

Research summary

Evaluation of the International Baccalaureate (IB) Middle Years Programme (MYP) mathematics skills framework

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

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Background

The National Foundation for Educational Research (NFER) was commissioned to evaluate the Middle Years Programme (MYP) mathematics skills framework as part of the International Baccalaureate's (IB) curriculum review of MYP mathematics. The MYP mathematics skills framework forms part of the MYP *Mathematics guide* (IBO, 2014), and sets out suggested content to support schools in structuring their own programmes of learning. This study aims to inform the review cycle through a curriculum comparison (Phase One) and an examination of the implementation of the MYP mathematics skills framework (Phase Two).

Research design

This mixed methods study provided a rich source of both quantitative and qualitative data to address the research questions. Four main research activities were carried out: a curriculum comparison, an expert panel discussion, a practitioner questionnaire (n = 679), and practitioner interviews (n = 4).

Curriculum comparison

The curriculum comparison entailed mapping the MYP mathematics skills framework against other national and international standards, specifically: the United States' (US) Common Core State Standards; the General Certificate of Secondary Education (GCSE) in the United Kingdom (UK); the International General Certificate of Secondary Education (IGCSE); Singapore's mathematics courses for secondary 1 to 4; the Australian Curriculum, Assessment and Reporting Authority (ACARA) framework; and the Quebec Education Program (QEP). To gain an overall understanding of the systems, NFER analysed the structure and format of each system and conducted a granular analysis of subject content.

Expert panel

Additional subject specialist input provided greater understanding of priorities in middle years mathematics education on an international scale. An expert panel discussion was organized to allow NFER to bring together a range of panel members, each with particular areas of specialist knowledge. The panel included three academic experts with a background in middle years curriculum design and two MYP mathematics practitioners who could help contextualize MYP mathematics.

Questionnaire and interviews

The second phase of the research study involved a global online questionnaire as well as follow-up interviews with MYP mathematics practitioners (heads of mathematics departments and teachers). Practitioners were asked about their perceptions of the MYP mathematics skills framework; use of the framework in their planning; enablers and challenges with using the framework; suggested refinements; and connections between the approaches of the IB Primary Years Programme (PYP) and the Diploma Programme (DP).

Findings: Written curriculum

Fitness-for-purpose

A fundamental aspect of the fitness-for-purpose of the MYP mathematics skills framework is whether the approach of dividing content across four branches and two challenge levels reflects current thinking in mathematics education. To address this question, NFER compared the structures of each of the systems through a curriculum comparison.

Structure of systems

The curriculum comparison showed that there are many ways to structure a content framework for middle years mathematics learning. All of the systems structure content into broad branches or strands (see Table 1). Although each system uses its own specific structures, there is a general trend towards dividing the curriculum into strands, involving: number (including number systems, arithmetic skills and proportionality), algebra, geometry/measures, and statistics/probability.

A key difference among the systems is the approach to dividing content by challenge level or age (see Table 1). The IB approach does not provide specific or suggested year-by-year content; instead it allows schools to structure this for themselves. Several systems, including the MYP mathematics skills framework, divide content across two or more challenge levels with an expectation that practitioners should decide on the appropriate challenge level for each learner. Other systems instead adopt a year-by-year structure, prescribing learning content for each year group within the middle years.

Middle years system	Structure		
	Branch/strand structure	Branch/strand names	Challenge levels/tier/suggested age groups
MYP	4 branches, subdivided into topics and skills	Number Algebra Geometry and trigonometry Statistics and probability	Ages 11 to 16 Two tiers Standard—all students Extended—more able students
Edexcel GCSE (9-1)	5 topic areas	Number Algebra Ratio, proportion and rates of change Geometry and measures Statistics and probability	Ages 14 to 16 Two tiers Foundation—all students Higher—more-able students
IGCSE	9 topics	Number Algebra and graphs Geometry Mensuration Co-ordinate geometry Trigonometry Matrices and transformations Probability Statistics	Ages 14 to 16 Two tiers Core curriculum—all students Extended curriculum—more-able students
Singapore Mathematics (Secondary 1-4)	3 strands, each subdivided into sub-strands, indicating content and learning experiences	Number and algebra Geometry and measurement Statistics and probability	Ages 12 to 16 5 different curriculum challenge levels: Mathematics O-Level, N(A)-level and N(T)-level Additional Mathematics N(A)-level and N(T) level Content organized by year: Secondary One Secondary Two Secondary Three/Four

