of mathematics at LC to their future studies and/or careers may be beneficial to

their intrinsic motivation to study the subject (or parts of it at) an advanced level (Authors, 2019).

Conclusion

Over the last seven years, annual statistics released by the SEC in Ireland have shown a marked increase in the number of students opting for LC HL mathematics. Latest figures show this number to have more than doubled from 15.8% in 2011 to 32.9% in 2019. This increase in participation has been attributed to the introduction of the BPI for mathematics in 2012. With such a growth in numbers opting for HL mathematics, the BPI would appear to be a resounding success. However, a closer look indicates that this increase in participation has not resulted in a simultaneous increase in attainment. This study delved further into examining the impact of the BPI, from the perspective of one of the main stakeholders, mathematics teachers. The main advantage of the initiative is that it increases the number of students opting for and continuing LC HL mathematics. However, while numbers may have increased, respondents noted concerns about the standard of some students now continuing at HL. In relation to the future of the BPI, the majority of participating HL mathematics teachers believed it should be retained but adjusted and there were some suggestions for future education policy to consider.

There are some limitations to the study. The authors used a stratified random sample of 400 post-primary schools, which was intended to cover 55% of the total number of schools. However, the response rate of 266 teachers across 173 schools means that the findings are only representative of 24% of the entire post-primary school sample. In addition to this, the authors are cognisant of the fact that the 266 teachers who responded all did so voluntarily and this may have led to some bias in the findings presented. These teachers may be the ones who had the strongest opinions regarding the BPI in mathematics and as such the results may be slightly skewed. It is anticipated,

however, that the representative nature of the sample in terms of geographical location and school type did help to reduce some of this potential bias.

Despite these limitations, this study brings to the fore an issue that needs to be considered by policymakers and those with a vested interest in education. The incentivisation of certain subjects over others through education policy is a matter that is becoming more topical both nationally and internationally. This study, while specific to a mathematics incentive in Ireland, has many lessons for other jurisdictions who may be considering using incentives to increase uptake of certain school subjects.

Perhaps the most noteworthy outcome of this research is the clear evidence of the mixed perceptions that exist amongst HL mathematics teachers towards the BPI. They are one of the main stakeholders affected by the initiative but their perceptions, for or against, are far from compelling. From an outside perspective, one could have reasonably assumed that mathematics teachers would have been amongst those in most favour of the BPI. It has further elevated the position of mathematics and promoted it over other subjects in a bid to increase numbers. However, while media headlines have flaunted its success regarding the record figures taking HL mathematics each year, many have not considered the knock-on effect that this has had on the teaching and learning of the subject. Mathematics teachers, who have been on the front line of this policy change, have identified several unintended consequences and this has led to some concerns around the initiative. Indeed, even amongst the 46% of teachers who agreed with the BPI, 43% felt that it had not raised the standard of mathematics in their school. This, along with other findings, poses serious questions regarding the future of the additional 25 CAO points. The initiative, originally designed to be a temporary short-term measure, has succeeded in its aim of increasing the numbers studying mathematics at an advanced level. However, it has not done so without consequence. The BPI has

not addressed any of the fundamental challenges and problems facing the teaching and learning of mathematics in our schools, but instead has served to mask many of the real issues (e.g. T35: "*I strongly believe that the current system has produced a quantity over quality issue. It is as if the quantity of students doing higher level maths is a measure of their mathematical ability instead of the quality of their work and their understanding of and enthusiasm for the subject being the measure*"). Eight years on from its introduction, surely now the time has come to once again focus on the quality rather than the quantity of mathematics education. This may require a more longer-term education policy which will possibly result in an initial drop-off from the current numbers taking LC HL mathematics. However, while these numbers are important criteria, they are also a narrow view of what is to 'count', and they should be trumped by other evidence such as students' knowledge, understanding and enjoyment of this cornerstone subject. Otherwise, is there a point?

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Appendix 1 – Section 4 of Research Instrument

1. Do you agree with the Bonus Points Initiative?
Yes □
No □
Not Sure □

Please explain your reasoning:

2. It was hoped that an increase in numbers studying the subject at the highest level would raise the standard of mathematics among those students when they finish secondary level. Do you believe this objective has been achieved in <u>your</u> school? (Choose one of the following options)

Yes □
No □
Not Sure □

Please explain your reasoning:

3. I would you like to see the Bonus Points Initiative…… (Choose one of the following options)

a) Maintained in its current form indefinitely □
b) Retained but adjusted □
c) Discontinued and not replaced □

Please explain the reasoning for your choice:

4. In your opinion, what are the main **advantages** of the Bonus Points Initiative?
Please elaborate:

5. In your opinion, what are the main **disadvantages** of the Bonus Points Initiative?
Please elaborate: