Research summary

Higher education outcomes for International Baccalaureate Diploma Programme mathematics higher level students

Summary developed by the IB Research department, based on a report prepared by

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Background

The main objective of this study was to explore and document International Baccalaureate (IB) Diploma Programme (DP) students' mathematical readiness for university studies. In particular, this study examined students' experiences with higher level (HL) mathematics in the DP[1], their mathematical self-confidence and self-efficacy and their perceived preparedness for the study of mathematics at university. Additionally, higher education (HE) data from the United Kingdom (UK) was analysed to examine the value-added of studying mathematics HL in comparison to other pre-university mathematics courses.

Research design

The study consisted of two main data collection strands as follows:

- A global DP mathematics HL alumni survey, which focused on views of the DP mathematics HL course, progression to university and mathematical self-confidence and self-efficacy. There was a total of 566 responses to the survey.
- A secondary data analysis of HE outcomes in the UK, which compared degree outcomes for DP mathematics HL students with students who had studied other pre-university mathematics courses, such as A-level mathematics. This data set consisted of a single cohort of students in UK universities (n = 97,558) who graduated in 2013/14, and had a mathematics qualification upon entry to university (in broad terms, these qualifications included: IB mathematics HL, A-level mathematics, AS-level mathematics, Scottish Highers or Scottish Advanced Highers).

Findings

Survey findings

Demographic overview of the sample

The respondents were 61% male, typically born in 1995, with a median age of 18 when completing the DP or DP coursework. The most commonly represented countries were the United States (30%), Canada (8%) and the UK (7%). In total, alumni from 64 countries participated in the survey. Respondents were evenly split between public and private schools.

In terms of self-reported attainment in the DP, survey respondents were awarded a mean mathematics HL final examination score of 5.2, which is slightly higher than the mean from the IBIS data (4.5). In other words, this is evidence that those responding to the survey were more highly achieving than the average mathematics HL alumni.

Mathematical self-confidence and self-efficacy

DP mathematics HL alumni had high levels of self-confidence across a variety of mathematical topics (figure 1). This was true for students going on to study a range of degrees, and not just mathematics. Figure 1 uses mean scores across all respondents, on a scale from 1 ("not confident at all") to 4 ("very

[1] In the DP, most subjects can be taken at either standard level (SL) or higher level (HL), but students must take at least three subjects at HL. Both SL and HL courses are meant to span the two years of the DP. SL courses are recommended to have at least 150 hours of instructional time, and HL courses are recommended to have at least 240 instructional hours. HL courses usually include a range of additional elements covered in more depth compared to SL courses.

confident"). It shows that the highest level of confidence was in "Manipulating algebraic expressions" (mean 3.7) and the lowest was on "Proofs/proving" (2.7).

