Evidence for Excellence in Education

Appendices

A: Expert Panel Report
B: Descriptive Statistics

Evaluation of the IB Middle Years Mathematics Skills Framework

National Foundation for Educational Research (NFER)

Appendices Explanation

There are two appendices in this document providing supplementary material for NFER's report 'Evaluation of the IB Middle Years Mathematics Skills Framework' (October 2017). Appendix A is a report of NFER's conduction of an expert panel which addressed breadth, depth and fitness of purpose for MYP's Mathematics Guide with Mathematics education experts and IB MYP Mathematics teachers. Appendix B gives supplementary data tables of descriptive statistics related to responses to a teacher questionnaire designed to elicit school perspectives on the IB MYP Guide and Mathematics Framework.

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Evidence for Excellence in Education

Appendix A: Expert Panel

Evaluation of the IB Middle Years Mathematics Skills Framework

Expert Panel Report

National Foundation for Educational Research (NFER)

independent • insights • breadth • connections • outcomes

Evaluation of the IB Middle Years Mathematics Skills Framework

Appendix A Expert Panel Report

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Appendix A Expert Panel Report

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Executive summary

An expert panel was held as part of the research project being conducted by the National Foundation for Educational Research (NFER) of the International Baccalaureate (IB) Middle Years Programme (MYP) Mathematics Skills Framework. Four experts were involved in the discussion. This included one academic expert from the USA, one curriculum-design and innovation expert from a UK-based company and two current IB MYP practitioners, one from the IBA region and one from the IBAEM region. The purpose of the panel was to gain expert opinion on the mathematical needs of current and future middle years learners and on the current framework and its use and effectiveness as a planning tool, to provide insights and questions to inform the IB's internal review cycle. Prior to the discussions, each expert had been asked to complete a questionnaire.

Section 2 of this report provides a high-level summary of the key discussion points from the main expert panel, together with some initial points of consideration for the IB review team. Section 2 also summarizes the pre-panel questionnaire responses.

On August 15th 2016, a further discussion was held between the NFER research team and another expert who had been unavailable for the main panel meeting. Secton 3 provides a high-level summary of the key points from this additional discussion.

1 Expert profiles

1.1 Ms Irina Amlin

Ms Amlin is a current IB practitioner based in the USA. She has over 6 years experience teaching in an IB school in Bermuda, where she was also involved in a comparison of the IB MYP with the GCSE and US Common Core. She is also involved in the e-assessment examination with IB.

1.2 Mr Alec Titterton

Mr Titterton currently works for computerbasedmath.org in the UK, part of the Wolfram software company. He is working to develop problem solving, computer based resources for teachers to use in schools. His background is in teaching, with experience teaching Maths, Science and IT. He has also worked with the UK's Specialist Schools and Academies Trust as the national coordinator for Mathematics and Computing specialist schools.

1.3 Dr Zalman Usiskin

Dr Usiskin is a professor emeritus of the University of Chicago. He is a leading figure internationally in mathematics education. He is the director for the University of Chicago School Mathematics Project, and was involved in teaching, writing and editing the courses which are now into their 3rd edition.

1.4 Mr Paul Venter

Mr Venter is a current IB practitioner based in Dubai. He is involved in a range of IB activities including being an IB examiner and workshop leader. He helps coordinators develop their understanding of the IB philosophy and conceptual based learning. Mathematics is his subject specialism.

1.5 Professor Peter Sullivan

Professor Peter Sullivan is currently an emeritus Professor of Science, Mathematics and Technology Education at Monash University, Australia. He has extensive published research in the field of mathematics education and has worked as a consultant in IB schools, at both primary and middle years, in a variety of IBAP locations. He was a lead writer of the mathematics element of the Australian Curriculum.

2 Part 1 – Main expert panel

2.1 Breadth, depth and fitness-for-purpose of the current Mathematics Guide

The first part of the expert panel focused on what is important in terms of mathematical education for current and future learners. The experts were asked for their opinions on the overall breadth, depth and fitness-for-purpose of the current IB MYP Mathematics Guide and Mathematics Skills Framework. Within this discussion, the increasing role that digital technologies can serve in the learning of mathematics was also discussed. Some additional comments were made, particularly by the two IB practitioners, about implementing the programme.

2.1.1 What is important in terms of mathematical development for current and future middle years learners?

- Middle years mathematics involves some significant aspects of development. Pre-middle years learners are quite naive in terms of the mathematical world they encounter. It is during the middle years that their level of sophistication grows.
- There is a sense in which middle years mathematics sees a shift from being a set of facts that can be memorised to a collection of inter-related ideas.
- Conceptual ideas are important. In a sense, there is a need to develop an intuitive 'feel' for mathematics (e.g. the ability to visualise the ideas of proportion in relation to many settings rather than simply being able to mechanically share quantities in a given ratio), which would probably not be developed via a solely procedural-based curriculum.
- Whilst there is still a need for learners to have appropriate techniques at their fingertips, the panel members agreed it is important to allow for the development of a creative mind / creative thinking as a vital aspect of mathematical learning.
- Learners should be able to apply mathematical ideas. There is a need to consider the dual role of mathematics as a discipline in its own right and being able to use mathematics as a tool.
- We also have to remember that there is a greater social development agenda within the middle years, and how this works within different cultures on an international scale.
- Within a school context, there is a need for learners to be able to transfer their mathematical skills to other school subjects.
- There was a rich discussion about the role of digital technology within mathematics learning – see Section 2.3 for more detail.

2.1.2 Breadth and depth and fitness-for-purpose– general discussion

- Generally, the overall breadth of the suggested subject content specified in the framework was considered to be appropriate to middle years learners, with some suggested revision of topics / skills and challenge levels. Specific issues are noted in the individual branch summaries in Section 3. Expert opinion on the challenge levels can be found in the pre-panel questionnaire summary provided as an appendix to this report.
- A significant discussion took place concerning how the framework is able to be used as a planning tool and how the framework connects with the full Mathematics Guide in developing a concept-driven curriculum with problem-solving, creative thinking and an intrinsic understanding of how and why mathematics can be used being high on the agenda. The key areas that were drawn out of the discussion are: the use of the framework for planning across the middle years, the influence of other systems, the lack of teacher experience, the connections between topics and the links to real life.
- Whilst the relative freedom within the MYP approach was considered to offer many idealistic benefits, there was significant discussion about the overall structure of the Mathematics Guide as a planning tool.
- A key issue raised was whether the Mathematics Skills Framework is used in its intended manner, as a part of the overall Mathematics Guide, which in itself is a part of the overarching MYP. The implications of using the Mathematics Skills Framework as a stand-alone document were a cause for concern, particularly linked to the lack of any guidance on what topics / skills were suitable for teaching in particular year groups.
- A disparity was noted between the language being used within the wider Mathematics Guide, emphasising conceptual approaches to learning, and a more procedural-based language used within the framework section in describing the topics and skills.
- A significant issue was whether planning was being structured appropriately across the middle years to ensure pre-requisite ideas and concepts were being developed in the earlier-middle years that would allow successful assimilation of some of the more sophisticated ones in the later-middle years or post-middle years. The IB practitioners noted that the Professional Development programme does strongly promote the IB philosophies and support practitioner's development, but if practitioners are, for any reason, unable to access / use the support, then perhaps the format of the current written documentation is not as helpful as it could be.
- Practitioners stated that in reality, planning within the middle years may be more likely to be based on 'planning backwards' from DP requirements. In this sense, there may be an issue linked to breadth and depth – although the panel generally

agreed the topics and skills specified in the framework seemed generally appropriate by the end of Year 5 of the MYP, it is unclear at what level of understanding learners should be able to demonstrate at different years for a particular skill. As an example, it would not be expected that learners in Years 1 or 2 of the MYP would show a fluency with solving problems involving trigonometric ratios, however there are underlying concepts based on similarity and ratio that do support this topic and which are appropriate in Years 1 or 2, yet may not be being appropriately planned for or delivered. This concept of embedding pre-requisite learning into the curriculum and guidance on age-appropriate learning was considered important by both the academic experts and IB practitioners, yet was not considered evident within the current structure of the framework. *(NFER note – we will be asking more about this in our 'Phase 2 Programme Implementation' practitioner questionnaire. We will also discuss this issue in more depth with Professor Peter Sullivan to gain a more focussed academic perspective on it.)*

- Both the academic experts and IB practitioners felt that there is a lack of written guidance in how to structure sequences of learning within a topic throughout the years. The successful assimilation of mathematical concepts and ideas is often embedded in pre-requisite ones having firstly been secured. The lack of any written guidance on this could be a significant barrier to successful learning. There may be an underlying assumption that practitioners are skilled in structuring sequences of learning throughout the years and building a curriculum, but this is in fact very complex and may not be something that is secure amongst practitioners.
- The examples provided on pages 16 and 17 of the framework were commented on positively by the IB practitioners as a way to support depth of planning across the years, however it was noted that the examples do not span the full framework content.
- It was also noted that the framework in its current form may lead to the underlying assumption within the IB MYP approach to planning that practitioners are confident and skilled at structuring their own sequences of learning and curriculums. Depending on their backgrounds, practitioners may expect to be provided with a more prescriptive set of criteria / curriculum to teach to, and may never have developed the curriculum design background required to make best use of the IB MYP framework. To some extent, this is beyond the scope of this research project, however it is a salient point worth considering – is the target audience sufficiently skilled to use the written documentation effectively in the format in which it is currently presented? *(NFER note: we intend to find out more about practitioners' levels of confidence with planning as part of our Phase 2 Programme Implementation part of the overall research project.)*
- Issues were raised with the IB's own MYP Year 5 e-assessment as to whether the lists of topics and skills provide a clear enough picture to allow teachers to understand the ways in which questions on topics may be framed.

- In terms of depth, it was noted that the inter-connections between the four branches were not explicit within the framework. Equally, some topics / skills may benefit from greater supporting detail to support connections within the branch itself. Further information on this is provided in the summaries for each branch of the framework and in the notes on Discrete Mathematics (see Section 3.5.4).
- A common theme arose from both the pre-panel questionnaires and during the discussion of many of the branch-specific issues that additional scaffolding within the existing skills would be more informative to planning. Additional guidance to provide advice on how topics /skills progress throughout the middle years would support practitioners in structuring learning. Within the pre-panel questionnaire, the experts had raised this concerning the algebra branch in particular with experts commenting on the lack of guidance provided by the framework in terms of what skills are suitable for each year of the middle years or how the skills develop over time. Anecdotal evidence from the panel suggested that without this guidance practioners have been known to simply work through blocks of topics from the framework and teach the prescribed skills without necessarily thinking if they are appropriate to the year group or the ability level of their students.
- An interesting comment made about the MYP framework and the relative flexibility it offers, is how it supports learning required by other systems. The key question is - if a learner moves from an IB school at the end of Year 3 will the IB approach have provided them with sufficient skills to adapt to a non IB system? Other systems are often more prescriptive in the expectations by certain age points (e.g. the Key Stage approach in England or the year-by-year approach in the US Common Core State Standards), and therefore transferability between systems may be an issue. Queries were also raised by the practitioners over the practical reality of delivering the IB MYP alongside other systems.
- There was a discussion around the structure of the Mathematics Guide and whether it places greater emphasis on a more traditional agenda of mathematics as a discipline in its own right or whether using mathematics as an integral part of 'real-life' is at the forefront of the agenda. The academic experts felt the IB documentation in its current form was based on the former approach, but that current thinking in mathematics education may be moving in the latter direction. The IB practitioners noted that applying mathematics in the real world is well-promoted at IB Professional Development workshops. An interesting discussion was raised over whether placing 'applying mathematics in real-life contexts' as the last of the four objectives may be interpreted by practitioners as subsidiary to the other three objectives that perhaps live more in the mathematical world, however it was noted that it is clearly explained via the IB that all four objectives should carry equal weighting. A question was also raised whether practitioners recognise the need to help learners transition between the real world and the mathematic world, and whether this is explicit within the Mathematics Guide. (*NFER note 1: see the Singapore curriculum as a case-study of how one written curriculum approaches this aspect. NFER note 2: the MYP 'Global contexts'*

philosophy does suggest a strong real-world link; we will follow up this point with Professor Peter Sullivan)

2.1.3 The use of digital technologies

- Experts highlighted the important role that digital technologies may offer us on how we apply mathematics.
- It should not be taken for granted that learners will just know how to use calculators. There is a need for them to be taught how to input / interpret values e.g. for very large and very small numbers. Within this consideration should also be given to how these sorts of numbers may be presented outside of the mathematics classroom – these ideas are not often cited in mathematics curriculum documents.
- There is opportunity to engage with 'problem solving' and 'interpreting results' aspects and allow digital technology to take over the processing. The deep question to consider is 'do you need to know how something works in order to be able to use it?' It is suggested that within the context of problem solving there is scope to use digital technology to carry out the processing of an arithmetic based problem and then at a suitable point in time, if needed, learners can engage with the mathematical concepts. This could involve using more sophisticated computer-based algebra or statistical analysis packages. (See also Section 3.2.2 for further discussion of the use of computer algebra packages.)
- There may always be a debate about whether it is important to be able to apply mathematical ideas or to have an understanding of why the mathematics works. The best curriculums are those that use applications to assist the learning of pure mathematics, and vice-versa.

2.1.4 Practicalities of implementing the MYP

- The MYP approach can be a 'hard sell' to parents who may have a more traditional / procedural view of mathematics / learning.
- As well as the mathematical agenda, there is a social implication to consider too. This may be different within different countries / regions. A challenge for practitioners is to help learners relate to the selected subject content given their own societal considerations.
- There is a strong need for teachers to be able to respond to the needs of their learners. Teachers must be able to know what is appropriate learning for their class. In this respect the openness of the framework can be positive, for example in MYP Year 1 there is scope for schools to tailor their mathematics curriculum to consolidate learners' prior knowledge and also introduce new ideas.
- As mentioned earlier in this report, questions were raised over how readily practitioners are able to assimilate the philosophies of the IB approach to middle

years learning. Additional professional development from IB was acknowledged as being an important part of the process.

- Practical issues were raised that have an impact on the use of the Mathematics Guide:
  - The stresses of moving to a new country - the reasons why staff have chosen to work in an international school and issues with staff turnover may affect how practitioners / mathematics departments are able to engage with the IB MYP documentation and guidance.
  - Where time / workload issues are prevalent, the reality may be that that practitioners tend only to use the Mathematics Skills Framework as a topic-list to teach, and rely on other systems they have used in previous schools to support their pedagogy, thus not fully engaging with the wider IB philosophies. Whilst this reflects challenges beyond the control of the IB, if the Mathematics Skills Framework is used in this way, out of the context of the wider philosophies of the IB MYP, then it may not promote effective teaching and learning.
  - Some frustration was also raised over the length of time it can take to obtain responses to enquiries from IB Answers.
- When providing guidance for planning, there is a delicate balancing act between allowing creative freedom for co-ordinators to develop their own curriculums and embedding support and scaffolding to allow for the effective development of concepts over the middle years. Without suitable guidance, practitioners may fall back on their 'old methods' from previous curriculums or systems, or draw on assessments (e.g. the IB Year 5 e-assessment, iGCSE criteria, or criteria from DP assessments that teachers then use to 'plan backwards'). The experts warned of the dangers of 'teaching to the test' but recognised that pressures linked to external factors may lead to this even amongst practitioners who wish to fully embrace the IB philosophies.
- An interesting point was raised over how readily practitioners themselves are able to work within the philosophies of the IB MYP if they themselves have only ever experienced a more traditional approach to learning mathematics.
- Several points were also raised over the impact of the e-assessment. Schools that have omitted certain topics from the framework within their own curriculum may feel disadvantaged. In addition, with the removal of the moderation process of student work from the previous model of assessment, there may be less certainty at a central level about whether classroom practice is still embracing the wider IB philosophies; in addition, there could be a shift to prioritising teaching topics that are likely to come up in the e-assessment.
- On a number of occasions in the panel discussion the historical development of ideas in mathematics was mentioned. There was an agreement that at some level learners should have an appreciation of this historical dimension of the development of mathematics. . The framework itself does not support this agenda; an interesting point for the IB's consideration is whether this is

something that practitioners will embed into their planning from guidance provided within the full Mathematics Guide.

2.2 Breadth, depth and fitness for purpose by branch of the framework

In addition to the more general discussions summarised in Section 2, more detailed discussions were held to consider each branch of the current framework. These discussions were supported by the feedback the experts had provided via the pre-panel questionnaire and some specific issues raised by NFER from our initial curriculum comparison work. Some discussion points spanned two or more of the branches, and are presented in Section 3.5 Cross-branch Issues. A summary of the pre-panel questionnaire results is provided as an appendix to this report.

2.2.1 Number

2.2.1.1 Exponents

- Calculators / technology allow easy calculation / computation with exponents. One expert questioned whether the framework promotes an understanding of using them in a problem-solving context such as population growth.
- One expert questioned whether 'fractional exponents' would be viewed by practitioners as promoting a sense of continuous nature of growth e.g. the infinite set of exponents between x^1 and x^2.
- See also section 3.5 Cross-branch Issues.

2.2.1.2 Number bases

- There was a lack of clarity over what this should look like in practice and this topic can end up being delivered as a quick stand-alone topic to 'cover the curriculum'.
- One expert commented that the topic did not seem to fit well with other topics, and that it was hard to relate it to the real-life / problem-solving agenda.
- Consideration of the use of base 2 to be able to use complementary addition to perform subtraction was mentioned, supporting the exploration of different base systems as a way to understand fundamental ideas of the number system in general and enrich the curriculum.
- Another expert commented that an appreciation of different number bases may act as a support to gaining a deeper understanding of the place value in general, and as such perhaps there is a need for this to be embedded into the pre-middle years learning.

2.2.1.3 Logarithms

- Experts agreed that it was sensible for logarithms to only feature in the extended challenge level guidance, considering how they are developed in DP courses.
- One expert raised an interesting point that even 13-14 year olds from some Asian cultures may become adept with mechanical aspects of using logarithms as a consequence of approaches taken to the ways in which they learn about number in general within pre-middle years. Conceptually, age 16 is more appropriate for this topic.
- One expert commented that logarithms are often introduced to 16 and 17 year olds with a focus on using them mechanically to re-write statements involving indices and manipulation skills. A second expert commented that this can provide support to other topics e.g. the development of algebraic manipulation skills, however within the middle years, there is less scope to develop problem-solving within this topic.
- One expert questioned whether learners are being provided with opportunities to develop a more conceptual sense of how logarithms help us deal with the difference between numbers of vastly different magnitude. This highlights a tension between embedding conceptual learning and helping learners succeed on assessment questions, which may not be complementary. This is not a criticism solely of the IB MYP framework, but of all systems in which the 'easily testable' is given higher priority than understanding the development of mathematical concepts.
- One expert commented that it was sensible to include logarithms within the framework from a 'completeness' perspective, linked to exponents and inverse functions.