Middle years system	Structure		
	Branch/strand structure	Branch/strand names	Challenge levels/tier/suggested age groups
US Common Core State Standards (Grades 6–8)	Each grade focuses on 5 domains; each domain is made up of standards	Ratios and proportional relationships (Grade 6 and 7 only) The number system Expressions and equations Functions (Grade 8 only) Geometry Statistics and probability	Ages 11 to 14 Content organized by grade
Australian Curriculum (ACARA) (Years 7–10)	3 strands, each subdivided into threads	Number and algebra Measurement and geometry Statistics and probability	Ages 12 to 16 Content organized by grade
Quebec Education Program	3 broad topic areas	Arithmetic and algebra Statistics and probability Geometry	Ages 12 to 16 Secondary cycle one Secondary cycle two (three possible pathways)

Table 1: Structures of key systems in curriculum comparison.

Written guidance

A fundamental design element of the MYP mathematics skills framework is for teachers to be able to use the guidance flexibly to construct their own programmes of study. As such, the content in the MYP mathematics skills framework is provided as a list of examples, as opposed to a prescribed curriculum. This approach is significantly different from the majority of other systems.

Support for structuring a mathematics course within the framework is addressed in other aspects of the guide (for example, “Planning the mathematics curriculum”). The expert panel pointed out that it’s important to view the framework in conjunction with the whole of the guide, other MYP documents, and the support system of the IB (such as, professional development events and other support). However, the expert panel also highlighted that the framework and its structure runs the risk of creating a “tick list” of content rather than being used within the conceptual learning frame of the entire programme.

Most of the other systems also provide greater written detail about what specific skills a learner should be able to demonstrate by a particular year or phase of the middle years age range. Additionally, the written guidance provided by other systems at times more clearly illustrates the connections between mathematical ideas. Evidence from the questionnaires and interviews supports findings from the curriculum comparison that the MYP mathematics skills framework may not always provide sufficient written guidance to support planning and implementation.

Breadth of content coverage

NFER classified MYP mathematics skills framework topics into three groups, in comparison to other systems in order to examine breadth of content coverage. Breadth of content was defined as guidance that is comprehensive enough in its coverage to provide learners with sufficient understanding at the end of five years of study to progress to further post-middle years mathematics learning.

- Group A: The topic is a feature of several other middle years systems, with similar levels of written support suggested by the number of curriculum references.
- Group B: The topic is a feature of several other middle years systems, but other systems have significantly more curriculum statements relating to this topic than the MYP mathematics skills framework topics and skills statements.
- Group C: The topic is not a key feature of the majority of other middle years systems.

Table 2 summarizes the findings of this classification process.

IB branch	Number	Algebra	Geometry and trigonometry	Statistics and probability
Group A	9	10	12	6
Group B	1	0	0	0
Group C	3	6	4	1

Table 2: Number of MYP framework topics per branch in each of the three classification groups.

The analysis indicates that the current MYP mathematics skills framework provides a breadth of learning that is broadly in line with other middle years systems. Overall, during the expert panel activities, there was general agreement that the majority of topics within the MYP mathematics skills framework were suitable for middle years learners.

The majority of the topics in group C were features of the extended challenge level of the MYP mathematics skills framework. At the extended level, the MYP mathematics skills framework contains a number of topics that are beyond the scope of the other key middle years systems analysed in this study (see Table 2.3 in the full report), although some do feature in additional programmes for more-able middle years learners. Some of these extended topics are not essential prerequisites to access DP mathematics courses. By including these topics, the extended challenge level content may be promoting breadth over depth of learning.