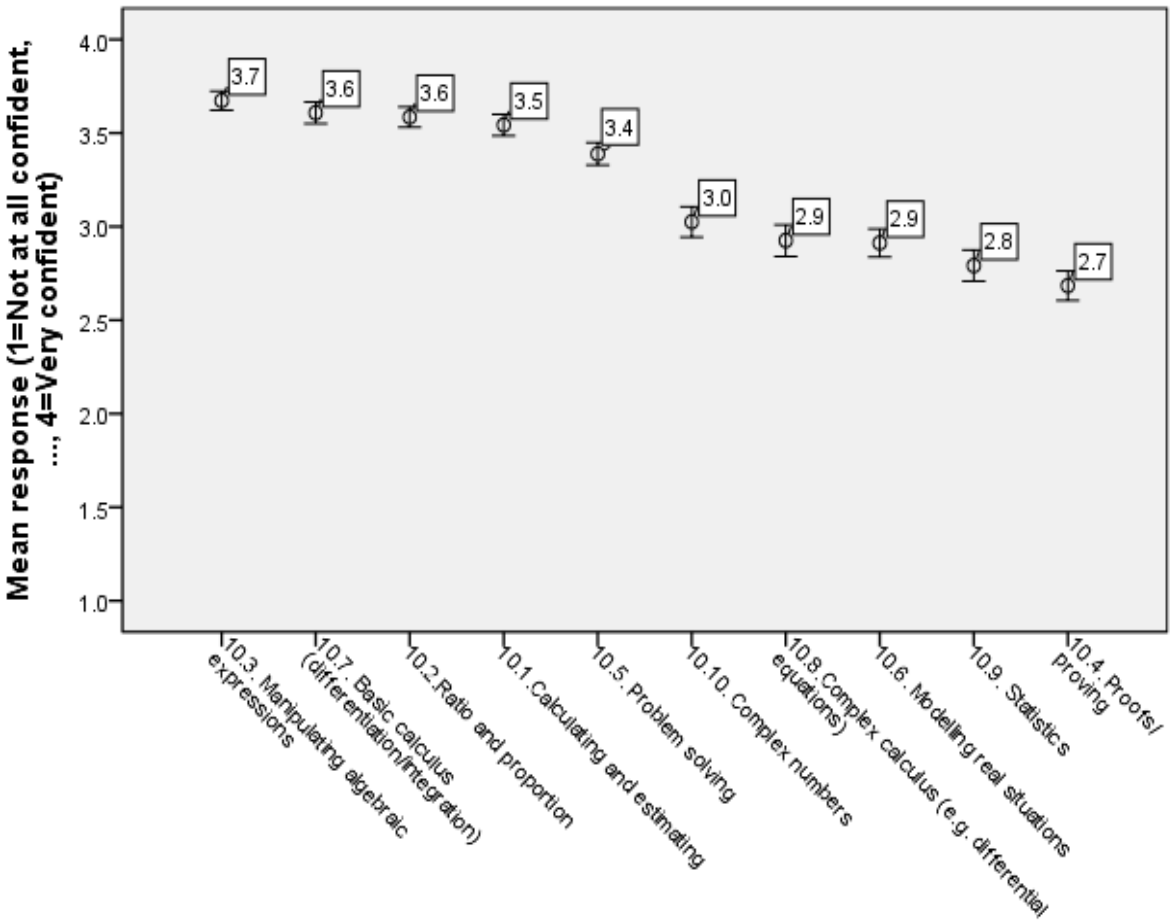

Figure 1. Mean response on confidence in mathematical topics on completion of DP mathematics HL

Respondents were also asked to assess their mathematical ability (ie their mathematical self-efficacy) across a range of fourteen Likert scale items (1 = "never" to 5 = "usually"). DP mathematics HL alumni had high levels of mathematical self-efficacy (figure 2). Again, this was true for students across a range of degrees.