2.2.1.4 Ratio and proportion

- The pre-panel questionnaire indicated agreement that the wording used for the topics / skills in the current framework does not reflect the richness of the underlying concepts.
- There was also a sense that the links between proportion and scaling in geometry were not clear in the current framework.
- One expert questioned the current moves in other curriculums linking this topic to rates, and whether this is necessary or is an overuse of the concepts.
- *(NFER note: due to time restrictions, we did not discuss this topic in detail; we intend to have a more full discussion with Peter Sullivan to gain an academic perspective on the depth of learning required in this topic.)*

2.2.1.5 Suggested additional topic - Surds / radicals

- This is not currently stated explicitly within the topics /skills, but developing confidence in manipulating and simplifying expressions involving surds was considered an important skill in terms of preparing students for future needs.

2.2.1.6 Suggested additional topic - Levels of accuracy / error analysis

- One expert raised this as a possible 'missing skill' in the current framework, considering it important for learners to be able to appreciate the level of accuracy of a given value and their potential variability.
- Error analysis and error propagation have the potential to mean different things to different people, based on individual backgrounds. If this topic were to be included, careful consideration would need to be given to the wording of the guidance. A focus on understanding the limits of accuracy may be age-appropriate; consideration of relative errors may be a more confusing topic area.

2.2.2 Algebra

2.2.2.1 Levels of demand throughout the middle years

- The experts agreed that more structure / scaffolding would be beneficial, providing guidance on suitable learning for different year groups. There is a strong need within this topic to consider student maturity levels to be able to deal with the conceptual ideas, and also what level of complexity is necessary for different learners, depending on their future needs.
- A question was raised as to whether the guidance supports the development of a strong foundation of skills that learners can build on. It was considered that in its current form, teachers may simply select statements from the framework to teach without really considering the progression of the topic over the middle years, with possibly detrimental consequences to deeper understanding. As an example, one expert raised that he had seen practitioners focussing planning on age-inappropriate mechanical algebraic manipulation rather than the conceptual development of the idea of variables.
- The teaching / learning of terminology was noted as important and should be embedded within learning activities.
- One expert questioned the approaches used by practitioners on factorization of quadratic forms. A typical pedagogical approach is to trial factors until a correct factorization is obtained, and investing a considerable amount of curriculum time on this. This potentially misses out on the richness of why some quadratic expressions are factorizable and others are not – see Section 3.2.2 for further discussion on this theme.

2.2.2.2 The role of computer-algebra packages

- A very interesting discussion was held over the potential for using computer algebra programmes to actually perform the manipulation.
- One expert commented that we need to be mindful of quality over quantity. Traditional based approaches can help develop a set of critical thinking skills if well-planned and there may be wider implications in making use of digital technology as a processing tool.

- This discussion also raised the issue of whether it will be more important in the future to invest curriculum time into the mechanics of traditional algebraic manipulation or into the ability to engage with computer algebra packages, and what skills will be important to employers in the future.
- One IB practitioner commented that the IB approach does allow scope for exploring different ideas within teaching and learning. At a practical level there may be lots of good ideas like this to embed, but it is time-consuming to research them all to see if they would be appropriate to use. Case studies offer potential to be used as an additional support mechanism from IB.
- The experts agreed there may be much tension within the use of digital technology within algebra. Succeeding in tests and requirements for further study may promote a more traditional pencil-and-paper manipulation approach. Parents also may expect a certain level of manipulative rigour based on their own experiences and be more resistant to the use of technology. On the other hand, employers may be increasingly valuing the ability to know how to translate a mathematical algebraic problem into a digital-technology language with a focus on checking and understanding the computer outputs as they relate to the problem.
- One expert questioned the degree of skills needed by students in more traditional algebraic manipulation, when this can be carried out by use of technology. Whilst acknowledging that this may be an extreme viewpoint, the expert perceived the role of the teacher to be to help translate a problem and support learners to understand how to relate mathematical algebra to coding functions within an algebraic package. The learning focus could then be more on the application of algebra to solve problems. Although other experts saw merit in this from an ideological or 'skills for employment' perspective, questions were raised whether this would support learners with future needs e.g. within DP courses.
- The topic of 'quadratics expressions' was discussed as an example. A technology-led perspective on factorizing quadratic expressions could be to use computer algebra packages to explore a wider range of expressions and consider whether they are factorizable or not, and to seek connections. This may help promote a greater richness of learning and deeper understanding of underlying concepts than a more traditional practice-based model of pedagogy.
- Several points were raised about levels of demand. Using digital technologies can allow learners to solve problems in which the algebraic manipulation is beyond their current skill level. One expert cited an example of a project in which digital technology is used to solve cubic equations, allowing learners to develop an understanding of forces and velocities of objects and drag equations which may take learners considerably beyond what a more traditional curriculum would allow.
- There may be scope to consider the use of technology within MYP courses particularly as it relates to Standard Level and Higher Level at DP. Students

progressing to Higher Level may need a stronger understanding in why the algebra works, whereas at Standard Level, there may be more of an emphasis on the need to be able to make use of computer algebra programmes. There is a big question to consider here about considering the future needs of different learners but being careful not to create two different classes of students.

2.2.2.3 Functions

- The experts felt this topic offered some genuine excitement to learners and has the potential for some rich exploration. One IB practitioner commented that the topic helped learners make more sense of prior learning on linear and quadratic functions and to be able to make more rapid progress in understanding the more generalised ideas.
- One expert commented that exponential functions could be sensible to include to provide a link to the exponents and logarithms topics in number and algebra. A second expert agreed that whilst the historical need to use exponential functions to evaluate logarithms may no longer be needed (simple instead to use calculators), exponential functions are relevant within many contexts.
- One expert commented that this is another topic in which it is important to consider the depth of knowledge required by different learners. Whilst all students may benefit from knowing about sine and cosine curves and periodicity, only some need to know how to sketch more complicated trigonometric functions. To this extent, the degree of demand in the current framework guidance may need reviewing.
- A second expert agreed that the current guidance needs more structure to allow practitioners to develop ideas / concepts earlier on that will underpin successful learning in the later middle years. As with other topics, the point was also raised that within the current guidance, practitioners may try to embed this topic too early in the curriculum without pre-requisites being secure.
- There is an obvious link within this topic to geometrical transformation, however it is unclear whether practitioners would make this link when planning courses.
- One expert stated the need for a clearer structure of how the learning of this topic can develop over the middle years as learners develop greater mathematical sophistication – there should be a natural progression to help develop understanding as opposed to learners simply being able to mirror what they have been shown.
- This topic was also considered to be one in which digital technology can provide a rich learning experience.

2.2.3 Geometry and trigonometry

2.2.3.1 Vectors and vector space

- One expert questioned whether other systems / curriculums include the same level of demand as the IB MYP on this topic as the topic seems very abstract for the middle years. Vectors themselves are understandable and appropriate as they relate to problems involving direction and magnitude, and may have applications relevant to the middle years, but more formal vector geometry / vector spaces may fit better beyond the middle years.
- As with some other topics / skills, the lack of additional guidance on what this looks like as it relates to the middle years leaves practitioners unsure what the focus of the topic is meant to be.
- One expert commented that vectors are included within Standard Level DP but are only in the extended challenge level at MYP.
- A comment was made about the use of vector geometry as a platform to offer elegant solutions to some geometric problems. One expert commented that just because a topic may be considered to include beautiful mathematics, it should not necessarily be a core component of a curriculum document; curriculum developers need to consider whether it is sensible to include in terms of overall breadth, depth and relevance to the learners in question.(*NFER note: we intend to discuss this further with Professor Peter Sullivan, and in particular whether this seems appropriate within the middle years).*

2.2.3.2 Similarity and congruence

- Links to other topic areas, especially proportion, are under-developed within the framework. See Section 3.5 Cross-Branch Issues.
- Even at the standard challenge level, students are able to understand the idea of similarity / proportionality and it was considered to often provide support to many other more demanding mathematical concepts as well as being a highly relevant in real-life.
- Similarity also offers a different perspective on geometrical thinking. Rather than considering shapes in terms of properties of their sides / angles, they can be considered as objects and consider how a transformation changes the whole object.

2.2.3.3 Three-dimensional co-ordinate geometry

- One expert commented that this felt like a stand-alone topic that didn't link well to the bigger picture of geometrical learning, and again that the level of guidance in the framework made it hard to ascertain what the IB intended for depth of learning

- The degree of continuity between the MYP and DP courses was commented on, with this topic only seeming to be touched on within the DP Higher Level courses, with links to Pythagoras' Theorem.
- One expert commented that the main value of this topic for all students is to help develop a sense that objects can be located in space by use of an ordered triple, and that this understanding supports future learning both in mathematical topics (e.g. geometries of higher dimensions, statistics and linear programming) and relates mathematics to physics and chemistry.

2.2.3.4 Suggested additional topic - Loci and constructions

- This is specified in other non-IB middle years systems but not in the current framework.
- If included in a revised framework, these topics may be better separated out.
- One expert commented that constructions can provide a context for some 'beautiful mathematics' within a deductive geometry system, allowing students to discover ideas and gain a deeper understanding of geometrical figures. The experts agreed that just learning the mechanics of ruler-and-compass constructions as an algorithmic process is not particularly useful or relevant to modern life.
- An understanding of loci may be better developed via practical or digital activities. One expert also commented on the level of relevance of this topic in real-life. From their own curriculum development work, they cited an example of search patterns (e.g. to identify the likely location of a missing airplane) and linking loci to degrees of freedom of variables within a system.
- If loci is to be included, careful consideration would need to be given as to the wording to ensure the guidance was interpreted as developing the concepts of loci rather than the mechanical paper-based construction work. Examples of what is desired could be offered to help practitioners understand the framework requirements. There may be scope to make use of geometric technology packages to support learning – not only can they mimic straight-edge-and – compass constructions, but they can also extend them.

2.2.3.5 Approaches to geometrical teaching and learning

- Throughout the discussion of this branch, comments were made relating to whether the priorities should be on conceptual ideas or learning sets of definitions / terminology / facts. The latter of these may be more prevalent in assessments, with implications for teaching.

2.2.4 Statistics and probability

- One expert commented on the sparseness of guidance in this topic, especially considering the emphasis on statistics even within Mathematical Studies at DP.

2.2.4.1 Distributions and the language used in the topics / skills statements

- Several experts noted that the word 'distribution' seemed a surprising omission from the topics and skills, and in particular that when data is collected it forms a distribution that can be analysed. On expert commented that there are some strong academic opinions about how statistical analysis and probability distributions connect together, with many believeing strongly that distributions of actual data should be examined before formal probability is employed.
- In considering probability distributions,the experts were not suggesting formal teaching of probabilistic models such as Binomial and Poisson distributions, but more on building the ideas behind them.
- One expert commented that the language used within the current framework seemed to place a greater emphasis on the construction of charts or the calculation of probabilities rather than the distributional analysis and interpretation aspects – some small changes to the language used in the topics / skills in this branch could enhance learning at a conceptual level rather than a mechanical one.

2.2.4.2 Standard deviation

- Experts agreed that understanding deviation as a concept, and then standard deviation as a measure of dispersion and being able to use it to compare distributions is appropriate even at the Standard and extended challenge level. As the topic is needed even within the Mathematical Studies DP course, it is useful to introduce it within the middle years from a conceptual development point of view. The more in-depth understanding of how standard deviation is calculated is more suited to the Extended challenge level only.
- One expert raised an interesting point that the quality of teaching and learning may differ depending on where a school is located. Anecdotal evidence was cited about schools in Australia performing considerably better within statistics, and a note that this branch is developed to a more advanced level within Australian mathematics text-books, reflecting the changes emphasis within the Australian curriculum itself.

2.2.4.3 Statistical reports

- The experts agreed that opportunities to critique statistical reports are an increasingly important area for curriculum development as they enable learners to judge and interpret statistical claims.
- There is currently some innovative practice linked to this topic e.g. the Wolfram Computer-Based Math programme as being used in Estonia. (*NFER note: we intend to include these within the constrained literature review aspect of this research project.)*
- One expert commented that the idea of studying reports goes beyond only statistics, for example the GAIMME report emphasizes results of mathematical modelling.
- One expert commented that the ideas underpinning hypothesis testing and how significant events are within a data set could be included within the middle years to help learners begin to consider the ideas of significance of statistical results.

2.2.4.4 Suggested additional topic - Randomness and simulations

- This was raised in the pre-panel questionnaire both in the context of probability-based ideas, but also in terms of understanding that samples taken from the same population will vary. One expert cited understanding the inherent variability of samples taken from a population as a fundamental idea within statistics.
- Experts questioned whether the current framework promotes the intrinsic links between statistics and probabilistic models. The traditional approaches of calculations of probabilities based on equally likely events etc. is very different to the ways in which probabilities are derived in meaningful real-world situations. In part this links to the use of technology to be able to deal with large data sets – it is now easier to actually use a full data set than to need to impose a theoretical model upon it to be able to analyse it.
- One expert commented in the pre-panel questionnaire about the need for learners to have opportunities to engage with technology-based simulations, such as the Monte-Carlo simulation, as a way to develop a meaningful understanding of statistical concepts.

2.2.5 Suggested additional topic - combinatorics

- Permutations and combinations were raised by one expert in the pre-panel questionnaire as a possible additional topic for inclusion within the branch. This also links to the fundamental ideas of counting systems within the number branch.

2.2.6 Cross-branch Issues

2.2.6.1 Sets and Venn diagrams

- The links between using sets and Venn diagrams to solve probability problems is not explicit in the current framework.
- A question was raised by an IB practitioner about the level of depth of learning expected as provided by the current framework. Additional guidance of skills such as the union or intersection of sets could help provide more support to this topic.

2.2.6.2 Exponents

- Experts highlighted an apparent mis-match between the challenge levels of this topic within the Number and the Algebra branches.
- This potentially also highlights a need for practitioners to consider how to help learners consider algebra as generalised form of number. The topics and skills within the current framework may not make this explicit.

2.2.6.3 Similarity and congruence, transformations and proportionality

- These themes span the Number, Algebra and Geometry and trigonometry branches and are a rich source of the inter-connections of mathematical ideas. If these topics are approached in isolation, there may be a lack of opportunity for students to appreciate these connections, which may impact on the depth of their learning.
- The experts felt this was a key area in which the current lists of topics and skills within each branch did not support this richness of learning.
- One expert cited example of the congruence of sine and cosine curves and the similarity of quadratic functions and exponential functions. Beyond the middle years there are powerful ideas that connect these concepts together, and there is a need to embed some of the initial conceptual development within the middle years.

2.2.6.4 Discrete mathematics

- Some experts felt that there was still a possible role for including discrete mathematics as an additional fifth branch, with careful thought about what should be included.
- If it were to be reintroduced, thought would need to be given as to what it may lead on to, both within and outside of the IB system, in order to promote the development of cohesive courses.
- A section on logic may be beneficial as it underpins a lot of mathematical thinking. One expert commented that there is a significant section on logic in Mathematical Studies at DP and so this would be supportive. It was noted that is something with which students often struggle.

- Expert views were divided on whether networks and path problems were relevant. One expert felt they serve a good purpose to help learners learn about mathematics and appreciate that mathematics is more than just numbers and algebra and to help understand the historical development of mathematical ideas. Others felt this aspect may not be an essential part of a middle years mathematics course when considering the longer-term needs of learners.
- Some aspects of discrete mathematics may be sensible to embed into other branches if they support the learning within those branches, e.g. combinatorics as a support for probability. One expert commented that this may be a more appropriate way to re-introduce relevant discrete mathematics ideas that are relevant to the middle years to promote richness and inter-connection of ideas.
- If discrete mathematics is re-introduced as a fifth branch, care would need to be taken so that the guidance does not come across to practitioners as just another list of things to teach with no intrinsic reason why it was considered important within the bigger picture of mathematical development.
- *(NFER note: we will use this initial short discussion from the expert panel to frame a more comprehensive discussion to take place with Professor Peter Sullivan).*

2.3 General comments about the Mathematics Guide / Framework

- The IB practitioners commented that teachers are not always using the guide as intended and seek out the topic lists, overlooking the rest of the Mathematics Guide. The intrinsic freedom of the IB philosophy to allow a school to structure its own curriculum according to its own needs was welcomed, however concern was raised that the practice may not always reflect the ideology.
- During the panel discussions, there were many instances in which the comments made suggested the current wording of the topics / skills tends to be more open to a procedural interpretation rather than a conceptual one. In addition, questions were raised whether the framework supports practitioners in helping learners develop their own understanding of mathematical language.
- The experts agreed that the current structure does not promote the depth of the links between areas of mathematics. Whilst they experts understood the need for the framework to fit into the bigger picture of the other IB MYP subject guides, there was agreement that the design issue of topic lists by branch is potentially detrimental to the development of a rich curriculum.
- The experts agreed that the layout of the current framework does not support viewing mathematical learning holistically. This point was alluded to in many of the branch-specific discussions, and the experts also agreed when asked the question explicitly. The experts agreed that practitioners were likely to work their

way through the topics as a list and to treat each one in isolation rather than looking for the connections between them, and a big part of this may be down to the actual design of the framework. Although the experts understood that the framework is part of the overall Mathematics Guide and is accompanied by a bigger professional development programme, overall the documentation was considered to cumbersome for practioners to use.