Depth of learning

In terms of depth of learning, research findings from both the curriculum comparison and expert panel suggest that the topics and skills within the MYP mathematics skills framework broadly mirror the levels of demand seen in other middle years curriculums and systems. There may be scope, however, for the IB to reconsider the challenge levels of some topics. For example, with regard to statistics and probability, the experts and curriculum comparison indicated that learners should learn to apply and interpret standard deviation at a basic level. As standard deviation is included in the DP standard level course, it would be useful for pupils to have an introduction to it in the middle years. For additional details and examples, see Table 2.5 in the full report.

The final aspect of depth of learning highlighted by the study was higher-order thinking within mathematics. The analysis indicated that the majority of the other systems include, not only problem-solving and reasoning skills, but also the additional element of metacognition—the ability to evaluate methods and results and consider improvements to strategies used. An emerging trend in other systems is to use mathematics as a modelling tool, and, as one expert stated, “to apply a mathematical lens to social problems”. The wider MYP *Mathematics guide* certainly promotes much of this agenda through the

use of global contexts and inquiry questions and in the publication *MYP: From principles into practice* (IBO, 2014). However, it may be beneficial to consider metacognition skills more explicitly within the MYP mathematics skills framework.

Areas of difference compared to other systems

The following section examines the two areas of the MYP mathematics skills framework (ratio and proportion, and statistics and probability) that differ the most from how other systems establish learning expectations and provide written guidance.

Ratio and proportion

The curriculum comparison showed wide variation in the written guidance for ratio and proportion in each of the systems (see Table 2.6 of the full report). The written curriculum guidance is considerably more comprehensive for ratio and proportion within the majority of other systems than it is within the MYP mathematics skills framework. In many other systems, however, the curriculum is also more prescriptive in terms of specifying what sorts of skills learners should be able to demonstrate. Within the context of ratio and proportion, the written guidance in other systems is more explicit in terms of connecting ratio to fractions, algebraic relationships or making connections between proportionality and graphical representation. The idea of making connections between mathematical topics is emphasized within the wider MYP *Mathematics guide*, however, in considering only the written guidance in the MYP mathematics skills framework, some key conceptual learning could be overlooked by MYP practitioners.

Among the expert panel, there was a strong feeling that the rich connection between the ideas of ratio/proportion may not be sufficiently developed within the MYP mathematics skills framework. The expert panel discussions also noted that developing an understanding of the links between fractions, decimals, percentages, ratio and proportion and the use of multiplicative relationships should be a key feature of middle years mathematics learning.

Statistics and probability

This branch was highlighted by the curriculum comparison as being the most variable in terms of the ways in which different systems set out learning expectations (see Table 2.7 of the full report). Current education thinking in this area places greater emphasis on the ideas of planning and undertaking effective statistical inquiry, using and analysing data distributions and critiquing statistical reports in the media. While many of these aspects of learning may be implicit in the overall MYP *Mathematics guide*, there may be an opportunity to improve the written guidance for this branch. There was also a rich discussion about whether the MYP mathematics skills framework in its current form promotes the intrinsic links between statistics and probabilistic models as well as opportunities to use technology to help learners develop deeper understanding.

Findings: Programme implementation

School perceptions of the MYP mathematics skills framework

Six-hundred-and-seventy-nine teachers from 279 schools from across the IB regions responded to a questionnaire about school perceptions of the MYP mathematics skills framework. Of these, 518 gave complete responses. In order to use the partial responses, analysis is presented here and in the full report on a question-by-question basis. Practitioners were asked for their views on the overall suitability of the MYP mathematics skills framework content, specifically considering how the framework supports future learning (Table 3). Practitioners rated their agreement with statements, on a scale from 1 to 6, with 1

showing strong agreement and 6 showing strong disagreement. As such, a lower mean score indicates a higher average level of agreement. Both heads of departments and teachers rated the statements similarly, with teachers showing slightly stronger agreement.

	Head of department (N)	Head of department average (M)	Teacher (N)	Teacher average (M)
MYP mathematics prepares students well for external assessments within the middle years	329	2.98	250	2.80
MYP mathematics prepares learners well for further study	329	2.49	249	2.34
Overall the content provides learners with sufficient mathematical knowledge for future learning in general	232	2.33	244	2.31

Table 3: Practitioners' perceptions of the overall suitability of the framework content.