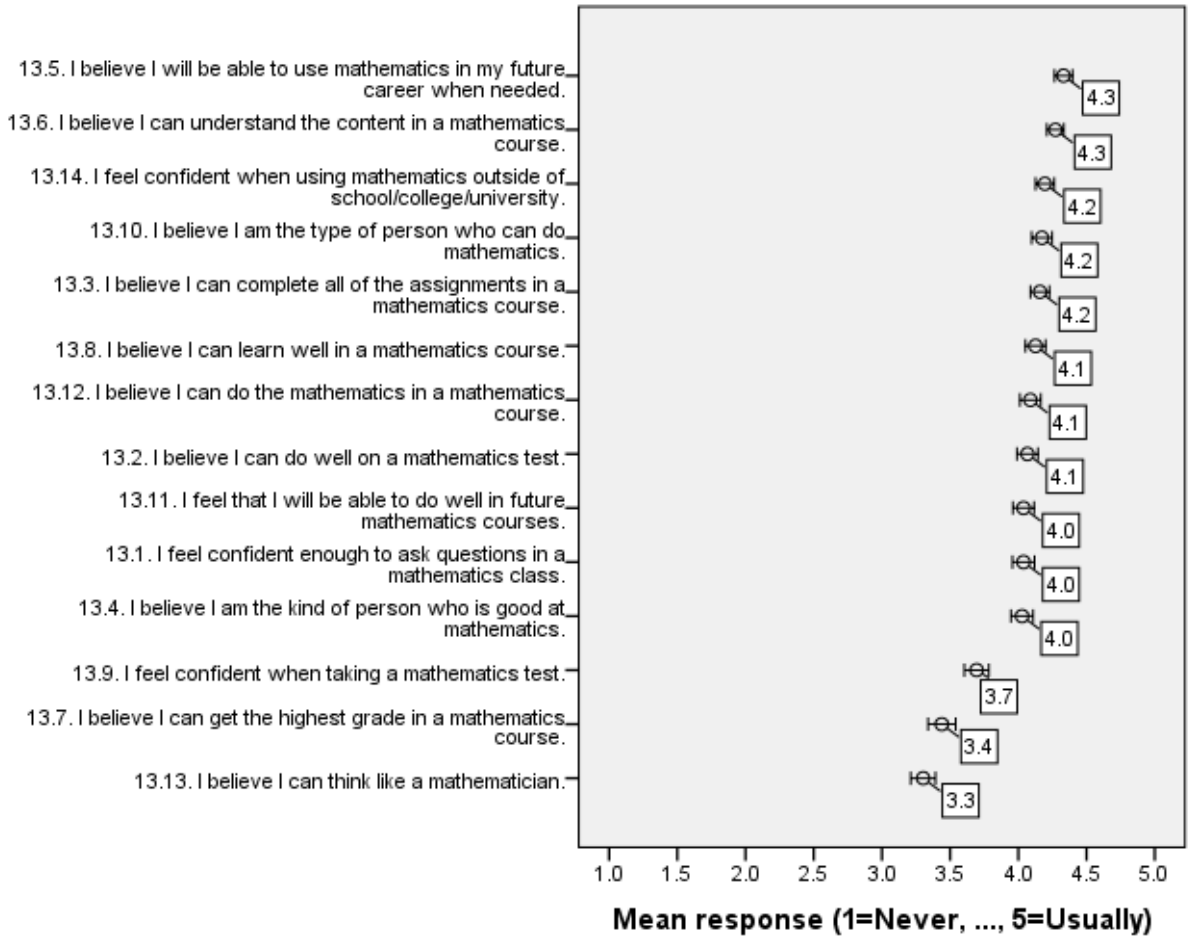

Figure 2. Mean response on mathematical self-efficacy

Student experiences with DP mathematics HL

When asked what they liked about the DP mathematics HL course, alumni reported that they appreciated the range and depth of particular topics, the challenge and rigour of the course, the quality of preparation for university studies and the emphasis on problem-solving and connections between topic areas. As one student explained in an open survey response: *"HL Mathematics prepared me well for my BSc in Mathematics, and it is a strong reason why I am currently pursuing an MSc in Mathematical Science"*. In terms of "dislikes", student responses fell into two major themes: challenges with the internal assessment (IA) and the apparent difficulty of the material. With regard to the internal assessment, one student noted that: "*The expected level of sophistication of IA is too high and it took a lot of efforts trying to come up with the right topic"*.

Preparation for university studies

Generally, the alumni in this survey indicated that they feel well prepared for further study in mathematics—this is clear from the self-confidence (figure 1) and self-efficacy (figure 2) data, as well as the open responses.

Respondents were asked about how well they felt DP mathematics HL had prepared them for university study. The results are summarized in figure 3, where it is clear that generally, alumni going on to degrees felt well prepared (at the very least) across the mathematical areas shown.