- An interesting point that was raised for several topics is that they felt somewhat stand-alone and were taught in isolation for completeness sake if a school deemed it necessary to cover all topics within the framework. These comments suggest that the layout of the current framework may be lending itself to practitioners viewing topics in isolation as opposed to making links and connections between topics and mathematical concepts when structuring their own curriculums.
- One expert commented that in the development of the US Common Core State Standards there was considerable discussion whether the ideas of 'standards for mathematical processes' and 'standards for mathematical content' should be split up or embedded together. The danger of presenting lists / tables of content is that all the other preceding information will be overlooked.
- The examples presented on pages 16 and 17 of the Mathematics Guide were commented on positively as a way to link the content to the general principles and a question was raised by one expert that there could be scope to present the full content in this way, with the framework acting more as a check-list. There was a sense that further guidance is needed to support practioners to do this effectively, both within the written documentation and within the wider IB support programmes. At the very least having these as a starting point, supported by resources, may promote the IB philosophies. There is a real time pressure upon practioners that may mean the desired IB approaches are not being embraced in reality.
- A priority for consideration within the framework is how to provide additional structure to support practitioners in planning for appropriate progression in learning. Linked to this, guidance on the complexity levels of skills would also be more supportive. A matrix design or an on-line framework providing links could help develop the level of guidance, the richness of support and a more holistic approach to planning for mathematical learning. One expert praised the Australian ACARA framework and the New Zealand curriculum as exemplary formats to support planning.
- As a caveat to any possible redesign, it was commented that if any lists of indicative content are produced, this may mean that the associated rich supporting text is likely to be overlooked by busy practitioners.

2.4 Pre-panel questionnaire results

Prior to the Expert Panel, each expert was asked to complete a pre-panel questionnaire.

The experts were asked to state whether they felt the current topics /skills were appropriate for middle years learners, and if so at what challenge level. Experts were also provided the opportunity to add brief comments and to suggest any other topics /skills that may be appropriate within each branch. These pre-panel comments helped NFER focus the discussion points within the panel.

A summary of the pre-panel responses is provided in this appendix.

Number – Topics	Current challenge level	Not appropriate (N)	Appropriate for 'Standard and extended mathematics' (S&E)	Appropriate for 'extended mathematics' (E)	Comments
Forms of numbers and Number systems	S&E	0	4	0	Emphasis on integers in early stages, no imaginary numbers in MYP These are two different ideas and should be separated.
Sets and Venn diagrams	S&E	0	4	0	Too restrictive, include networks and hierarchies, do union and intersection but delete their properties.
The four number operations	S&E	0	4	0	As applied to all number systems taught
Prime numbers and factors	S&E	1	3	0	
Number lines	S&E	0	4	0	
Estimation	S&E	0	4	0	Vague – but estimation as it applies to all topics taught at each respective level, yes
Units of measurement	S&E	0	4	0	

Ratio, percentage; direct and inverse proportion	S&E	0	4	0	
Number sequences	S&E	0	4	0	
Integer exponents	S&E	0	4	0	
Fractional exponents	E	1	1	2	
Logarithms	E	1	0	3	
Number bases	E	1	1	2	In my experience, this gets taught as a quick stand-alone topic to fulfil framework requirements, and is quickly forgotten as it is difficult to make real-world connections in the MYP level. This was the case with matrices which were since removed from the framework.

Priorities for development – Number

Topic	**Brief notes**	
Ratio, percentage, direct and inverse proportion	Teachers need more structured guidance on this topic in regards to levelling out some skills across the different MYP years.	
Number lines	What should the breath of this topic be?	
Sets and Venn diagrams	Depth in which MYP teachers should teach this section.	
Calculator use	How calculators represent numbers, use for very large and very small numbers, using calculators for complicated calculations, estimation	

Real exponents	To adequately describe exponential growth and the binary operation of exponentiation (powering)	
The four number operations	Use of technology appropriate to the complexity of the operation.	
Number bases	For the construction of counting systems at Standard, not operations using different bases.	
Ratio, percentage, proportion	The construction of mental imagery for proportion and the relationship between the representations of ratio, fractions, decimals and equations	

Additional topics for possible inclusion within Number branch		
Topic	**Challenge level**	**Brief notes**
Radicals/surds – simplification and the 4 operations	S&E level	
Rationalizing the denominator	E level	
Matrices	E	Important as data storage; representations of transformations and geometric figures
Accuracy and error	S&E	For continuous variables, an appreciation of the accuracy that a given number is presented with and the potential variability in their value as a result of this imprecision. Extended only—Error propagation in simple calculations.

Algebra - Topics	Current challenge level	N	S&E	E	Comments
Add, subtract, multiply and divide algebraic terms	S&E	0	4	0	How complex? Do terms include polynomials?
Factorization of algebraic expressions	S&E	0	3	0	Why factor quadratics?
Substitution	S&E	0	4	0	
Rearranging algebraic expressions	S&E	0	4	0	
Algebraic fractions	S&E	0	3	1	First degree – 2nd degree extended How complex? E for expressions with polynomials in numerator and denominator?
Integer and fractional exponents	S&E	0	2	2	Only E under Number
Patterns and sequences	S&E	0	4	0	
Algorithms	S&E	0	4	0	
Functions (types, domain and range, transformations)	S&E	0	4	0	
Equations (linear, quadratic, simultaneous)	S&E	0	4	0	
Inequalities	S&E	0	4	0	E (linear)
Logarithms with different base number	E	1	0	3	

Functions and graphs (sine, cosine, log and rational)	E	0	2	2	S&E for sine and cosine S&E sine, cosine
Inequalities	E	0	1	3	
Transformations of functions	E	0	1	3	more advanced
Arithmetic and geometric series	E	0	1	3	Interesting that sequences are listed in Number and series in Algebra S&E for discrete forms of linear and exponential functions

Priorities for development – Algebra	
Topic	**Brief notes**
Arithmetic and geometric series	This topic links in well with criterion B; however, teachers would need to take their students mathematical ability into account.
Equations (linear, quadratic, simultaneous)	Teachers need more structured guidance on this topic in regards to levelling out some skills across the different MYP years.
Functions (types, domain and range, transformations)	Teachers need more structured guidance on this topic in regards to levelling out some skills across the different MYP years.
Graphs of functions	Graphs are sets of points with geometric properties such as being congruent or similar
CAS	Using CAS to show that expressions are equivalent, to factor, to approximate solutions to equations
Algorithms	Not just how to follow a sequence of instructions but how to formulate, verify and critique an algorithmic solution.

Additional topics for possible inclusion within Algebra branch		
Topic	**Challenge level**	**Brief notes**
Inverse functions	E	Worth discussing at the extended level but not an essential addition
Mathematical modelling	S&E	General notions; patterns that lead to specific classes of functions. See GAIMME (2016) report (downloadable from http://www.comap.com/Free/GAIMME/index.html).
Using algebra to solve problems.	S&E	Getting away from pen and paper manipulation of algebra to forming correct models of real life and implementing with code or computer-based algebra.

Geometry and trigonometry – Topic	Current challenge level	N	S&E	E	Comments
Geometrical elements and their classification	S&E	0	4	0	
Distance	S&E	0	4	0	
Angle properties	S&E	0	4	0	
Triangle properties	S&E	0	4	0	
Perimeter / Area / Volume	S&E	0	4	0	
The Cartesian Plane	S&E	0	4	0	
Trigonometric ratios in right angled triangle	S&E	0	4	0	
Simple transformations, including isometric transformations	S&E	0	4	0	Better language is “isometries” (replace enlarging as in the framework with a better term)
Circle geometry	S&E	1	2	1	
Three-dimensional co-ordinate geometry	E	1	1	2	
Similarity and congruence	E	0	3	1	
Vectors and vector spaces	E	1	0	3	Vectors yes, vector spaces not at this stage
Sine and cosine rules	E	0	2	2	S&E and tangents
Angle measures	E	0	0	3	
The unit circle	E	0	0	4	

Priorities for development – Geometry and trigonometry	
Topic	**Brief notes**
Transformations	Should include the operation of composition, composite of two reflections is a rotation or translation; relationship of all this to congruence and to similarity
Polygons	Definition, classification by number of sides, dissection into triangles, angle-sum theorems
Polar coordinates	For S&E, the use of different coordinate systems including reasons for the choice of one over another.
Angle properties	Emphasis of the mental imagery of movement of the lines and angles and problem solving, rather than memorising the names of types of angle relationship (i.e. be able to explain how a line that intersects a pair of parallel lines makes sets of angles and how they are related rather than know the names alternate, corresponding etc.)

Additional topics for possible inclusion within Geometry and trigonometry branch		
Topic	**Challenge level**	**Brief notes**
Functions and their transformations	S&E	Noted in Algebra section, but worth noting in geometry as well, to imply drawing functions and their transformations (and possibly inverses for extended) on a Cartesian plane as opposed to manipulating them algebraically. Standard – linear and quadratic, Extended – also exponential, logarithmic, sine and cosine
Geometric Constructions	S& E	Helps students truly understand : Geometrical elements and their classification
Symmetry		Reflection and rotation symmetry in terms of transformations, applications both synthetically and analytically (on coordinate graphs).
Tessellations		Construction, relation to congruence and isometries, uses in tilings, architecture, space filling
Specification of location, degrees of freedom, loci.	S&E	How to specify the location of a point in 2D and 3D space and the implications of under specification. Loci as the appreciation of degrees of freedom.

Statistics and probability – Topic	**Current challenge level**	**N**	**S&E**	**E**	**Comments**
Graphical analysis and representation	S&E	0	4	0	

Population sampling	S&E	0	4	0	
Measures of central tendency / location	S&E	0	4	0	
Measures of dispersion	S&E	0	4	0	
Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	S&E	0	4	0	
Standard deviation	E	0	4	0	(S&E) Standard ought to learn to apply and interpret using calculators/computers, and Extended can learn to calculate manually in addition to this
Conditional probability	E	0	1	3	

Priorities for development – Statistics and probability

Topic	**Brief notes**
Standard deviation	This topic is in maths SL Studies; we should include some sort of introduction for Standard.
Distributions	The language of distributions – that one is finding statistics of a distribution; that the collection of relative frequencies in an experiment and the probabilities of simple events in a sample space are distributions whose values add to 1 (in the discrete case – the continuous case can wait until later study).
Randomness and variability	That samples taken from the same population vary – a fundamental idea in statistics
Judging and interpreting statistical claims	The GAISE report of the American Statistical Association is a resource to consult for everything in this topic area.
Probability of an event from data / probabilistic models.	Classical probability calculated from symmetry dominates the school curriculum but is virtually non-existent in real-life. A link to statistics and how probabilistic models can be built from data is vital. Link to Monte-Carlo comment below.

Additional topics for possible inclusion within Statistics and probability branch

Topic	**Challenge level**	**Brief notes**
Normal distribution	E	

Z-Scores	E	
Scatter Diagrams	S&E	Introduce students to scatter diagrams were We can start talking about outliers. This will help bulb on vocabulary for DP
Permutations	S&E	Fundamental in counting and calculating probabilities
Combinations	E	Also fundamental, but more advanced than permutations
Games of Chance/Lotteries	E	Importance of randomness, ability to calculate the odds of winning
Hypothesis testing	E	Setting up of a hypothesis. Using computer-based systems to calculate p-values. Interpreting the results.
Monte-Carlo simulations	E	Building computer-based simulations to generate probability distributions

3 Part 2 – Additional expert discussion

3.1 Breadth, depth and fitness-for-purpose of the current Mathematics Guide

3.1.1 What is important in terms of mathematical development for current and future middle years learners?

- The two key global trends in mathematics education at present are:
  - (1) how can we develop more student-focussed learning without sacrificing rigour or the capacity to explore the specialisms within mathematics
  - (2) collaborative approaches to ongoing teacher development – an understanding that there is a need for professional development linked to pedagogical approaches.
    - It is important to think about the nature of the mathematics we want students to be learning and to consider what enquiry means in the context of mathematics. From personal experience, IB schools have a very strong commitment to this agenda.
- It is important that the learner gets to make meaning of their learning, not for the teacher to make meaning for them. This is important to help the learner make meaning and develop understanding that fosters connections between domains and sub-domains.
- Open-ended and open-middle (only one 'answer' but many different methods to obtain it) tasks allow learners to make decisions about strategies and responses, which in turn can support them to search for commonalities and generalisations. This openness creates a sense of enquiry in mathematics learning.
- A sense of enquiry that allows learners more control of their learning may help promote richer learning and dispel negative attitudes. The importance of this can be challenging to get across in written curriculum documents.
- As well as applying mathematics to real world problems, learners should gain an appreciation of mathematics as a discipline in its own right, and enjoy the wonders of mathematical ideas e.g. of proving a result, or of the concept of infinity.
- An interesting issue to consider is whether learners should learn to think like a professional mathematician, who would often be likely to think only about a single problem in great depth. If we want learners to develop these skills we need to ask them questions that they don't know the answer to and time to explore the problem in multiple ways and learn from each other.

- One of the biggest criticisms of any mathematics curriculum is if it tries to cover too much too superficially. Making connections between ideas is vitally important. A standard approach often used in practice in developing programmes of learning is to teach one topic at a time. It is really important to ensure teachers help structure learning to allow students to see the whole picture. The nature of enquiry needs to build connections between the domains and develop interconnected ideas rather than just being a list of topics to deliver. The danger of superficial learning is that learners only develop temporary knowledge which then gets easily forgotten.

3.1.2 Breadth and depth and fitness-for-purpose– general discussion

- As a whole, the current IB MYP documents are user-friendly, comprehensive, accessible and well written. It is important that teachers understand that the Mathematics Skills Framework is only 'part of the story' – although the sections of the Mathematics Guide may look like separate documents teachers must see how they relate to each other as a whole. Teachers do have to have a capacity to read the full documents – the way they use the documentation may depend on whether they have a constructivist or didactic approach to teaching.
- Whilst there is clearly a need to prepare learners for DP courses, it is imperative that MYP should allow learners to develop skills from PYP in a way that makes them real to their lives. Learners should engage with problems from the real world in a meaningful way – they should learn to apply a mathematics lens to social issues.
- The written documentation may benefit from revising to more clearly indicate that teachers should be using the information to support their own their own decisions about what is 'right' for their learners and to satisfy their own cultural needs.
- The documentation would benefit from further exemplification of embedding mathematical learning within meaningful real-life settings. As an example, there is just as much scope to embed the learning of proportional reasoning within the context of migration / population comparisons as there is in rates of change. It is a challenge to find a way to embed this into written curriculum documents - examples can be really helpful to teachers.
- As a metaphor to help teachers connect the framework with the overall Mathematics Guide / MYP philosophies, the content in the framework can be viewed as the nouns in our sentences, and the wider information in the guide (conceptual learning, fluency, reasoning, problem-solving etc.) as the verbs. Traditionally the nouns may have driven curriculum design, but perhaps the verbs should be the driving force in the future.

3.1.3 The use of digital technologies

- The role of digital technology is not all that well specified in the current documentation.

3.1.4 Practicalities of implementing the MYP

- Intrinsic to developing depth of learning is allowing sufficient time to explore topics. This may mean that not every topic can be taught in each school year, but perhaps systems such as a double-year cyclical system allows for greater depth of learning in the longer-term. There may be a big question as to whether this is something that can work in schools in practice.
- The use of the different challenge levels is a sensible way to delineate content. It is perhaps right, and likely to be an expectation of many IB schools and communities, that some more-able students will want opportunities to develop a more in-depth and specialist knowledge. Within this, however, there is some sense in which all learners may benefit from some understanding of many topics currently listed in the extended only content. Structuring learning activities that have a low floor and a high ceiling can give more students more access to more topics.
- There may be some inconsistencies across mathematical communities in terms of what middle years learning should look like. Universities and some current thinking may be more strongly promoting schools to deliver mathematics learning in a more topic-by-topic approach rather than a holistic manner. In this sense there is discord between the ideals of many written curriculum documents and what is actually being promoted in practice.

3.2 Breadth, depth and fitness for purpose by branch of the framework

In addition to the more general discussions summarised in Section 2, more detailed discussions were held to consider each branch of the current framework. These discussions were supported by the feedback provided via the pre-panel questionnaire and some specific issues raised by NFER from our initial curriculum comparison work. Some discussion points spanned two or more of the branches, and are presented in Section 3.5 Cross-branch Issues. A summary of the pre-panel questionnaire results is provided as an appendix to this report.

3.2.1 Number

3.2.1.1 Ratio and proportion

- Multiplicative relationships and the concept of sharing are fundamental ideas of mathematics. Number as applied to social contexts and situations is almost entirely about ratios and patterns. The 'traditional' way this topic is addressed in textbooks etc is often more mundane and does not necessarily provide the generalizable techniques and powerful tools that learners need to be fluent in this topic area. These ideas are not only transferable across the world of mathematics but in everyday life too.
- This is a topic area in which teachers need to help learners connect ideas together rather than compartmentalising them to allow transfer of skills and deeper understanding about concepts.
- Some content that is often specified in mathematics curriculums does not really reflect real-life e.g. compound interest, which works mathematically as an iterative process based on exponential growth iterative process, but does not reflect modern life in which interest is often linked to repayments. The mathematics behind this may involve use of more complex formulae, but, supported by technology, could provide more scope to develop deeper and more meaningful connections.

3.2.1.2 Exponential growth

- In developing the Australian curriculum, there was discussion whether exponentiation should precede quadratic functions as there may be many more realistic contexts that can be modelled by exponential functions. This is certainly an appropriate topic for consideration for inclusion in the upper middle years curriculum.

3.2.1.3 Logarithms

- Understanding transforming functions and transforming axes is a powerful tool, in terms of real-life modelling, however this is more suitable for . Diploma level mathematics courses.

- Any topic in which the learning is introduced as superficial 'learn these rules' rather than at a deeper conceptual level can be counter-productive longer term in terms of promoting a deeper understanding. In this regard it may be more sensible to leave introducing this topic until logarithms are used in a more general sense.

3.2.1.4 Limits of accuracy / error analysis

- This is an important idea in middle years but is perhaps under-emphasised in the current written guidance.
- It again aligns with proportionality and the idea of measurement and units.

3.2.2 Algebra

3.2.2.1 Should Number and Algebra be combined as a single branch?

- In Australia, Number and Algebra are together. The rationale for this is that in the primary years there is a significant amount of number work that is algebraic in nature. Equally in the middle years there are algebraic concepts that can often be best introduced and understood through number work (e.g. the associative, commutative and distributive laws).
- Making connections between different ways to think algebraically is an important part of mathematical fluency.

3.2.2.2 Levels of demand throughout the middle years

- Teacher should provide learners with opportunities to think about similar ideas in different ways and not just do 'more of the same'
- It is only in making connections between different representations that students will come to understand the underlying abstractions that support algebraic understanding and fluency.
- The richness of algebra comes from engaging students in actually thinking about what is going on. Rather than learning lists of isolated rules.

3.2.2.3 Functions

- The IB approach to this topic seems to allow for a stronger understanding of the idea of transformations, and in particular of translating the axes, than other curriculums.
- Equations of circles is suitable within middle years within this topic as a whole.