Practitioners were also asked to consider the suitability of the MYP mathematics skills framework in terms of preparing learners for the DP. Ratings of 1, 2 or 3 were treated as positive ratings, and ratings of 4, 5 or 6 were treated as negative ratings. Generally, practitioners felt that the content in both the standard level guidance and the extended challenge level guidance prepare learners well for DP studies. Heads of departments and teachers were slightly more positive about the standard content (68% positive agreement for both department heads and teachers) than about the extended content (58% and 60% positive agreement for teachers and department heads respectively). Additionally, a larger number of practitioners felt that more detailed written guidance was needed in some topics at the extended challenge level.

The practitioner questionnaire indicated predominantly positive feedback about the MYP mathematics skills framework, although there were concerns from some practitioners about the appropriateness of certain topics and the level of planning support. With regard to topic appropriateness, practitioners were asked to rate on a scale of 1 to 6 if a topic was appropriate for inclusion in the MYP mathematics skills framework (where a rating of 1 indicated **highly** appropriate and a rating of 6 indicated **not at all** appropriate). There were no average ratings above a rating of 3, which indicates that all topics fell in the positive range of the Likert scale for appropriate inclusion in the middle years. Respondents were less positive about certain elements of the extended challenge level, for example: fractional exponents, functions and graphs, and number bases, among others. Interview responses supported this theme from the questionnaire, with interviewees suggesting that they often have the most difficulty with the extended challenge level content.

Planning support

Of schools that deliver the full five years of MYP mathematics, approximately 80% of survey respondents agreed that the MYP mathematics skills framework is supportive of planning within a year and across different years, and that the framework allows for effective progression to DP courses. However, the

practitioner questionnaires and interviews indicate that the current mathematics skills framework does not always provide sufficient written detail to support planning. Interview responses were mixed about how practitioners feel about the current MYP mathematics skills framework as a planning tool. Although some interviewees acknowledged the importance of flexibility for a global framework, others identified this as a challenge. Some suggested that the MYP mathematics skills framework is too brief, meaning that teachers must rely on their own experience or additional tools, which can create inconsistencies between classes and schools.

For some teachers, there seemed to be a challenge in linking content from the MYP mathematics skills framework to the wider MYP philosophies of learning, as specified in the full MYP *Mathematics guide*. Practitioners were asked to rate on a scale of 1 to 6 their agreement with the statement, “it is easy to embed the topics and skills into the wider MYP philosophies of learning, as specified in the full *Mathematics guide*” (1 indicated “agree strongly” and 6 indicated “disagree strongly”). Generally, practitioners neither strongly agreed nor strongly disagreed that it was easy to embed the topics and skills with other features of the guide, with mean ratings of 2.82 and 2.84 for department heads and teachers respectively. However, nearly one quarter of both heads and teachers responded negatively to this question. This suggests that being able to embed the content of the MYP mathematics skills framework into the wider IB philosophies for teaching and learning, as described in the *Mathematics guide*, is a challenge for a proportion of practitioners.

Summary

Overall, while there are some opportunities for improvement, the authors conclude that the MYP mathematics skills framework is broadly fit-for-purpose in its current form. A key difference between the MYP and several of the other systems is that the MYP does not provide specific or suggested year-by-year content, but allows schools to structure this themselves. In terms of content specified, the MYP mathematics skills framework contains broadly similar content to other middle years systems at the standard challenge level. At the extended challenge level, however, the MYP mathematics skills framework contains a number of topics that are beyond the scope of other middle years systems.

The practitioner questionnaire indicated predominantly positive feedback about the MYP mathematics skills framework, although there were concerns from some practitioners about the appropriateness of certain topics and the level of planning support. Many practitioners indicated that the mathematics skills framework allows them to structure their mathematics curriculum for each year group, however, embedding the content within the wider IB philosophy was seen as more of a challenge.

References

- International Baccalaureate Organization. 2014. Middle Years Programme *Mathematics guide*. Cardiff, Wales. IBO.
- International Baccalaureate Organization. 2014. *MYP: From principles into practice*. Cardiff, Wales. IBO.

This summary was developed by the IB Research department. A copy of the full report is available at ibo.org/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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