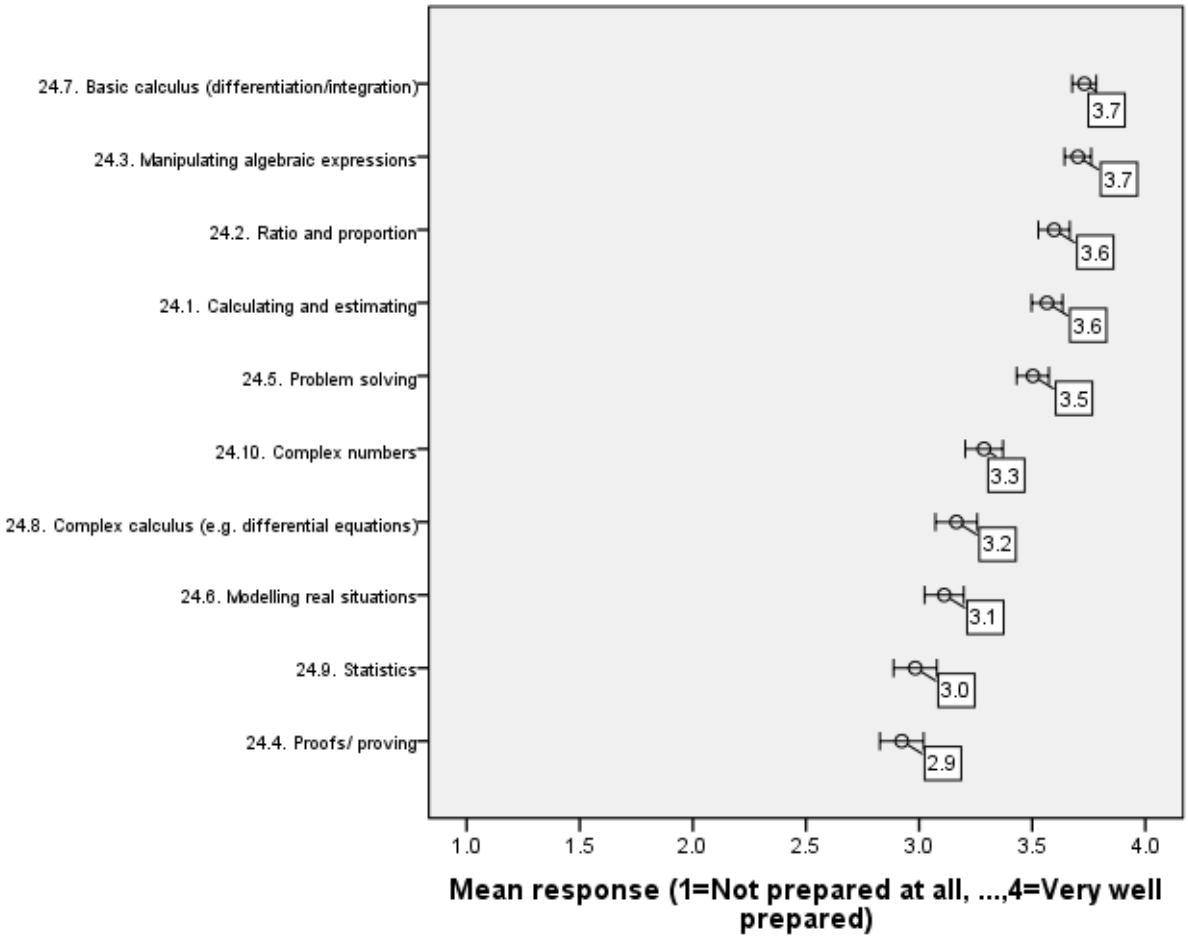

Figure 3. Mean response on preparedness for mathematical topics

IB mathematics HL alumni typically had very positive attitudes towards mathematics as a subject, and strongly recognized its importance to their future careers. In terms of broad classification of degrees chosen by IB mathematics HL alumni, data from the survey indicates that over a third of mathematics HL students (37%) go into the "Professions" (eg Medicine, Law). The second most popular field of study is the "Natural Sciences" (24%), followed by the "Social Sciences" (17%) and "Mathematical Sciences" (12%). In terms of reasons for choosing particular areas of study, respondents reported that "being good at mathematics", "enjoying mathematics" and "being interested in mathematics" were all important in their choice.

Higher education outcomes

With regard to HE outcomes, table 1 shows that the IB students performed well in comparison to the other qualifications examined in this study; 33.9% of the DP students obtained a first class degree — compared to 27.6% of those who had done A-level mathematics.

		Class of first degree				
		First class honours	**Upper second class honours**	**Lower second class honours**	**Third class honours /Pass**	**Unclassified**
Pre-university mathematics qualification type	A-level	27.6%	46.6%	15.9%	3.0%	6.8%
	AS-level	20.2%	53.5%	18.5%	3.1%	4.7%
	Scottish Advanced Highers	29.5%	40.0%	10.0%	2.2%	18.3%
	Scottish Highers	14.3%	43.1%	16.5%	1.8%	24.2%
	IB higher level	33.9%	45.7%	10.7%	1.7%	8.0%
Total		24.9%	47.3%	16.3%	2.9%	8.7%

Table 1. Class of degree by pre-university mathematics qualification

Figure 4 shows the estimated (adjusted) mean performance (degree classification) for each pre-university mathematics qualification. This analysis controls for a range of key co-variates (including UCAS points scores)[2]. It indicates that once different levels of qualifications upon entry (and other demographics) are accounted for, IB students receive the best degree classifications on average (here, 1 = First class, 2 = Upper second class degree and so on, so that lower scores correspond to better classes of degree). Typically, DP mathematics HL students earn better than an Upper second class, whereas students taking other qualifications do not score as highly.