3.2.2.4 Computer algebra packages

- There is scope for use of computer algebra packages to act as a tool; however there is actually a need for some level of algebraic understanding to support the syntax requirements of using technology (e.g. knowing how to structure a formula to be able to use a spreadsheet).

3.2.3 Geometry and trigonometry

3.2.3.1 Vectors and vector space

- This could be removed within MYP – with sufficient grounding in understanding of co-ordinate geometry, learners would be able to pick up on this topic post-middle years if / when needed.

3.2.3.2 Constructions

- This could be worth including – students can find it engaging and interesting.

3.2.3.3 Nets, 2D / 3D shapes

- Nets of shapes and properties shapes seems generally more appropriate for primary years.

3.2.4 Statistics and probability

3.2.4.1 The role of statistics

- The statistics aspects seem 'dullish' in the way they are written.
- Statistics has a central part in our understanding of the world mathematically. Certainly it is a key part of the mathematical future in Australia, to the extent that there was consideration of referring to the school subject as 'Mathematics and Statistics' rather than only mathematics.
- Statistics may be considerably more accessible to a wider range of students than other aspects of mathematics e.g. algebra.

3.2.4.2 Distributions and trends

- There are some very powerful statistical tools (e.g. Tinker Plots) that can be used to allow learners to generate distributions and make statistical inference about trends etc.
- The concept of the sampling distribution is complex so this idea, and even implied confidence intervals, is best left until beyond middle years.
- The ideas of expectation and observation, as a pre-requisite to more complex ideas, is perhaps under emphasised within the middle years.

3.2.5 Cross-branch Issues

3.2.5.1 Sets and Venn diagrams

- This is currently specified in Number, but may be more appropriate embedded within Statistics and probability – these are powerful tools within the context of probability, and may be better placed in this branch.

3.2.5.2 Discrete mathematics

- This branch is appropriate to leave until post-middle years without any significant detriment. Promoting breadth and depth within other branches means something has to be left out.
- Where there are topics that are relevant to middle years, these should be embedded into other branches e.g. in within Statistics and probability, beginning to consider the underlying ideas of combinations / permutations (e.g. Cartesian products) is important within middle years.

3.3 Pre-discussion questionnaire results

Number – Topics	Current challenge level	Not appropriate (N) Appropriate for 'Standard and extended mathematics' (S&E) Appropriate for 'extended mathematics' (E)
Forms of numbers and Number systems	S&E	S&E
Sets and Venn diagrams	S&E	S&E
The four number operations	S&E	S&E
Prime numbers and factors	S&E	S&E
Number lines	S&E	S&E
Estimation	S&E	S&E
Units of measurement	S&E	S&E
Ratio, percentage; direct and inverse proportion	S&E	S&E
Number sequences	S&E	S&E
Integer exponents	S&E	S&E
Fractional exponents	E	E
Logarithms	E	E
Number bases	E	E

Priorities for development – Number		
Order	**Topic**	**Brief notes**
1	Sets and Venn diagrams	Actually I think that this should be in probability rather than number, but it is a wonderful topic for exploring the world, and also those aspects of probability that seem under treated in the documents
2	Ratios etc	I am assuming you meant topics above (rather than different ones). In the case of ratio, there is no more important topic in applying mathematics to describe and understand the world. For example, there are many inquiries suitable for MYP levels that explore personal choices related to sustainability

Algebra - Topics	**Current challenge level**	**Not appropriate (N) Appropriate for 'Standard and extended mathematics' (S&E) Appropriate for 'extended mathematics' (E)**
Add, subtract, multiply and divide algebraic terms	S&E	S&E
Factorization of algebraic expressions	S&E	S&E
Substitution	S&E	S&E
Rearranging algebraic expressions	S&E	S&E
Algebraic fractions	S&E	S&E
Integer and fractional exponents	S&E	S&E
Patterns and sequences	S&E	S&E
Algorithms	S&E	S&E
Functions (types, domain and range, transformations)	S&E	S&E
Equations (linear, quadratic, simultaneous)	S&E	S&E
Inequalities	S&E	S&E
Logarithms with different base number	E	E
Functions and graphs (sine, cosine, log and rational)	E	S&E
Inequalities	E	????
Transformations of functions	E	S&E
Arithmetic and geometric series	E	S&E

Priorities for development – Algebra		
Order	Topic	Brief notes
1		It is hard to answer this question (without much more detailed study of the documents) but the issue for me in algebra is about connections between different representations. Building the connections between equations, tables, graphs, descriptions etc is critical. The documents seem to make these look like independent topics.

Geometry and trigonometry – Topic	Current challenge level	Not appropriate (N) Appropriate for 'Standard and extended mathematics' (S&E) Appropriate for 'extended mathematics' (E)
Geometrical elements and their classification	S&E	S&E
Distance	S&E	S&E
Angle properties	S&E	S&E
Triangle properties	S&E	S&E
Perimeter / Area / Volume	S&E	S&E
The Cartesian Plane	S&E	S&E
Trigonometric ratios in right angled triangles	S&E	S&E
Simple transformations, including isometric transformations	S&E	S&E
Circle geometry	S&E	S&E
Three-dimensional co-ordinate geometry	E	S&E
Similarity and congruence	E	S&E
Vectors and vector spaces	E	E
Sine and cosine rules	E	E
Angle measures	E	S&E
The unit circle	E	S&E

Priorities for development – Geometry and trigonometry		
Order	Topic	Brief notes
1		Again it is the connections between ideas, and between the ideas and the world that need development.

Statistics and probability – Topic	**Current challenge level**	**Not appropriate (N)** **Appropriate for 'Standard and extended mathematics' (S&E)** **Appropriate for 'extended mathematics' (E)**
Graphical analysis and representation	S&E	S&E
Population sampling	S&E	S&E
Measures of central tendency / location	S&E	S&E
Measures of dispersion	S&E	S&E
Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	S&E	S&E
Standard deviation	E	S&E
Conditional probability	E	S&E

Priorities for development – Statistics and probability		
Order	Topic	Brief notes
1		I would have Venn diagrams here.
2		While conditional probability is more difficult, there are many "problems" that are really conditional but which can be solved by reasoned argument that are suitable for all learners.

3.4 Post-discussion feedback on additional topics

Evaluation of the IB MYP Mathematics Skills Framework

Expert panel follow up questions for Professor Peter Sullivan

1. These topics / skills are in the 'Standard and extended' challenge level guidance but do not appear explicitly within the majority of other middle years curriculums / systems within our comparison work
   Do you think these are appropriate / useful / relevant topics for all middle years students to learn about?

Topic / skill	Branch	Comment
Multiplicative relationships / unit rates	Number	The concept of proportionality is a fundamental one that spans across many other mathematical ideas. This concept is often poorly treated in curriculums / text books. Number as applied to social contexts/situations is almost entirely about ratios and patterns.
Inequalities / solving and graphing linear inequalities / linear programming	Algebra	There are real world applications that use inequalities and linear programming so my view is that it is accessible for all students.
Functions – domain and range	Algebra	This is more like preparation for higher mathematics as can be left to the enrichment stream.
Algorithms / analysing and using well-defined procedures for solving complex problems	Algebra	When done formally, this can be left to the enrichment strand students

2. These topics / skills are in the 'Extended' challenge level guidance but do not appear explicitly within the other middle years curriculums / systems within our comparison work
   Do you think these are appropriate / useful / relevant topics for the most able middle years students to learn about or may they be better left until post-middle years study?

Topic / skill	Branch	Comment
Number bases / performing operations in different number bases	Number	When done formally, this can be left to the extended/challenge level students
Logarithms / Evaluating logarithms (N) and using laws of logarithms (A)	Number / Algebra	Not a critical topic. Opportunity to develop concept of translating the axes / transforming functions and link to exploring exponential functions.
Arithmetic and geometric series / finding the sum of the series, including the infinite series	Algebra	When done formally, this can be left to the extended/challenge level students
Trigonometric identities / using simple identities to simplify expressions and solve equations in interval [0°, 360°]	Geometry and trigonometry	When done formally, this can be left to the extended/challenge level students
Angle measure / converting between degrees and radians	Geometry and trigonometry	This is useful and can be accessible for all students.
Vector spaces	Geometry and trigonometry	This could be removed from MYP and introduced in DP courses without any significant detriment to learning.

3. These topics / skills occur in some other middle years curriculums / systems at a level that all students would be likely to engage with. These topics. /skills are not explicitly stated in the IBMYP.

Do you think they are implicit within the IB MYP framework guidance, and also are they appropriate / useful / relevant to middle years learners?

Topic / skill	Comment
Financial capability e.g. best buys, interest, unit pricing	This is useful and can be accessible for all students
Distance-time graphs	This is useful and can be accessible for all students
Constructions using ruler and compass e.g. perpendicular bisectors	Worth including – a topic that weaker students can often enjoy / succeed with. *NFER question to Peter – in main expert panel, comments were made that constructions can allow for a lot of deductive geometry learning. What are your thoughts on using constructions as a way to allow students to develop conceptual understanding of geometrical facts / relationships?* I agree with the views of the panel.
Loci	
Bearings	This is in Australian primary programme – important as an application of angles.
2D/ 3D representation and nets of shapes	In PYP
Scale drawings and map scales	This is useful and can be accessible for all students
Systematic listing strategies	Sensible for MYP to include work on ideas of Cartesian pairs. A more formal understanding of combinations / permutations is beyond MYP but the underlying ideas could be developed in MYP.

4. These topics / skills occur in some other middle years curriculums / systems for more able students... These topics. /skills are not explicitly stated in the IBMYP.
   Do you think these are implicit in the IB MYP framework, and also are they appropriate / useful / relevant topics for the most able middle years students to learn about or may they be better left until post-middle years study?

Topic / skill	Comment
Limits of accuracy / upper and lower bounds	Probably under-emphasised in framework and agree that this is important to know about. Concept of errors / relative errors important within measuring and also aligns to concepts of proportionality.
Equation of a circle with centre at the origin; equation of tangent to a circle	Equations of circles / graphing is something that middle years students can understand. Not an 'essential' topic for middle years, but scope to include as 'optional' content for completeness of learning.
Iterative processes	This is useful and can be accessible for all students
Factor / remainder theorems	This is for the extension/ challenge students
Estimating gradients of curves via use of tangents /	This is for the extension/ challenge students
Estimating areas under curves	This is for the extension/ challenge students
Matrices	This is for the extension/ challenge students
Logic	Low priority for MYP – adding more topics /breadth could be detrimental to dept of learning elsewhere.

Evidence for Excellence in Education

Descriptive Statistics Appendix B

Evaluation of the IB Middle Years Programme Mathematics Skills Framework

National Foundation for Educational Research (NFER)

Appendix B Descriptive Statistics

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1. Descriptive Statistics Questionnaire – general planning

Descriptive statistics for Section 2 of the Teacher Questionnaire

This appendix provides descriptive statistics for questions in section 2 of the teacher questionnaire where teachers were asked how they use the MYP Mathematics guide to plan courses and learning in their schools. A 6 point likert scale was used to indicate agreement to various statements; 1 indicates strong agreement and 6 indicates strong disagreement.

The data is presented in themes, as in the questionnaire design. Two sets of descriptive statistics are provided for each theme:

- The first table provides the number of responses (N), the mean rating and the standard deviation of the ratings.
- The second table provides the percentage of responses for each rating. Additonally, cumulative ratings are provided in two ways:

  Agree (1-3) and Disagree (4-6) – these are the combined percentages for ratings 1, 2 and 3 which indicate agreement at some level and 4, 5 and 6 which indicate disagreement at some level.

  Agree (1 & 2) and Disagree (5 & 6) -these are the combined percentages for ratings 1 and 2 which indicate a stronger level of agreement and 4 and 6 which indicate a stronger level of disagreement.

Questions about the Mathematics Guide (Tables B1-1 & B1-2)

Teachers were asked the extent to which they agreed with a series of statements about the MYP Mathematics Guide. Mean responses are based on the 6 point rating scale used for agreement. A rating of 1 indicates strong agreement with the statement and a rating of 6 indicates strong disagreement. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates agreement, whereas a rating of 4, 5, or 6 indicates disagreement. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated.

As you can see in table B1-1 respondents indicated agreement with these statements. Planning and guidance (Q2_2D & Q2_2 G) were right on the edge of agreement and disagreement however with means of 3.03 and 3.01 respectively.

Table B1-1 Mathematics Guide Questions Mean Responses

Survey Questions		N	Mean	Std. Deviation
Q2_2A	The Mathematics Guide in its current form is a useful planning tool	596	2.60	1.311
Q2_2B	The 'Aims and Objectives' on pages 7 to 9 allow me to plan for effective mathematics learning across the middle years	593	2.65	1.224
Q2_2C	The 'Aims and Objectives' specified on pages 7 to 9 provide learners with appropriate mathematical development across the middle years.	589	2.60	1.182
Q2_2D	The 'Planning the mathematics curriculum' examples on pages 16 and 17 provide sufficient support to allow me to plan other similar cross-year learning programmes.	592	3.03	1.280
Q2_2E	The 'Statements of inquiry' and 'Inquiry questions' examples on pages 20 to 23 provide sufficient support to allow me to develop my own examples.	593	2.96	1.345
Q2_2F	The guidance in the Mathematics Guide allows me to plan cohesive programmes of study for each year group within the middle years.	580	2.73	1.207
Q2_2G	The guidance in the Mathematics Guide allows me to plan appropriate courses that cater for students of different ability levels.	580	3.01	1.254
Q2_2H	When planning a mathematics course in my school, I am more likely to initially consider the topics and skills in the Mathematics Skills Framework than the wider MYP philosophy.	578	2.56	1.223
Q2_2I	I am able to make connections between the 'Aims and Objectives' of the MYP and the subject content specified in the Mathematics Skills Framework.	581	2.56	1.120

Table B1-2 indicates cumulative percents of the likert scale ratings. For example, 22.8% of the 596 survey respondents who answered this question strongly agreed with the statement 'The Mathematics Guide in its current form is a useful planning

tool', whereas 8.4% indicated strong disagreement. Subsequent columns combined the ratings into overall agreements, i.e. percent of respondents who indicated either a 1,2, or 3 (Agreement), or a 4,5,6 (disagreement) on the likert scales. For example 78.4% of the respondants indicated an overall agreement that the guide is a useful planning tool. Finally NFER split the strongly agree or disagree ratings at the upper ends indicating 1 & 2, or 5 & 6 ratings. For example, 52% of survey respondents indicated strong agreement that the guide is a useful planning tool, whereas 10.9% indicated strong disagreement with this statement.

As can be seen, Q2_2D & Q2_2E which asked about examples in the guide showed the highest percent of disagreement with regards to statements of inquiry and planning sufficiency of support at 15 and 16 percent respectively. However overall respondents indicated high levels of agreement with regards to the MYP Mathematics Guide's sufficiency for planning and appropriate levelling.

Table B1-2: Mathematics Guide Questions Percent Responses & Cumulative Ratings

Survey Question	1 Agree strongly (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Disagree strongly (%)	1 Agree (1-3) (%)	2 Disagree (4-6) (%)	1 Agree (1 & 2) (%)	2 Disagree (5 & 6) (%)
Q2_2A	22.8	29.4	26.2	10.7	8.4	2.5	78.4	21.6	52.5	10.9
Q2_2B	16.2	36.3	26.1	11.8	7.4	2.2	78.6	21.4	52.5	9.6
Q2_2C	15.4	39.2	26.0	10.7	6.8	1.9	80.6	19.4	54.6	8.7
Q2_2D	9.6	28.0	31.8	15.2	11.3	4.1	69.4	30.6	76.6	15.4
Q2_2E	12.0	30.0	29.3	12.6	10.8	5.2	71.3	28.7	42.0	16.0
Q2_2F	13.3	35.5	27.8	13.4	7.9	2.1	76.6	23.4	48.8	10.0
Q2_2G	9.1	29.8	29.5	17.9	10.0	3.6	68.4	31.6	38.9	13.6
Q2_2H	16.4	42.0	22.8	9.5	6.2	2.9	81.3	18.7	58.4	9.1
Q2_2I	13.4	43.4	26.9	8.4	6.4	1.5	83.6	16.4	56.8	7.9

Questions about how well MYP Mathematics prepares learners for external assessments and future learning (Tables B2-1 and B2-2)

Teachers were asked the extent to which they agreed with the following statements about how well MYP Mathematics prepares learners for external assessments and future learning. Mean responses are based on the 6 point rating scale used for agreement. A rating of 1 indicates strong agreement with the statement and a rating of 6 indicates strong disagreement. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates agreement, whereas a rating of 4, 5, or 6 indicates disagreement. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated.

As you can see in table B2-1 respondents indicated middle level agreement with regards to the MYP Mathematics preparation for external assessments and further study at mean ratings of 2.8 and 2.39 respectively.

Table B2-1 MYP Mathematics Preparation Questions Mean Responses				
Survey Questions		N	Mean	Std. Deviation
Q2_3A	IB MYP Mathematics prepares students well for external assessments within the middle years (e.g. statutory state / national tests).	520	2.83	1.341
Q2_3B	IB MYP Mathematics prepares learners well for further study.	588	2.39	1.247

Table B2-2 indicates cumulative percents of the likert scale ratings to these two questions. For example, just 15.0% of the 520 survey respondents who responded to this item strongly agreed the course prepared students for external assessments, whereas 25.4% (of 588 respondents) strongly agreed that MYP Mathematics prepares students well for further study. Subsequent columns combined the ratings into overall agreements and disagreements, i.e. percent of respondents who indicated either a 1,2, or 3 (Agreement), or a 4,5,6 (disagreement) on the likert scales. For example 71.3% of the respondants indicated an overall agreement that the course prepared students for external assessments and 82.6% indicated MYP Mathematics prepares students well for further study. Finally NFER split the strongly agree or disagree ratings at the upper ends indicating 1 & 2, or 5 & 6 ratings. For example, 44.7% of survey respondents indicated strong agreement (rating 1 or 2) that the guide prepares students for external assessments, whereas 13.2% indicated stronger disagreement (5 & 6) with this statement.

Table B2-2: Mathematics Preparation Questions Percent Responses & Cumulative Rating										
Survey Question	1 Agree strongly (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Disagree strongly (%)	1 Agree (1-3) (%)	2 Disagree (4-6) (%)	1 Agree (1 & 2) (%)	2 Disagree (5 & 6) (%)
Q2_3A	15.0	32.7	23.7	15.4	9.0	4.2	71.3	28.7	47.7	13.2
Q2_3B	25.4	38.0	19.2	10.2	4.3	2.9	82.6	17.4	63.4	7.2

Questions about using the MYP Mathematics topics and skills to support planning (Tables B3-1 & B3-2)

Teachers were asked the extent to which they agreed with the following statements about how well MYP Mathematics prepares learners for external assessments and future learning. Mean responses are based on the 6 point rating scale used for agreement. A rating of 1 indicates strong agreement with the statement and a rating of 6 indicates strong disagreement. NFER established inferences from the six point

ratings; A rating of 1, 2, or 3 indicates agreement, whereas a rating of 4, 5, or 6 indicates disagreement. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated.

As you can see in table B3-1 respondents indicated middle level agreement (close to a mean of 3) with regards to the the topics and skills in each of the branches on a) their in- school use (breadth across the five years), b) framework allowance for planning and appropriate subject content, c) topic and skill inclusion in the branches as sufficient for planning effective mathematics learning.

Table B3-1 MYP Mathematics Topics and Skills Percent Responses & Cumulative Rating

Survey Questions		N	Mean	Std. Deviation
Q2_4A	Over the five years of MYP, my school includes all of the suggested topics and skills from across the four branches.	450	1.99	1.181
Q2_4B	The framework allows me to identify appropriate subject content for each year group.	574	2.44	1.151
Q2_4C	The framework allows me to plan for effective year-on-year progression.	573	2.52	1.167
Q2_4D	The topics and skills in the 'Number' branch provide me with enough information to plan for effective mathematics learning.	574	2.56	1.168
Q2_4E	The topics and skills in the 'Algebra' branch provide me with enough information to plan for effective mathematics learning.	575	2.55	1.173
Q2_4F	The topics and skills in the 'Geometry and trigonometry' branch provide me with enough information to plan for effective mathematics learning.	568	2.56	1.159
Q2_4G	The topics and skills in the 'Statistics and probability' branch provide me with enough information to plan for effective mathematics learning.	568	2.57	1.137
Q2_4H	When planning, it is easy to make links between topics and skills specified in different branches	570	2.62	1.129
Q2_4I	It is easy to embed the topics and skills into the wider IB MYP philosophies of learning (as specified in the full Mathematics Guide	570	2.82	1.159
Q2_4J	Overall, the content provides learners with sufficient mathematical knowledge for future learning in general.	567	2.32	1.071
Q2_4K	Overall, the 'Standard and extended mathematics' content prepares learners well for DP Standard Level courses.	452	2.34	1.186
Q2_4L	Overall, the 'Extended mathematics' content prepares learners well for DP Higher Level courses.	420	2.51	1.258

Table B3-2 indicates cumulative percents of the likert scale ratings to these questions. For example, 41.8% of the 450 survey respondents who responded to this item strongly agreed that over the five years of the MYP their school included all suggested topics and skills from across the four branches. Whereas only 14.0% of the 570 survey respondents who responded to this item, strongly agreed that it was easy to embed topics and skills into the wider IB MYP philosophies of learning (as specified in the full Mathematics guide). Subsequent columns combined the ratings

into overall agreements and disagreements, i.e. percent of respondents who indicated either a 1,2, or 3 (Agreement), or a 4,5,6 (disagreement) on the likert scales. For example of the four branches; Statistics and Probability as well as Geometry and Trigonometry had higher agreement levels for providing enough information to plan effective mathematics learning at 81.2% of respondents giving a rating of 1, 2, or 3, over the Number and Algebra branches at 79.6%.

Finally NFER split the strongly agree or disagree ratings at the upper ends indicating 1 & 2, or 5 & 6 ratings. For example, 64.6% of survey respondents indicated strong agreement (rating 1 or 2) that MYP Mathematics Standard and Extended Mathematics content prepares learners well for DP Standard level courses, whereas 58% of respondents indicated strong agreement for MYP preparation for DP Higher Level Mathematics Study.

Table B3-1 MYP Mathematics Topics and Skills Questions Mean Responses

Survey Question	1 Agree strongly (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Disagree strongly (%)	1 Agree (1-3) (%)	2 Disagree (4-6) (%)	1 Agree (1 & 2) (%)	2 Disagree (5 & 6) (%)
Q2_4A	41.8	36.7	10.2	5.8	3.6	2.0	88.7	11.3	78.5	5.6
Q2_4B	19.7	41.1	22.8	10.1	4.5	1.7	83.6	16.4	60.8	6.2
Q2_4C	19.0	36.0	27.4	10.8	5.1	1.7	82.4	17.6	55.0	6.8
Q2_4D	16.6	39.5	23.5	13.1	5.9	1.4	79.6	20.4	56.1	7.3
Q2_4E	17.7	37.9	24.2	13.0	5.7	1.4	79.8	20.2	55.6	7.1
Q2_4F	17.4	37.0	26.8	11.4	6.2	1.2	81.2	18.8	54.4	7.4
Q2_4G	16.4	37.7	27.1	11.6	6.3	0.9	81.2	18.8	54.1	7.2
Q2_4H	14.0	38.8	25.8	14.7	5.6	1.1	78.6	21.4	52.8	6.7
Q2_4I	10.5	31.9	33.7	14.6	7.0	2.3	76.1	23.9	42.4	9.3
Q2_4J	20.3	46.7	19.4	9.2	3.2	1.2	86.4	13.6	67.0	4.4
Q2_4K	24.6	40.0	21.9	6.6	4.4	2.4	86.5	13.5	64.6	6.8
Q2_4L	21.1	36.9	23.1	9.5	6.7	2.6	81.2	18.8	58.0	9.3

Questions about use of PYP documents to support MYP planning (Tables B4-1 and B4-2)

In Table B4-1 teachers were asked whether or not they used the'Mathematics in the Primary Years Programme Scope and Sequence' document to help plan their MYP courses. A rating of 1 indicates yes and a rating of 2 indicates no. Teachers were then asked the extent to which they agreed with the following statements. Mean responses are based on the 6 point rating scale used for agreement. A rating of 1 indicates strong agreement with the statement and a rating of 6 indicates strong disagreement. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates agreement, whereas a rating of 4, 5, or 6 indicates disagreement. N equals the number of respondents who completed this item in the questionnaire.

Please note that Q2_5A-G were only asked of respondents who indicated a 'yes'[1] response to using the PYP Mathematics scope and sequence document in their MYP Mathematics planning. Standard deviations are also indicated. As you can see in table B4-1 teachers and heads of school who responded to the survey indicated high levels of agreement (between 1 and 2) how well the PYP scope and sequence and MYP Mathematics guidance created sufficiency for vertical planning and student preparation.

Table B4-1 Use of PYP document for planning Question

Survey Questions		N	Mean	Std. Deviation
Q2_5	Do you use the 'Mathematics in the Primary Years Programme Scope and Sequence' document to help plan your MYP courses?	567	1.84	.364
Q2_5A	The guidance in the PYP scope and sequence document allows me to plan an appropriate course for Year 1 of MYP that builds successfully on the learning outcomes outlined in the PYP.	88	2.03	1.022
Q2_5B	The actual prior knowledge, understanding and outcomes of pre-MYP learners closely matches those outlined in the PYP.	87	2.20	.963
Q2_5C	The MYP 'Number' guidance builds successfully on the PYP 'Number' guidance.	87	2.03	.958
Q2_5D	The MYP 'Algebra' guidance builds successfully on the PYP 'Pattern and function' guidance.	85	2.06	.968
Q2_5E	The MYP 'Geometry and trigonometry' guidance builds successfully on the PYP 'Measurement' and 'Shape and space' guidance.	86	2.05	.932
Q2_5F	The MYP 'Statistics and probability' guidance builds successfully on the PYP 'Data-handling' guidance.	86	2.01	.952
Q2_5G	Mathematics Guides make it easy to plan across the age continuum.	86	2.12	.999

Table B4-2 indicates cumulative percents of the likert scale ratings to the respondents use of the PYP scope and sequence in their planning and it's alignment sufficiency for MYP. For example, 35.2% of the 88 survey respondents who responded to this item strongly agreed the PYP scope and sequence document allowed them to plan an appropriate course for MYP Mathematics year 1. Subsequent columns combined the ratings into overall agreements and disagreements, i.e. percent of respondents who indicated either a 1,2, or 3 (Agreement), or a 4,5,6 (disagreement) on the likert scales. For example between 91.8 and 92.% respondents indicated a 1,2, or 3 response of agreement that all four branches of the MYP Mathematics Skills Framework built sufficiently from PYP guidance. Finally NFER split the strongly agree or disagree ratings at the upper ends indicating 1 & 2, or 5 & 6 ratings. For example, 64.3% of survey respondents

[1] 18.5% of Head of School and 11.9% of teachers indicated yes to the use of the PYP scope and sequence in their planning. See Table 3.14 in the main report

indicated strong agreement (rating 1 or 2) that the actual prior knowledge, understanding and outcomes of pre-MYP learners closely matched those outlined in the PYP scope and sequence.

Table B4-2: Use of PYP documents to support MYP planning Questions Percent Responses & Cumulative Ratings

Survey Question	1 Agree strongly (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Disagree strongly (%)	1 Agree (1-3) (%)	2 Disagree (4-6) (%)	1 Agree (1 & 2) (%)	2 Disagree (5 & 6) (%)
Q2_5A	35.2	37.5	19.3	4.5	3.4	0.0	92.0	8.0	72.7	3.4
Q2_5B	26.4	37.9	26.4	8.0	1.1	0.0	90.8	9.2	64.3	1.1
Q2_5C	33.3	39.1	19.5	6.9	1.1	0.0	92.0	8.0	72.4	1.1
Q2_5D	32.9	37.6	21.2	7.1	1.2	0.0	91.8	8.2	70.5	1.2
Q2_5E	30.2	44.2	17.4	7.0	1.2	0.0	91.9	8.1	74.4	1.2
Q2_5F	33.7	40.7	17.4	7.0	1.2	0.0	91.9	8.1	74.4	1.2
Q2_5G	31.4	36.0	24.4	5.8	2.3	0.0	91.9	8.1	67.4	2.3

Questions about using DP documents to support MYP planning (Tables B5-1 & B5-2)

In Table B5-1 teachers were asked whether or not they used any of the DP Mathematics Guides to help plan their MYP courses. A rating of 1 indicates yes and a rating of 2 indicates no. Teachers were then asked the extent to which they agreed with the following statements. Mean responses are based on the 6 point rating scale used for agreement. A rating of 1 indicates strong agreement with the statement and a rating of 6 indicates strong disagreement. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates agreement, whereas a rating of 4, 5, or 6 indicates disagreement. N equals the number of respondents who completed this item in the questionnaire. Please note that Q2_6A-D were only asked of respondents who indicated a 'yes'[2] response to using DP Mathematics Guides in their MYP Mathematics planning. Standard deviations are also indicated .

As you can see in table B5-1 teachers and heads of school who responded to the survey indicated high levels of agreement (between 1 and 2) how well the MYP Mathematics guidance created sufficiency for vertical planning and student preparation for DP Mathematics study, although a slight discrepancy in agreement is

[2] 56.7% of Head of School and 42.6% of teachers indicated yes to the use of the PYP scope and sequence in their planning. See Table 3.14 in the main report.

indicated between DP Standard (2.39) or Higher Level (2.57) course preparation, indicating close to a 3, or on the edge of NFER's inference of agreement.

Table B5-1 Use of DP Mathematics Guides for planning Question				
Survey Questions		N	Mean	Std. Deviation
Q2_6	Do you use any of the DP Mathematics Guides to help plan your MYP courses?	565	1.49	.500
Q2_6A	The MYP 'Standard and extended' guidance provides a strong base for DP Standard Level courses.	286	2.39	1.149
Q2_6B	The MYP 'Extended' guidance provides a strong base for DP Higher Level courses.	278	2.57	1.243
Q2_6C	When planning courses for Years 4 and 5 of the MYP, the DP guidance is more helpful than the MYP guidance.	281	2.53	1.213
Q2_6D	Overall, the layouts and structures of the MYP Mathematics Guide and DP course guides make it easy to plan across the age continuum.	283	2.68	1.193

Table B5-2 indicates cumulative percents of the likert scale ratings to the respondents use of DP Mathematics in their planning and it's alignment sufficiency for MYP. For example, 35.2% of the 88 survey respondents who responded to this item strongly agreed the PYP scope and sequence document allowed them to plan an appropriate course for MYP Mathematics year 1. Subsequent columns combined the ratings into overall agreements and disagreements, i.e. percent of respondents who indicated either a 1,2, or 3 (Agreement), or a 4,5,6 (disagreement) on the likert scales. For example between 91.8 and 92.% respondents indicated a 1,2, or 3 response of agreement that all four branches of the MYP Mathematics Skills Framework built sufficiently from PYP guidance. Finally NFER split the strongly agree or disagree ratings at the upper ends indicating 1 & 2, or 5 & 6 ratings. For example, 64.3% of survey respondents indicated strong agreement (rating 1 or 2) that the actual prior knowledge, understanding and outcomes of pre-MYP learners closely matched those outlined in the PYP scope and sequence.

Table B5-2: Use of DP documents to support MYP planning Questions Percent Responses & Cumulative Ratings										
Survey Questions	1 Agree strongly (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Disagree strongly (%)	1 Agree (1-3) (%)	2 Disagree (4-6) (%)	1 Agree (1 & 2) (%)	2 Disagree (5 & 6) (%)
Q2_6A	22.0	38.8	24.8	8.7	3.5	2.1	85.7	14.3	60.8	5.6
Q2_6B	19.1	34.9	28.8	7.9	6.1	3.2	82.7	17.3	54.0	9.3

Q2_6C	20.3	35.6	24.6	11.7	6.0	1.8	80.4	19.6	55.9	7.8
Q2_6D	14.5	33.9	32.2	10.6	6.0	2.8	80.6	19.4	48.4	8.8

2. Descriptive Statistics Questionnaire – Details by branch

The next series of tables describe the results of the teacher questionnaire by branch of the MYP Mathematics Skills framework. For each branch eleven tables are given depicting teacher responses to their inclusion of a branch's topic and at which level; the sufficiency of guidance for a branch's topics to provide breadth of learning; the appropriateness of the topics inclusion in the MYP Mathematics framework, sufficiency of guidance for a branch's topics to provide depth of understanding, and the quality of the written guidance for a branch's topics.

Number

Number Branch Topic Inclusion and levels (Table B6)

Teachers were asked to indicate which topics and skills in the framework under the Number branch are included in their school's middle years mathematics courses, and whether they are delivered at the 'Standard and Extended' (S&E) challenge level or only the 'Extended' (E) challenge level. The Percentage of the survey participants (N=679) indicating inclusion and at what levels are shown in the Table B6[3]. As can be seen most Number topic and skills are included in school's mathematics courses. Although there are discrepencies. Notably, Sets and Venn diagrams, Fractional exponents, Logarithms, and Number bases seem to be included the least with over 10% of respondents indicating 'no' to the question; "Is this topic include in your mathematics courses?". In contrast 96% of respondents indicated they included Integer exponents, ratio, percentage; direct and inverse proportion in their courses. Fractional exponents, Logarithms, and number bases seem to be utilized frequently by schools at the 'extended' level although most topics and skills show broad use at both levels.

Table B6 Number Branch Topic Inclusion and Level Questions

Survey Question	MYP Mathematics Framework Topics	1 No (%)	2 Yes at S&E (%)	3 Yes at E only (%)
Q3_2A1	Forms of numbers and Number systems	3.6	93.5	2.9
Q3_2A2	Sets and Venn diagrams	11.7	79.6	8.8
Q3_2A3	The four number operations	1.4	94.9	3.6
Q3_2A4	Prime numbers and factors	2.2	94.9	2.9
Q3_2A5	Number lines	2.2	93.5	4.3

[3] A total of 679 practitioners in 279 schools completed the survey. 518 responded to the full questionnaire and 161 provided partial responses.

Q3_2A6	Estimation	3.6	93.5	2.9
Q3_2A7	Units of measurement	2.9	94.9	2.2
Q3_2A8	Ratio, percentage; direct and inverse proportion	1.4	96.4	2.2
Q3_2A9	Number sequences	6.5	87.0	6.5
Q3_2A10	Integer exponents	0.0	96.4	3.6
Q3_2A11	Fractional exponents	11.0	63.2	25.7
Q3_2A12	Logarithms	20.6	36.0	43.4
Q3_2A13	Number bases	16.3	50.4	33.3

Number branch topics and skill guidance for breadth of learning (Tables B7-1 and B7-2)

Teachers were asked the extent to which they agreed with a statement about the number branch's guidance sufficiency for breadth of learning provision. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated. As you can see in table B7 participants generally feel guidance is sufficient to provide breadth of learning in the Number branch.

Table B7-1 Number Branch Guidance for Breadth of Learning

Survey Question		N	Mean	Std. Deviation
Q3_2ai	Overall, to what extent do you think the current guidance for Number in the Mathematics Skills Framework provides sufficient breadth of learning?	138	2.62	1.148

Table B7-2 indicates cumulative percents of the likert scale ratings to the respondents of the guidance sufficiency for breadth of learning provision. Subsequent columns combine the ratings into overall sufficiencies i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 44.2% of the 138 survey respondents who responded to this item felt the number branch guidance gave a rating of 2. Additionally 79.0% of respondents indicated a 1,2, or 3 response of sufficiency with 56% of this group indicating 1 and 2). However over 20% felt guidance of the number branch was insufficient to provide breadth of learning although only 10% of this group felt guidance was strongly insufficient.

Table B7-2: Topic and Skills Sufficiency Questions Percent Responses & Cumulative Ratings										
	1 Fully sufficient (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient (%)	1 Sufficient (1-3) (%)	2 Not sufficient (4-6) (%)	1 Sufficient (1 & 2) (%)	2 Not Sufficient (5 & 6 (%)
Q3_2ai	12.3	44.2	22.5	10.9	10.1	0.0	79.0	21.0	56.5	10.1

Appropriateness of Number Branch Topic Inclusion (Tables B8-1 & B8-2)

Table B5-1 depicts respondent's answers to this question: 'In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each topic is for inclusion in the framework?'

Mean responses are based on the 6 point rating scale NFER used for agreement/appropriateness. A rating of 1 indicates strong appropriateness with the statement and a rating of 6 indicates strong inappropriateness of the inclusion of the topic in this MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates appropriateness, whereas a rating of 4, 5, or 6 indicates inappropriateness. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated.