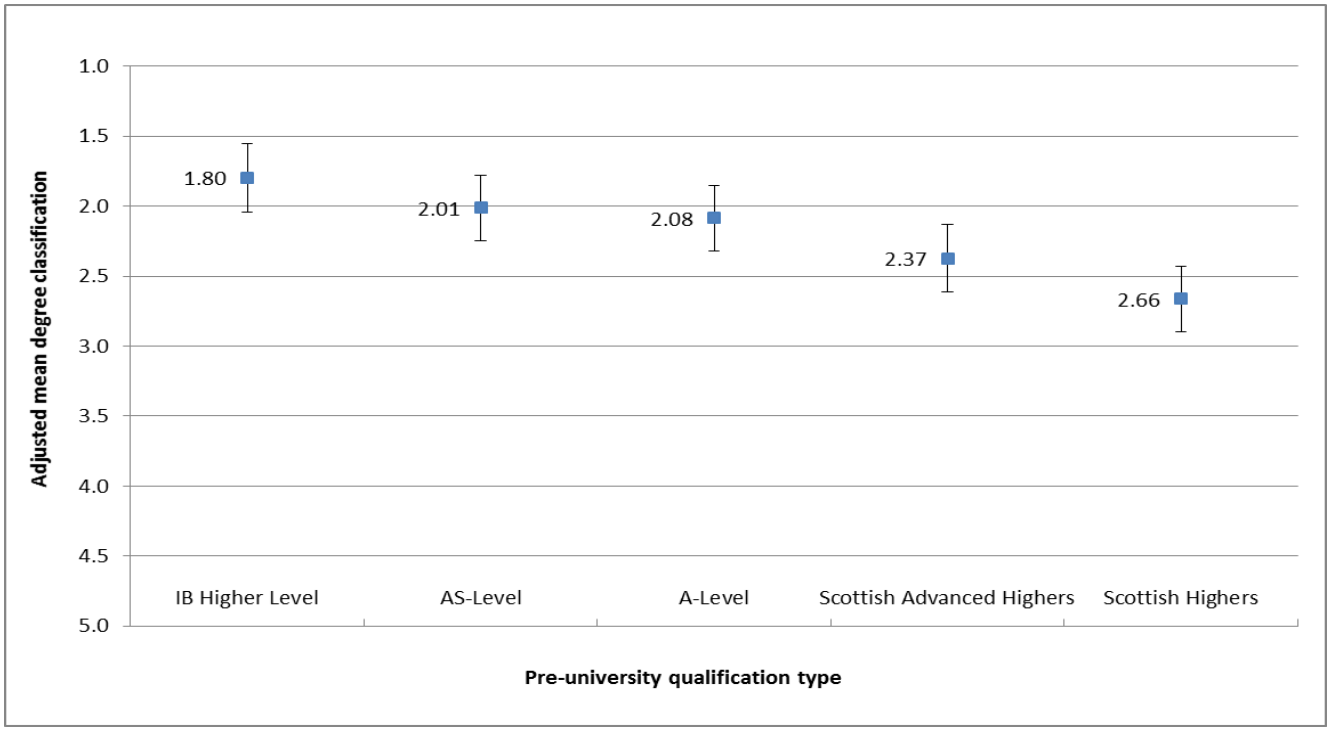

Figure 4. Adjusted mean degree classification by pre-university mathematics qualification

[2] The Universities and Colleges Admissions Service (UCAS) manages the application process for entry to most higher education institutions in the UK. Entry qualifications are scored on a common scale using the UCAS tariff system.

This pattern continues when considering principal degree subject, as shown in figure 5. DP mathematics HL students appear to be achieving better across the board in their degrees compared to students who followed other pre-university mathematics courses. The largest effect is in Chemistry, although the sample size was small, so these findings should be interpreted cautiously.