As you can see in table B8-1 teachers and heads of school who responded to the survey indicated high levels of appropriateness (between 1 and 2) of the inclusion of the Number branch's topics in the MYP framework. Logarithms and Number bases with 2.34 and 2.31 mean responses respectively have the highest means approaching 3, the cut off for 'appropriate' inclusion in the MYP framework. Also of note, along with fractional exponents these topics have the highest standard deviations of the set of topics indicating wider variation comparative to other topics in respondents views about these topics appropriate inclusion.

Table B8-1 Appropriateness of Number Branch Topics for MYP Mathematics Skills Framework				
Survey Question		N	Mean	Std. Deviation
Q3_2aii_1	Forms of numbers and Number systems	135	1.89	1.084
Q3_2aii_2	Sets and Venn diagrams	134	2.22	1.133
Q3_2aii_3	The four number operations	136	1.72	1.016
Q3_2aii_4	Prime numbers and factors	136	1.79	1.034
Q3_2aii_5	Number lines	135	1.87	1.061
Q3_2aii_6	Estimation	135	1.93	1.045
Q3_2aii_7	Units of measurement	135	1.81	1.038
Q3_2aii_8	Ratio, percentage; direct and inverse proportion	136	1.75	1.002

Q3_2aii_9	Number sequences	133	2.01	1.184
Q3_2aii_10	Integer exponents	133	1.76	1.001
Q3_2aii_11	Fractional exponents	133	2.12	1.297
Q3_2aii_12	Logarithms	133	2.34	1.387
Q3_2aii_13	Number bases	134	2.31	1.235

Table B8-2 indicates cumulative percents of the likert scale ratings of respondents responses to appropriateness of number branch topic inclusion in the MYP Mathematics Skills Framework. Subsequent columns combine the ratings into overall appropriateness i.e. percent of respondents who indicated either a 1,2, or 3 (appropriate), or a 4,5,6 (inappropriate) on the likert scales. For example, 56.6% of respondents gave the four number operators topic a highly appropriate rating, indicating strong appropriateness for inclusion. On the lower end only 29.9% of respondents gave a highly appropriate rating to number bases and only 33.8% of them gave the same rating for logarithms. However subsequent columns point out that over 80% of respondents for these two topics still fell within an appropriate inclusion for the MYP skills framework (giving a rating of 1,2, or 3). 63% of these groups indicate strong appropriate ratings.

Table B8-2 Cumulative Percents of Appropriateness of Number Branch Topics for Inclusion in the MYP Mathematics Skills Framework

Survey Question	1 Highly appropriate (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all appropriate (%)	1 Appropriate (1-3) (%)	2 Not appropriate (4-6) (%)	1 Appropriate (1 & 2) (%)	2 Not appropriate (5 & 6) (%)
Q3_2aii_1	47.4	29.6	13.3	5.9	3.7	0.0	90.4	9.6	77.0	3.7
Q3_2aii_2	32.8	31.3	20.9	11.2	3.7	0.0	85.1	14.9	64.1	3.7
Q3_2aii_3	56.6	25.0	10.3	5.9	2.2	0.0	91.9	8.1	81.6	2.2
Q3_2aii_4	52.2	27.2	11.8	6.6	2.2	0.0	91.2	8.8	79.4	2.2
Q3_2aii_5	48.1	28.1	14.8	5.9	3.0	0.0	91.1	8.9	76.2	3.0
Q3_2aii_6	43.7	31.9	13.3	9.6	1.5	0.0	88.9	11.1	75.6	1.5
Q3_2aii_7	50.4	28.9	12.6	5.2	3.0	0.0	91.9	8.1	79.3	3.0
Q3_2aii_8	52.9	29.4	9.6	5.9	2.2	0.0	91.9	8.1	82.3	2.2
Q3_2aii_9	42.9	33.1	11.3	6.0	6.8	0.0	87.2	12.8	76.0	6.8
Q3_2aii_10	52.6	28.6	11.3	5.3	2.3	0.0	92.5	7.5	81.2	2.3
Q3_2aii_11	41.4	30.1	13.5	7.5	5.3	2.3	85.0	15.0	71.5	7.6
Q3_2aii_12	33.8	30.1	18.0	9.8	3.0	5.3	82.0	18.0	63.9	8.3
Q3_2aii_13	29.9	33.6	20.1	10.4	3.7	2.2	83.6	16.4	63.5	5.9

Number Branch Guidance Sufficiency for Promoting Student Depth of Understanding (Tables B9-1 & B9-2)

Teachers were asked the extent to which they agreed with a statement about the number branch's guidance sufficiency for depth of student understanding provision. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B9-1 participants generally feel guidance is sufficient to provide depth of understanding in the Number branch.

Table B9-1 Number Branch Topic Depth of understanding

Survey Question		N	Mean	Std. Deviation
Q3_2aiii	Overall, to what extent do you think the current guidance for Number in the Mathematics Skills Framework provides sufficient depth of learning?	136	2.40	1.071

Table B9-2 indicates cumulative percents of the likert scale ratings of respondents answers to the Number branch topics guidance for depth of understanding provision. Subsequent columns combine the ratings into overall sufficiency i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 44.9% of respondents indicate a close to fully sufficient rating for the number branch guidance for depth of understanding. However 14.7% of respondents do indicate low sufficiency of the number branch's guidance provision of depth of learning.

Table B9-1 Number Branch Topic Guidance for Depth of Understanding

	1 Fully sufficient (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient (%)	1 Sufficient (1-3) (%)	2 Not sufficient (4-6) (%)	1 Sufficient (1 & 2) (%)	2 Not Sufficient (5 & 6 (%)
Q3_2aiii	17.6	44.9	22.8	9.6	4.4	0.7	85.3	14.7	62.5	5.1

Number Branch Topic Guidance for Depth of Understanding (Tables B10-1 and B10-2)

For each topic area in the number branch, teachers were asked to rate the depth of understanding suggested by the written guidance. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the

number branch topics. A rating of 1 indicated greater depth for a topic was needed, a rating of 2 indicates 'appropriate' depth, and a rating of 3 indicates 'insufficient depth'. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B10-1 indicates most topics were rated 'appropriate depth' for the guidance given to provide student depth of understanding.

Table B10-1 Number Branch Topic Guidance for Depth of Understanding

Survey Question		N	Mean	Std. Deviation
Q3_2Aiv_1	Forms of numbers and Number systems	130	2.01	.384
Q3_2Aiv_2	Sets and Venn diagrams	128	2.03	.375
Q3_2Aiv_3	The four number operations	130	1.98	.383
Q3_2Aiv_4	Prime numbers and factors	130	2.02	.383
Q3_2Aiv_5	Number lines	130	2.00	.329
Q3_2Aiv_6	Estimation	129	2.03	.374
Q3_2Aiv_7	Units of measurement	129	2.04	.362
Q3_2Aiv_8	Ratio, percentage; direct and inverse proportion	128	2.02	.386
Q3_2Aiv_9	Number sequences	128	2.02	.376
Q3_2Aiv_10	Integer exponents	129	2.03	.413
Q3_2Aiv_11	Fractional exponents	127	2.05	.452
Q3_2Aiv_12	Logarithms	124	2.06	.490
Q3_2Aiv_13	Number bases	126	2.06	.478

Table B10-2 gives the breakdown of individual number branch topic responses to the question of guidance appropriateness. It indicates for example that 10% or more respondents rated integer exponents, fractional exponents, logarithms and number bases guidance as potentially insufficient for promoting depth of understanding.

Table B10-2 Number Branch Topic Guidance for Depth of Understanding			
Survey Item	1 Greater depth than needed (%)	2 Appropriate depth (%)	3 Insufficient depth (%)
Q3_2Aiv_1	6.9	85.4	7.7
Q3_2Aiv_2	5.5	85.9	8.6
Q3_2Aiv_3	8.5	85.4	6.2
Q3_2Aiv_4	6.2	85.4	8.5
Q3_2Aiv_5	5.4	89.2	5.4
Q3_2Aiv_6	5.4	86.0	8.5
Q3_2Aiv_7	4.7	86.8	8.5
Q3_2Aiv_8	6.2	85.2	8.6
Q3_2Aiv_9	6.2	85.9	7.8
Q3_2Aiv_10	7.0	82.9	10.1
Q3_2Aiv_11	7.9	79.5	12.6
Q3_2Aiv_12	8.9	75.8	15.3
Q3_2Aiv_13	8.7	77.0	14.3

Number Branch Topic Guidance for Planning Appropriate Learning for All Students (Tables B11-1 and B11-2)

For each topic area in the number branch, teachers were asked to rate the written guidance provided to plan appropriate learning for all students. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. Mean responses are based on the 6 point rating scale NFER used for sufficiency. A rating of 1 indicates strong sufficiency with the statement and a rating of 6 indicates strong insufficiency of the inclusion of the topic in the MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficiency, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B11-1 indicates a close to strong sufficiency for all the topics in providing enough written guidance to help teachers plan appropriate learning for all their students with means of 2. However fractional exponents, logarithms and number bases indicate close to a rank of 3 indicating the possibility of teachers wanting more written guidance for planning appropriate learning for these topics.

Table B11-1 Number Branch Topic Guidance for Planning Appropriate Learning				
Does the written guidance provide you with sufficient detail to allow you to plan appropriate learning for all students?				
Survey Questions		N	Mean	Std. Deviation
Q3_3_1	Forms of numbers and Number systems	130	2.61	1.261
Q3_3_2	Sets and Venn diagrams	128	2.66	1.294
Q3_3_3	The four number operations	130	2.51	1.277
Q3_3_4	Prime numbers and factors	130	2.57	1.282
Q3_3_5	Number lines	130	2.56	1.258
Q3_3_6	Estimation	130	2.67	1.278
Q3_3_7	Units of measurement	130	2.58	1.251
Q3_3_8	Ratio, percentage; direct and inverse proportion	128	2.58	1.246
Q3_3_9	Number sequences	128	2.66	1.282
Q3_3_10	Integer exponents	128	2.60	1.270
Q3_3_11	Fractional exponents	127	2.80	1.347
Q3_3_12	Logarithms	126	2.83	1.357
Q3_3_13	Number bases	126	2.83	1.321

Table B11-2 indicates the cumulative percents of the likert scale ratings of respondents answers to the number branch topics written guidance for planning appropriate learning for all students. Subsequent columns combine the ratings into overall sufficiency ratings i.e. the percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example the four number operations, prime numbers and factors, and number lines, and units of measurement all received the highest ratings for sufficient written guidance for depth of understanding at between 23.1% to 20.0% of respondents rating it at 1 for fully sufficient guidance. Conversely the topics partcipants ranked lowest were sets and venn diagrams, fractional exponents, logarithms and number bases at about 10% of respondents indicating a 5 for insufficient guidance. Subsequent columns give an indication of strength of this finding. For example 25.2% of survey participants ranked fractional exponents as not having sufficient guidance (rating this subject between 4-6).

Table B11-2 Cumulative Percents Number Branch Topic Guidance for Planning Appropriate Learning										
Survey Item	1 Fully sufficient guidance (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient guidance (%)	1 Sufficient guidance (1-3) (%)	2 Not sufficient guidance (4-6) (%)	1 Sufficient guidance (1 & 2) (%)	2 Not Sufficient guidance (5 & 6 (%)
Q3_3_1	20.0	33.1	24.6	12.3	8.5	1.5	77.7	22.3	53.1	10.0
Q3_3_2	16.4	38.3	23.4	8.6	10.9	2.3	78.1	21.9	54.7	13.2
Q3_3_3	23.1	35.4	20.8	10.8	8.5	1.5	79.2	20.8	58.5	10.0
Q3_3_4	21.5	33.8	23.1	10.8	9.2	1.5	78.5	21.5	55.3	10.7
Q3_3_5	20.8	34.6	23.8	10.8	8.5	1.5	79.2	20.8	55.4	10.0
Q3_3_6	18.5	33.1	24.6	12.3	10.0	1.5	76.2	23.8	51.6	11.5
Q3_3_7	20.0	34.6	24.6	10.8	8.5	1.5	79.2	20.8	54.6	10.0
Q3_3_8	18.8	37.5	22.7	10.9	8.6	1.6	78.9	21.1	56.3	10.2
Q3_3_9	18.0	35.2	24.2	10.2	10.9	1.6	77.3	22.7	53.2	12.5
Q3_3_10	19.5	35.2	23.4	10.9	9.4	1.6	78.1	21.9	54.7	11.0
Q3_3_11	15.7	33.1	26.0	9.4	12.6	3.1	74.8	25.2	48.8	15.7
Q3_3_12	15.1	31.7	28.6	9.5	10.3	4.8	75.4	24.6	46.8	15.1
Q3_3_13	14.3	31.7	29.4	10.3	10.3	4.0	75.4	24.6	46.0	14.3

Algebra

Algebra Branch Topic Inclusion and Levels (Table B12)

Teachers were asked to indicate which topics and skills in the framework under the Algebra branch are included in their school's middle years mathematics courses, and whether they are delivered at the 'Standard and Extended' (S&E) challenge level or only the 'Extended' (E) challenge level. The percentage of the survey participants (N=679) indicating inclusion and at what levels are shown in the Table B12[4]. As can be seen more than 90% of respondents indicated they included; a) Add, subtract, multiply and divide algebraic terms, b) factorization of algebraic expressions, c) substitution and c) re-arranging algebraic expressions at S & E Levels. Conversely between 21% and 29% of participants indicated they do not include a) Logarithms with different base numbers, b) the arithmetic and geometric series, and c) functions and graphs. However table B-12 also shows that above 30% of respondents include many of these Algebra topics at extended level.

[4] A total of 679 practitioners in 279 schools completed the survey. 518 responded to the full questionnaire and 161 provided partial responses.

Table B-12 Algebra Branch Topic Inclusion and Level Questions				
Please indicate which topics and skills in the framework you include in your school's middle years mathematics courses, and whether they are delivered at the 'Standard and extended' (S&E) challenge level or only the 'Extended' (E) challenge level		1 No (%)	2 Yes at S&E (%)	3 Yes at E only (%)
Q31_2A1	Add, subtract, multiply and divide algebraic terms	1.4	96.4	2.1
Q31_2A2	Factorization of algebraic expressions	2.1	93.6	4.3
Q31_2A3	Substitution	1.4	96.4	2.1
Q31_2A4	Rearranging algebraic expressions	0.0	96.4	3.6
Q31_2A5	Algebraic fractions	4.3	87.9	7.9
Q31_2A6	Integer and fractional exponents	2.9	90.7	6.4
Q31_2A7	Patterns and sequences	4.3	89.3	6.4
Q31_2A8	Algorithms	19.7	72.3	8.0
Q31_2A9	Functions (types, domain and range, transformations)	4.3	87.1	8.6
Q31_2A10	Equations (linear, quadratic, simultaneous)	2.1	91.4	6.4
Q31_2A11	Inequalities	5.0	87.8	7.2
Q31_2A12	Logarithms with different base number	29.9	29.2	40.9
Q31_2A13	Functions and graphs (sine, cosine, log and rational)	21.6	41.7	36.7
Q31_2A14	Inequalities	14.7	59.6	25.7
Q31_2A15	Transformations of functions	20.4	48.9	30.7
Q31_2A16	Arithmetic and geometric series	25.7	43.6	30.7

Algebra Branch Topics and Skills Guidance for Breadth of Learning (Tables B13-1 & B13-2)

Teachers were asked the extent to which they agreed with a statement about the Algebra branch's sufficiency for breadth of learning guidance. Mean responses are based on the 6 point rating scale were used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated. As you can see in table B13 participants generally feel guidance is sufficient to provide breadth of learning in the Algebra branch overall.

Table B13-1 Number Branch Guidance for Breadth of Learning				
Survey Question		N	Mean	Std. Deviation
Q31_2ai	Algebra - Overall, to what extent do you think the current guidance for Algebra in the Mathematics Skills Framework provides sufficient breadth of learning?	142	2.28	.956

Table B13-2 indicates cumulative percents of the likert scale ratings to the respondents of the guidance sufficiency for breadth of learning provision. Subsequent columns combine the ratings into overall sufficiencies i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 50.7% of 142 survey respondents felt the Algebra branch guidance gave a rating of 2. Additionally 89.4% of respondents indicated a 1,2, or 3 response of sufficiency with 68.3% of this group indicating 1 and 2. However over 10.6% felt guidance of the Algebra branch was insufficient to provide breadth of learning although only 3.5% of this group felt guidance was strongly insufficient.

Table B13-2: Topic and Skills Sufficiency Questions Percent Responses & Cumulative Ratings										
Survey Item	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q31_2ai	17.6	50.7	21.1	7.0	3.5	0.0	89.4	10.6	68.3	3.5

Appropriateness of Algebra Branch Topic Inclusion (Tables B14-1 & B14-2)

Table B14-1 depicts respondent's answers to this question: 'In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each topic is for inclusion in the framework?'.

Mean responses are based on the 6 point rating scale NFER used for agreement/appropriateness. A rating of 1 indicates strong appropriateness with the statement and a rating of 6 indicates strong inappropriateness of the inclusion of the topic in this MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates appropriateness, whereas a rating of 4, 5, or 6 indicates inappropriateness. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

As you can see in table B14-1 teachers and heads of school who responded to the survey indicated high levels of appropriateness (between 1 and 2) of the inclusion of the Algebra branch's topics in the MYP framework. Logarithms with different base numbers and Functions and Graphs with 2.46 and 2.18 mean responses respectively approached 3, the cut off for 'appropriate' inclusion in the MYP framework. Also of note, along with Algorithms, Inequalities, Transformations of functions and Arithmetic and geometric series these topics have the highest standard deviations which indicates wider variation in perspectives on appropriate inclusion comparatively to other topics.

Table B14-1 Appropriateness of Algebra Branch Topics for MYP Mathematics Skills Framework

Survey Items		N	Mean	Std. Deviation
Q31_2aii_1	Algebra S&E - Add, subtract, multiply and divide algebraic terms	134	1.44	.677
Q31_2aii_2	Algebra S&E - Factorization of algebraic expressions	134	1.49	.712
Q31_2aii_3	Algebra S&E - Substitution	133	1.49	.692
Q31_2aii_4	Algebra S&E - Rearranging algebraic expressions	135	1.52	.721
Q31_2aii_5	Algebra S&E - Algebraic fractions	134	1.61	.794
Q31_2aii_6	Algebra S&E - Integer and fractional exponents	134	1.56	.781
Q31_2aii_7	Algebra S&E - Patterns and sequences	134	1.60	.851
Q31_2aii_8	Algebra S&E - Algorithms	133	1.95	1.154
Q31_2aii_9	Algebra S&E - Functions (types, domain and range, transformations)	134	1.72	.931
Q31_2aii_10	Algebra S&E - Equations (linear, quadratic, simultaneous)	134	1.51	.743
Q31_2aii_11	Algebra S&E - Inequalities	133	1.69	.854
Q31_2aii_12	Algebra E - Logarithms with different base number	134	2.46	1.480
Q31_2aii_13	Algebra E - Functions and graphs (sine, cosine, log and rational)	132	2.18	1.307
Q31_2aii_14	Algebra E - Inequalities	132	1.93	1.154
Q31_2aii_15	Algebra E - Transformations of functions	133	2.04	1.138
Q31_2aii_16	Algebra E - Arithmetic and geometric series	133	2.16	1.224

Table B14-2 indicates cumulative percents of the likert scale ratings of respondents responses to appropriateness of Algebra branch topic inclusion in the MYP Mathematics Skills Framework. Subsequent columns combine the ratings into overall appropriateness i.e. percent of respondents who indicated either a 1,2, or 3 (appropriate), or a 4,5,6 (inappropriate) on the likert scales. For example, 65.7% of respondents gave the Algebra S&E Add, subtract, multiply and divide algebraic terms topic a highly appropriate rating, indicating strong appropriateness for inclusion. On

the lower end only 32.8% of respondents gave a highly appropriate rating to Logarithms with different base number. However subsequent columns point out that 79.9% of respondents felt this topic still fell within an appropriate inclusion for the MYP skills framework (giving a rating of 1,2, or 3).

Table B14-2 Cumulative Percents of Appropriateness of Algebra Branch Topics for Inclusion in the MYP Mathematics Skills Framework

Survey Question	1 Highly appropriate (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all appropriate (%)	1 Appropriate (1-3) (%)	2 Not appropriate (4-6) (%)	1 Appropriate (1 & 2) (%)	2 Not appropriate (5 & 6) (%)
Q31_2aii_1	65.7	25.4	8.2	0.7	0.0	0.0	99.3	0.7	91.9	0.0
Q31_2aii_2	61.9	28.4	8.2	1.5	0.0	0.0	98.5	1.5	90.3	0.0
Q31_2aii_3	61.7	28.6	9.0	0.8	0.0	0.0	99.2	0.8	90.3	0.0
Q31_2aii_4	59.3	31.9	6.7	2.2	0.0	0.0	97.8	2.2	91.2	0.0
Q31_2aii_5	53.7	35.1	8.2	2.2	0.7	0.0	97.0	3.0	88.8	0.7
Q31_2aii_6	59.0	29.1	9.0	3.0	0.0	0.0	97.0	3.0	88.1	0.0
Q31_2aii_7	57.5	29.9	9.7	2.2	0.0	0.7	97.0	3.0	87.4	0.7
Q31_2aii_8	45.9	28.6	15.0	6.8	2.3	1.5	89.5	10.5	74.5	3.8
Q31_2aii_9	53.0	29.9	10.4	6.0	0.7	0.0	93.3	6.7	82.9	0.7
Q31_2aii_10	62.7	25.4	10.4	1.5	0.0	0.0	98.5	1.5	88.1	0.0
Q31_2aii_11	49.6	36.8	9.8	2.3	1.5	0.0	96.2	3.8	86.4	1.5
Q31_2aii_12	32.8	26.9	20.1	7.5	6.7	6.0	79.9	20.1	59.7	12.7
Q31_2aii_13	40.2	25.8	19.7	7.6	3.8	3.0	85.6	14.4	66.0	6.8
Q31_2aii_14	45.5	31.8	13.6	3.8	3.8	1.5	90.9	9.1	77.3	5.3
Q31_2aii_15	40.6	30.1	19.5	6.0	2.3	1.5	90.2	9.8	70.7	3.8
Q31_2aii_16	36.8	30.8	20.3	6.0	3.8	2.3	88.0	12.0	67.6	6.1

Algebra Branch Guidance Sufficiency for Promoting Student Depth of Understanding (Tables B15-1 & B15-2)

Teachers were asked the extent to which they agreed with a statement about the Algebra branch's sufficiency for providing depth of student understanding in the guidance provided by the guide. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B15-1 participants generally feel guidance is sufficient to provide depth of understanding in the Algebra branch.

Table B15-1 Algebra Branch Topic Depth of understanding				
Survey Question		N	Mean	Std. Deviation
Q31_2aiii	Algebra - Overall, to what extent do you think the current guidance for Algebra in the Mathematics Skills Framework provides sufficient depth of learning?	137	2.18	.868

Table B15-2 indicates cumulative percents of the likert scale ratings of respondents answers to the Number branch topics guidance for depth of understanding provision. Subsequent columns combine the ratings into overall sufficiency i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 43.8% of respondents indicate a close to fully sufficient rating for the algebra branch guidance for depth of understanding. However 7.3% of respondents do indicate low sufficiency of the Algebra branch's guidance provision of depth of learning.

Table B15-2 Algebra Branch Topic Guidance for Depth of Understanding										
	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q31_2aiii	22.6	43.8	26.3	7.3	0.0	0.0	92.7	7.3	66.4	0.0

Algebra Branch Topic Guidance for Depth of Understanding (Tables B16-1 and B16-2)

For each topic area in the Algebra branch, teachers were asked to rate the depth of understanding suggested by the written guidance. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the Algebra branch topics. A rating of 1 indicated greater depth for a topic was needed, a rating of 2 indicates 'appropriate' depth, and a rating of 3 indicates 'insufficient depth'. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated.

Table B16-1 indicates most topics were rated 'appropriate depth' for the guidance given to provide student depth of understanding.

Table B16-1 Algebra Branch Topic Guidance for Depth of Understanding				
For each topic area, please rate the depth of understanding suggested by the written guidance				
Survey Items		N	Mean	Std. Deviation
Q31_2Aiv_1	Algebra S&E - Add, subtract, multiply and divide algebraic terms	129	2.01	.342
Q31_2Aiv_1	Algebra S&E - Factorization of algebraic expressions	128	2.02	.319
Q31_2Aiv_1	Algebra S&E - Substitution	129	2.03	.352
Q31_2Aiv_1	Algebra S&E - Rearranging algebraic expressions	130	2.04	.361
Q31_2Aiv_1	Algebra S&E - Algebraic fractions	128	2.01	.407
Q31_2Aiv_1	Algebra S&E - Integer and fractional exponents	130	2.01	.384
Q31_2Aiv_1	Algebra S&E - Patterns and sequences	129	2.02	.385
Q31_2Aiv_1	Algebra S&E - Algorithms	128	2.05	.467
Q31_2Aiv_1	Algebra S&E - Functions (types, domain and range, transformations)	128	2.02	.434
Q31_2Aiv_1	Algebra S&E - Equations (linear, quadratic, simultaneous)	129	2.02	.364
Q31_2Aiv_1	Algebra S&E - Inequalities	129	1.99	.424
Q31_2Aiv_1	Algebra E - Logarithms with different base number	129	2.01	.476
Q31_2Aiv_1	Algebra E - Functions and graphs (sine, cosine, log and rational)	129	2.01	.508
Q31_2Aiv_1	Algebra E - Inequalities	129	2.02	.404
Q31_2Aiv_1	Algebra E - Transformations of functions	128	1.98	.493
Q31_2Aiv_1	Algebra E - Arithmetic and geometric series	128	2.00	.470

Table B16-2 gives the breakdown of individual Algebra branch topic responses to the question of guidance appropriateness. It indicates for example that 10% or more respondents rated integer exponents, fractional exponents, logarithms and number bases guidance as potentially insufficient for promoting depth of understanding.

Table B16-2 Number Branch Topic Guidance for Depth of Understanding			
Survey Item	1 Greater depth than needed (%)	2 Appropriate depth (%)	3 Insufficient depth (%)
Q31_2Aiv_1	5.4	88.4	6.2
Q31_2Aiv_2	3.9	89.8	6.2
Q31_2Aiv_3	4.7	87.6	7.8
Q31_2Aiv_4	4.6	86.9	8.5

Q31_2Aiv_5	7.8	83.6	8.6
Q31_2Aiv_6	6.9	85.4	7.7
Q31_2Aiv_7	6.2	85.3	8.5
Q31_2Aiv_8	8.6	78.1	13.3
Q31_2Aiv_9	8.6	81.2	10.2
Q31_2Aiv_10	5.4	86.8	7.8
Q31_2Aiv_11	9.3	82.2	8.5
Q31_2Aiv_12	10.9	77.5	11.6
Q31_2Aiv_13	12.4	74.4	13.2
Q31_2Aiv_14	7.0	83.7	9.3
Q31_2Aiv_15	13.3	75.8	10.9
Q31_2Aiv_16	10.9	78.1	10.9

Algebra Branch Topic Guidance for Planning Appropriate Learning for All Students (Tables B17-1 and B17-2)

For each topic area in the Algebra branch, teachers were asked to rate the written guidance provided to plan appropriate learning for all students. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. Mean responses are based on the 6 point rating scale NFER used for sufficiency. A rating of 1 indicates strong sufficiency with the statement and a rating of 6 indicates strong insufficiency of the inclusion of the topic in the MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficiency, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B17-1 indicates a close to strong sufficiency for all the topics in providing enough written guidance to help teachers plan appropriate learning for all their students with means of 2. However logarithms with different base numbers indicate close to a rank of 3 (close to the edge of sufficiency) with a mean of 2.75. This could indicate the possibility teachers would like more written guidance for planning appropriate learning for this topic.

Table B17-1 Algebra Branch Topic Guidance for Planning Appropriate Learning

Does the written guidance provide you with sufficient detail to allow you to plan appropriate learning for all students?

Survey Questions		N	Mean	Std. Deviation
Q31_3_1	Algebra S&E - Add, subtract, multiply and divide algebraic terms	129	2.47	1.206
Q31_3_2	Algebra S&E - Factorization of algebraic expressions	129	2.51	1.206
Q31_3_3	Algebra S&E - Substitution	129	2.49	1.238

Q31_3_4	Algebra S&E - Rearranging algebraic expressions	130	2.55	1.240
Q31_3_5	Algebra S&E - Algebraic fractions	129	2.53	1.206
Q31_3_6	Algebra S&E - Integer and fractional exponents	130	2.55	1.252
Q31_3_7	Algebra S&E - Patterns and sequences	129	2.57	1.261
Q31_3_8	Algebra S&E - Algorithms	128	2.72	1.292
Q31_3_9	Algebra S&E - Functions (types, domain and range, transformations)	128	2.55	1.183
Q31_3_10	Algebra S&E - Equations (linear, quadratic, simultaneous)	127	2.39	1.223
Q31_3_11	Algebra S&E - Inequalities	127	2.61	1.222
Q31_3_12	Algebra E - Logarithms with different base number	128	2.75	1.375
Q31_3_13	Algebra E - Functions and graphs (sine, cosine, log and rational)	129	2.69	1.304
Q31_3_14	Algebra E - Inequalities	127	2.61	1.285
Q31_3_15	Algebra E - Transformations of functions	128	2.70	1.325
Q31_3_16	Algebra E - Arithmetic and geometric series	129	2.66	1.338

Table B17-2 indicates the cumulative percents of the likert scale ratings of respondents answers to the Algebra branch topics written guidance for planning appropriate learning for all students. Subsequent columns combine the ratings into overall sufficiency ratings i.e. the percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example Equations, Operations (add, subtract, multiply and divide algebraic terms), and substitutions show the highest sufficiency ratings with 62.2%, 60.5% and 58.8% of respondents rating them at sufficient guidance (1 & 2 rating). Conversely the topics partcipants ranked lowest for sufficiency of guidance were logartithms with different base numbers at 13.3% of respondents rating these topics at 5 & 6. Additionally, algorithms, transformation of functions and arithmetic and geometric series were the next lowest ranked for sufficiency of guidance for planning appropriate learning with 11.7% of the participants giving them a rank of 5 & 6.

Table B17-2 Algebra Branch Topic Guidance for Planning Appropriate Learning

Survey Questions	1 Fully sufficient guidance (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient guidance (%)	1 Sufficient guidance (1-3) (%)	2 Not sufficient guidance (4-6) (%)	1 Sufficient guidance (1 & 2) (%)	2 Not Sufficient guidance (5 & 6 (%)
Q31_3_1	20.2	40.3	20.9	11.6	4.7	2.3	81.4	18.6	60.5	7.0
Q31_3_2	19.4	38.8	22.5	12.4	4.7	2.3	80.6	19.4	58.2	7.0
Q31_3_3	21.7	37.2	21.7	11.6	5.4	2.3	80.6	19.4	58.9	7.7
Q31_3_4	20.0	36.2	23.8	11.5	6.2	2.3	80.0	20.0	56.2	8.5
Q31_3_5	18.6	38.8	24.0	10.9	5.4	2.3	81.4	18.6	57.4	7.7

Q31_3_6	20.8	34.6	23.8	12.3	6.2	2.3	79.2	20.8	55.4	8.5
Q31_3_7	18.6	38.0	24.0	10.9	4.7	3.9	80.6	19.4	56.6	8.6
Q31_3_8	14.8	36.7	25.8	10.9	7.8	3.9	77.3	22.7	51.5	11.7
Q31_3_9	15.6	43.0	22.7	10.9	5.5	2.3	81.2	18.8	58.6	7.8
Q31_3_10	24.4	37.8	21.3	9.4	4.7	2.4	83.5	16.5	62.2	7.1
Q31_3_11	17.3	35.4	26.8	11.8	6.3	2.4	79.5	20.5	52.7	8.7
Q31_3_12	18.0	31.2	27.3	10.2	7.8	5.5	76.6	23.4	49.2	13.3
Q31_3_13	15.5	38.0	24.0	11.6	6.2	4.7	77.5	22.5	53.5	10.9
Q31_3_14	18.9	35.4	24.4	11.0	7.1	3.1	78.7	21.3	54.3	10.2
Q31_3_15	16.4	36.7	24.2	10.9	7.0	4.7	77.3	22.7	53.1	11.7
Q31_3_16	17.8	37.2	22.5	10.9	7.0	4.7	77.5	22.5	55.0	11.7

Geometry and Trigonometry

Geometry and Trigonometry Branch Topic Inclusion and levels (Table B18)

Teachers were asked to indicate which topics and skills in the framework under the Geometry and Trigonometry branch are included in their school's middle years mathematics courses, and whether they are delivered at the 'Standard and Extended' (S&E) challenge level or only the 'Extended' (E) challenge level. The Percentage of the survey participants (N=679) indicating inclusion and at what levels are shown in the Table B6[5]. As can be seen most Trigonometry topic and skills are included in schools' mathematics courses, although there are discrepencies. Notably, Three Dimensional Co-ordinate Geometry, and Vectors and Vector Spaces seem to be included the least with over 30% of respondents indicating 'no' to the question; "Is this topic include in your mathematics courses?". In contrast 88.9% of respondents indicated they included geometrical elements and their classifications. at the 'standard and extended' levels.

Table B18 Geometry and Trigonometry Branch Topic Inclusion and Level Questions

Please indicate which topics and skills in the framework you include in your school's middle years mathematics courses, and whether they are delivered at the 'Standard and extended' (S&E) challenge level or only the 'Extended' (E) challenge level

Survey Question	MYP Mathematics Framework Topics	1 No (%)	2 Yes at S&E (%)	3 Yes at E only (%)
Q32_2A1	Geometrical elements and their classifications	5.9	88.9	5.2
Q32_2A2	Distance	6.7	87.3	6.0
Q32_2A3	Angle properties	5.9	86.7	7.4

[5] A total of 679 practitioners in 279 schools completed the survey. 518 responded to the full questionnaire and 161 provided partial responses.

Q32_2A4	Triangle properties	6.7	85.9	7.4
Q32_2A5	Perimeter/area/volume	4.5	88.8	6.7
Q32_2A6	The Cartesian Plane	5.3	85.6	9.1
Q32_2A7	Trigonometric rations in right angled triangles	10.4	83.0	6.7
Q32_2A8	Simple Transformations, including Isometric Transformations	9.0	80.5	10.5
Q32_2A9	Circle geometry	15.7	76.9	7.5
Q32_2A10	Three Dimensional Co-ordinate Geometry	32.3	38.5	29.2
Q32_2A11	Similarity and Congruence	12.0	67.7	20.3
Q32_2A12	Vectors and Vector Spaces	36.8	33.1	30.1
Q32_2A13	Sine and Cosine Rules	17.2	58.2	24.6
Q32_2A14	Trigonometric Identities	21.8	41.4	36.8
Q32_2A15	Angle Measures	10.4	62.2	27.4
Q32_2A16	The Unit Circle	21.2	40.2	38.6

Geometry and Trigonometry branch topics and skill guidance for breadth of learning (Tables B19-1 and B19-2)

Teachers were asked the extent to which they agreed with a statement about the Geometry and Trigonometry branch's sufficiency for breadth of learning guidance. Mean responses are based on the 6 point rating scale were used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B19-1 participants generally feel guidance is sufficient to provide breadth of learning in the geometry and trigonometry branch.

Table B19-1 Geometry and Trigonometry Branch Guidance for Breadth of Learning				
Survey Question		N	Mean	Std. Deviation
Q32_2ai	Geom & Trigo - Overall, to what extent do you think the current guidance for Geometry and trigonometry in the Mathematics Skills Framework provides sufficient breadth of learning?	139	2.50	1.052

Table B19-2 indicates cumulative percents of the likert scale ratings to the respondents of the guidance sufficiency for breadth of learning provision. Subsequent columns combine the ratings into overall sufficiencies i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 35.3% of the 139 survey respondents who responded to this item felt the Geometry and Trigonometry branch guidance was moderately sufficient and gave it a rating of 2. Additionally 84.4% of respondents indicated a 1,2, or 3 response of sufficiency with 52% of this group indicating 1 and 2. However over 15.8% felt guidance of the geometry and trigonometry branch was insufficient to provide breadth of learning although only 3.6% of this group felt guidance was strongly insufficient.

Table B19-2 Geometry and Trigonometry Branch Topic and Skills Sufficiency Questions Percent Responses & Cumulative Ratings										
	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q32_2ai	17.3	35.3	31.7	12.2	2.9	0.7	84.2	15.8	52.6	3.6

Appropriateness of Geometry and Trigonometry Branch Topic Inclusion (Tables B20-1 & B20-2)

Table B20-1 depicts respondent's answers to this question: 'In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each topic is for inclusion in the framework?'.