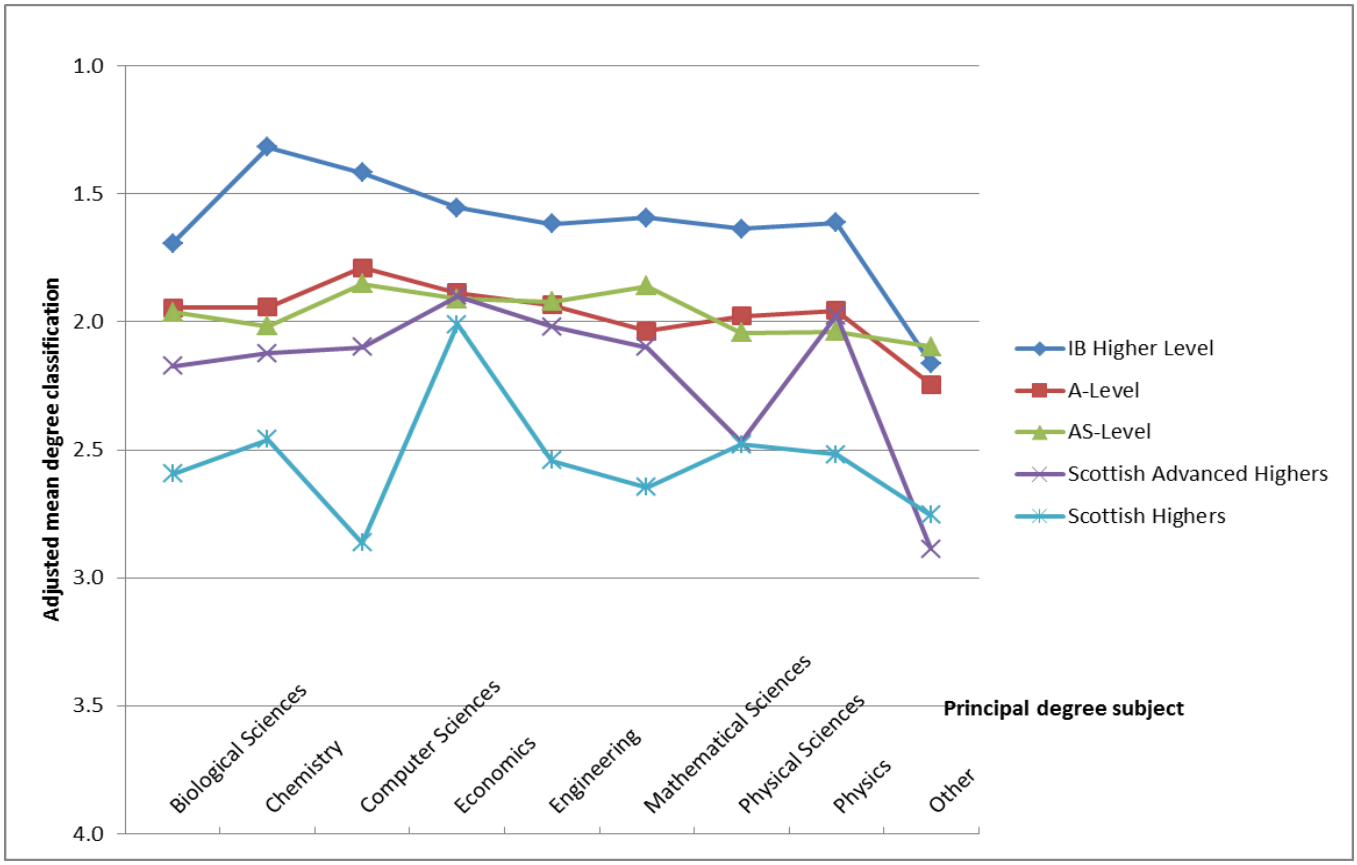

Figure 5. Adjusted mean class of degree by principal degree subject and pre-university mathematics qualification

Recommendations

Based on the findings of the study, the researchers made some recommendations with regard to potential curriculum development areas for DP mathematics HL:

- There could be greater emphasis, or perhaps better support materials, for Proofs—students don't seem to feel as confident in this type of mathematical activity compared to others. The open comments from the survey also suggest this topic area could be further developed.
- Statistics is another area that might benefit from review—based on some of the responses in the survey. Again, self-confidence is relatively low in this area.
- As reported in the survey, there have been some challenges with the introduction of the internal assessment. This is an area that may benefit from further consideration.
- The rigour required to be successful in DP mathematics HL was widely welcomed in the survey data. Any reform of the curriculum should not dilute or change this key characteristic of the subject.

This summary was developed by the IB Research department. A copy of the full report is available at www.ibo.org/en/about-the-ib/research/. For more information on this study or other IB research, please email research@ibo.org.

To cite the full report, please use the following:
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