Mean responses are based on the 6 point rating scale NFER used for agreement/appropriateness. A rating of 1 indicates strong appropriateness with the statement and a rating of 6 indicates strong inappropriateness of the inclusion of the topic in this MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates appropriateness, whereas a rating

of 4, 5, or 6 indicates inappropriateness. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

As you can see in table B20-1 teachers and heads of school who responded to the survey indicated high levels of appropriateness (between 1 and 2) of the inclusion of the Geometry and Trigonometry branch's topics in the MYP framework. Vectors and Vector Spaces a mean of 2.40 had the highest mean approaching 3, the cut off for 'appropriate' inclusion in the MYP framework.

Table B20-1 Appropriateness of Geometry and Trigonometry Branch Topics for MYP Mathematics Skills Framework

In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each current topic is for inclusion within the framework?

Survey Question		N	Mean	Std. Deviation
Q32_2aii_1	Geom & Trigo S&E - Geometrical elements and their classification	130	1.62	.729
Q32_2aii_2	Geom & Trigo S&E - Distance	132	1.67	.860
Q32_2aii_3	Geom & Trigo S&E - Angle properties	130	1.57	.746
Q32_2aii_4	Geom & Trigo S&E - Triangle properties	128	1.58	.759
Q32_2aii_5	Geom & Trigo S&E - Perimeter / Area / Volume	129	1.60	.825
Q32_2aii_6	Geom & Trigo S&E - The Cartesian Plane	128	1.61	.853
Q32_2aii_7	Geom & Trigo S&E - Trigonometric ratios in right angled triangles	130	1.61	.812
Q32_2aii_8	Geom & Trigo S&E - Simple transformations, including isometric transformations	128	1.75	.887
Q32_2aii_9	Geom & Trigo S&E - Circle geometry	130	1.85	.960
Q32_2aii_10	Geom & Trigo E - Three-dimensional co-ordinate geometry	127	2.31	1.238
Q32_2aii_11	Geom & Trigo E - Similarity and congruence	130	1.88	.985
Q32_2aii_12	Geom & Trigo E - Vectors and vector spaces	127	2.40	1.323
Q32_2aii_13	Geom & Trigo E - Sine and cosine rules	128	1.96	1.139
Q32_2aii_14	Geom & Trigo E - Trigonometric identities	128	2.00	1.191
Q32_2aii_15	Geom & Trigo E - Angle measures	130	1.72	.915
Q32_2aii_16	Geom & Trigo E - The unit circle	128	2.06	1.169

Table B20-2 indicates cumulative percents of the likert scale ratings of respondents responses to appropriateness of the Geometry and Trigonometry branch topic inclusion in the MYP Mathematics Skills Framework. Subsequent columns combine the ratings into overall appropriateness i.e. percent of respondents who indicated either a 1,2, or 3 (appropriate), or a 4,5,6 (inappropriate) on the likert scales. For example, 60.9% of respondents gave the Cartesian plane topic a highly appropriate rating, indicating strong appropriateness for inclusion. On the lower end only 29.9%

of respondents gave a highly appropriate rating to vectors and vector spaces. However subsequent columns point out that over 80% of respondents felt this topic still fell within an appropriate inclusion for the MYP skills framework (giving a rating of 1,2, or 3).

Table B20-2 Cumulative Percents of Appropriateness of Geometry and Trigonometry Branch Topics for Inclusion in the MYP Mathematics Skills Framework

Survey Item	1 Highly appropriate (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all appropriate (%)	1 Appropriate (1-3) (%)	2 Not appropriate (4-6) (%)	1 Appropriate (1 & 2) (%)	2 Not appropriate (5 & 6) (%)
Q32_2aii_1	52.3	33.1	14.6	0.0	0.0	0.0	100.0	0.0	85.4	0.0
Q32_2aii_2	54.5	26.5	16.7	1.5	0.8	0.0	97.7	2.3	81.0	0.8
Q32_2aii_3	58.5	26.2	15.4	0.0	0.0	0.0	100.0	0.0	84.7	0.0
Q32_2aii_4	58.6	25.0	16.4	0.0	0.0	0.0	100.0	0.0	83.6	0.0
Q32_2aii_5	58.1	27.1	12.4	1.6	0.8	0.0	97.7	2.3	85.2	0.8
Q32_2aii_6	60.9	19.5	17.2	2.3	0.0	0.0	97.7	2.3	80.4	0.0
Q32_2aii_7	56.9	27.7	13.8	0.8	0.8	0.0	98.5	1.5	84.6	0.8
Q32_2aii_8	49.2	31.2	15.6	3.1	0.8	0.0	96.1	3.9	80.4	0.8
Q32_2aii_9	46.2	29.2	20.8	1.5	2.3	0.0	96.2	3.8	75.4	2.3
Q32_2aii_10	31.5	29.1	25.2	7.9	3.9	2.4	85.8	14.2	60.6	6.3
Q32_2aii_11	43.1	33.8	16.9	4.6	0.8	0.8	93.8	6.2	76.9	1.6
Q32_2aii_12	29.9	28.3	26.0	7.1	4.7	3.9	84.3	15.7	58.2	8.6
Q32_2aii_13	44.5	29.7	16.4	5.5	2.3	1.6	90.6	9.4	74.2	3.9
Q32_2aii_14	44.5	28.1	17.2	4.7	3.9	1.6	89.8	10.2	72.6	5.5
Q32_2aii_15	52.3	29.2	13.1	4.6	0.8	0.0	94.6	5.4	81.5	0.8
Q32_2aii_16	38.3	34.4	18.0	3.1	4.7	1.6	90.6	9.4	72.7	6.3

Geometry and Trigonometry Branch Guidance Sufficiency for Promoting Student Depth of Understanding (Tables B21-1 & B21-2)

Teachers were asked the extent to which they agreed with a statement about the number branch's guidance sufficiency for depth of student understanding provision. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B21-1 participants generally

feel guidance is sufficient to provide depth of understanding in the Geometry and Trigonometry branch.

Table B21-1 Number Branch Topic Depth of understanding				
Survey Question		N	Mean	Std. Deviation
Q32_2aiii	Geom & Trigo - Overall, to what extent do you think the current guidance for Geometry and trigonometry in the Mathematics Skills Framework provides sufficient depth of learning?	135	2.45	.998

Table B21-2 indicates cumulative percents of the likert scale ratings of respondents answers to the Geometry and Trigonometry branch topics guidance for depth of understanding provision. Subsequent columns combine the ratings into overall sufficiency i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 15.6% of respondents indicate a close to fully sufficient rating for the Geometry and Trigonometry branch guidance for depth of understanding. However 12.6% of respondents do indicate low sufficiency of the Geometry and Trigonometry branch's guidance provision for depth of learning.

Table B21-2 Geometry and Trigonometry Branch Topic Guidance for Depth of Understanding										
Survey Item	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q32_2aiii	15.6	42.2	26.7	12.6	3.0	0.0	84.4	15.6	57.8	3.0

Geometry and Trigonometry Branch Topic Guidance for Depth of Understanding (Tables B22-1 and B22-2)

For each topic area in the Geometry and Trigonometry branch, teachers were asked to rate the depth of understanding suggested by the written guidance. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. A rating of 1 indicated greater depth for a topic was needed, a rating of 2 indicates 'appropriate' depth, and a rating of 3 indicates

'insufficient depth'. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B22-1 indicates all topics were rated 'appropriate depth' for the guidance given in this branch for providing depth of understanding.

Table B22-1 Geometry and Trigonometry Branch Topic Guidance for Depth of Understanding

For each topic area, please rate the depth of understanding suggested by the written guidance

Survey Items		N	Mean	Std. Deviation
Q32_2Aiv_1	QGeom & Trigo S&E - Geometrical elements and their classification	126	1.96	.367
Q32_2Aiv_2	Geom & Trigo S&E - Distance	125	1.98	.369
Q32_2Aiv_3	Geom & Trigo S&E - Angle properties	125	2.00	.381
Q32_2Aiv_4	Geom & Trigo S&E - Triangle properties	125	1.99	.348
Q32_2Aiv_5	Geom & Trigo S&E - Perimeter / Area / Volume	124	1.97	.336
Q32_2Aiv_6	Geom & Trigo S&E - The Cartesian Plane	124	2.03	.381
Q32_2Aiv_7	Geom & Trigo S&E - Trigonometric ratios in right angled triangles	125	1.99	.370
Q32_2Aiv_8	Geom & Trigo S&E - Simple transformations, including isometric transformations	125	2.02	.508
Q32_2Aiv_9	Geom & Trigo S&E - Circle geometry	124	2.00	.477
Q32_2Aiv_10	Geom & Trigo S&E - Three-dimensional co-ordinate geometry	123	1.99	.536
Q32_2Aiv_11	Geom & Trigo E - Similarity and congruence	124	2.10	.467
Q32_2Aiv_12	Geom & Trigo E - Vectors and vector spaces	121	2.04	.554
Q32_2Aiv_13	Geom & Trigo E - Sine and cosine rules	124	1.95	.457
Q32_2Aiv_14	Geom & Trigo E - Trigonometric identities	122	2.00	.481
Q32_2Aiv_15	Geom & Trigo E - Angle measures	124	1.97	.402
Q32_2Aiv_16	Geom & Trigo E - The unit circle	123	1.99	.520

Table B22-2 gives the breakdown of individual geometry and trigonometry branch topic responses to the question of guidance appropriateness. It indicates for example that 10% or more respondents rated Circle geometry, trigonometric identities, Simple transformations-including isometric transformations, Sine and cosine rules, Vectors and vector spaces, the unit circle, and trigonometric identities as potentially insufficient for promoting depth of understanding.

Table B22-2 Geometry and Trigonometry Branch Topic Guidance for Depth of Understanding			
Survey Item	1 Greater depth than needed (%)	2 Appropriate depth (%)	3 Insufficient depth (%)
Q32_2Aiv_1	8.7	86.5	4.8
Q32_2Aiv_2	8.0	86.4	5.6
Q32_2Aiv_3	7.2	85.6	7.2
Q32_2Aiv_4	6.4	88.0	5.6
Q32_2Aiv_5	7.3	88.7	4.0
Q32_2Aiv_6	5.6	85.5	8.9
Q32_2Aiv_7	7.2	86.4	6.4
Q32_2Aiv_8	12.0	74.4	13.6
Q32_2Aiv_9	11.3	77.4	11.3
Q32_2Aiv_10	14.6	71.5	13.8
Q32_2Aiv_11	6.5	77.4	16.1
Q32_2Aiv_12	13.2	69.4	17.4
Q32_2Aiv_13	12.9	79.0	8.1
Q32_2Aiv_14	11.5	77.0	11.5
Q32_2Aiv_15	9.7	83.9	6.5
Q32_2Aiv_16	13.8	73.2	13.0

Geometry and Trigonometry Branch Topic Guidance for Planning Appropriate Learning for All Students (Tables B23-1 and B 23-2)

For each topic area in the Geometry and Trigonometry branch, teachers were asked to rate the written guidance provided to plan appropriate learning for all students. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. Mean responses are based on the 6 point rating scale NFER used for sufficiency. A rating of 1 indicates strong sufficiency with the statement and a rating of 6 indicates strong insufficiency of the inclusion of the topic in the MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficiency, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B 23-1 indicates a close to strong sufficiency for all the topics in providing enough written guidance to help teachers plan appropriate learning for all their students with means of 2. However circle geometry at 2.71, and three-dimensional co-ordinate geometry at 2.66 indicate the topics closest to a rank of 3 indicating the

possibility that teachers want more written guidance for planning appropriate learning for these topics.

Table B23-1 Geometry and Trigonometry Branch Topic Guidance for Planning Appropriate Learning

Does the written guidance provide you with sufficient detail to allow you to plan appropriate learning for all students?

Survey Questions		N	Mean	Std. Deviation
Q32_3_1	Geom & Trigo S&E - Geometrical elements and their classification	122	2.48	1.123
Q32_3_2	Geom & Trigo S&E - Distance	121	2.48	1.141
Q32_3_3	Geom & Trigo S&E - Angle properties	121	2.46	1.176
Q32_3_4	Geom & Trigo S&E - Triangle properties	121	2.47	1.170
Q32_3_5	Geom & Trigo S&E - Perimeter / Area / Volume	121	2.45	1.190
Q32_3_6	Geom & Trigo S&E - The Cartesian Plane	120	2.50	1.195
Q32_3_7	Geom & Trigo S&E - Trigonometric ratios in right angled triangles	121	2.53	1.184
Q32_3_8	Geom & Trigo S&E - Simple transformations, including isometric transformations	121	2.62	1.226
Q32_3_9	Geom & Trigo S&E - Circle geometry	121	2.71	1.281
Q32_3_10	Geom & Trigo E - Three-dimensional co-ordinate geometry	116	2.66	1.208
Q32_3_11	Geom & Trigo E - Similarity and congruence	120	2.54	1.159
Q32_3_12	Geom & Trigo E - Vectors and vector spaces	117	2.64	1.148
Q32_3_13	Geom & Trigo E - Sine and cosine rules	120	2.53	1.092
Q32_3_14	Geom & Trigo E - Trigonometric identities	118	2.55	1.083
Q32_3_15	Geom & Trigo E - Angle measures	120	2.47	1.076
Q32_3_16	Geom & Trigo E - The unit circle	116	2.53	1.123

Table B23-2 indicates the cumulative percents of the likert scale ratings of respondents answers to the number branch topics written guidance for planning appropriate learning for all students. Subsequent columns combine the ratings into overall sufficiency ratings i.e. the percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example; distance, angle properties, triangle properties, perimeter/area/volume, the cartesian plane, trigonometric ratios in right angled triangles and similarity and congruence all received the highest ratings for sufficient written guidance for depth of understanding with over 20% of respondents rating it at 1 for fully sufficient guidance. Conversely the topics partcipants ranked lowest were circle geometry and three-dimensional co-ordinate geometry with over 9% of respondents indicating a 5 for insufficient guidance. Subsequent columns give an indication of strength of this finding. For example over 10% of survey participants ranked these two topics as not having sufficient guidance (rating this topic between 4-6).

Table B23-2 Cumulative Percents Number Branch Topic Guidance for Planning Appropriate Learning										
	1 Fully sufficient guidance (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient guidance (%)	1 Sufficient guidance (1-3) (%)	2 Not sufficient guidance (4-6) (%)	1 Sufficient guidance (1 & 2) (%)	2 Not Sufficient guidance (5 & 6 (%)
Q32_3_1	19.7	33.6	32.8	8.2	4.1	1.6	86.1	13.9	53.3	5.7
Q32_3_2	21.5	30.6	33.9	8.3	4.1	1.7	86.0	14.0	52.1	5.8
Q32_3_3	22.3	33.1	28.9	9.1	5.0	1.7	84.3	15.7	55.4	6.7
Q32_3_4	22.3	32.2	28.9	10.7	4.1	1.7	83.5	16.5	54.5	5.8
Q32_3_5	23.1	33.1	27.3	9.9	5.0	1.7	83.5	16.5	56.2	6.7
Q32_3_6	22.5	30.8	29.2	10.8	5.0	1.7	82.5	17.5	53.3	6.7
Q32_3_7	20.7	31.4	31.4	9.1	5.8	1.7	83.5	16.5	52.1	7.5
Q32_3_8	19.0	31.4	28.9	11.6	7.4	1.7	79.3	20.7	50.4	9.1
Q32_3_9	16.5	33.9	25.6	12.4	9.1	2.5	76.0	24.0	50.4	11.6
Q32_3_10	17.2	31.0	31.0	10.3	9.5	0.9	79.3	20.7	48.2	10.4
Q32_3_11	20.0	30.8	32.5	9.2	6.7	0.8	83.3	16.7	50.8	7.5
Q32_3_12	16.2	30.8	34.2	12.0	5.1	1.7	81.2	18.8	47.0	6.8
Q32_3_13	17.5	33.3	34.2	9.2	5.0	0.8	85.0	15.0	50.8	5.8
Q32_3_14	16.1	34.7	33.9	9.3	5.1	0.8	84.7	15.3	50.8	5.9
Q32_3_15	18.3	36.7	30.8	9.2	4.2	0.8	85.8	14.2	55.0	5.0
Q32_3_16	18.1	34.5	31.9	8.6	6.0	0.9	84.5	15.5	52.6	6.9

Statistics and probability

Statistics and probability Branch Topic Inclusion and levels (Table B24)

Teachers were asked to indicate which topics and skills in the framework under the statistics and probability branch are included in their school's middle years mathematics courses, and whether they are delivered at the 'Standard and Extended' (S&E) challenge level or only the 'Extended' (E) challenge level. The percentage of the survey participants (N=679) indicating inclusion and at what levels are shown in the Table B6[6]. As can be seen most Number topic and skills are included in school's mathematics courses. Although there are discrepencies. Notably, over 20% of respondents indicated 'no' for inclusion of measures of dispersion, and standard deviation in their mathematics courses. In contrast 92% of respondents indicated they included graphical analysis and representation and 85% include measures of central tendency/location. Standard deviation and conditional

[6] A total of 679 practitioners in 279 schools completed the survey. 518 responded to the full questionnaire and 161 provided partial responses.

probability appear to be the topics utilized most frequently by schools at the 'extended' level.

Table B24 Number Branch Topic Inclusion and Level Questions				
Please indicate which topics and skills in the framework you include in your school's middle years mathematics courses, and whether they are delivered at the 'Standard and extended' (S&E) challenge level or only the 'Extended' (E) challenge level				
Survey Question MYP Mathematics Framework Topics		1 No (%)	2 Yes at S&E (%)	3 Yes at E only (%)
Q33_2A1	Stat & Prob S&E - Graphical analysis and representation	3.7	92.5	3.7
Q33_2A2	Stat & Prob S&E - Population sampling	15.7	76.9	7.5
Q33_2A3	Stat & Prob S&E - Measures of central tendency / location	9.8	85.0	5.3
Q33_2A4	Stat & Prob S&E - Measures of dispersion	20.3	71.4	8.3
Q33_2A5	Stat & Prob S&E - Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	11.2	82.8	6.0
Q33_2A6	Stat & Prob E - Standard deviation	23.9	38.8	37.3
Q33_2A7	Stat & Prob E - Conditional probability	18.7	44.0	37.3

Statistics and Probability topics and skill guidance for breadth of learning (Tables B25-1and B25-2)

Teachers were asked the extent to which they agreed with a statement about the statistics and probability branch's guidance sufficiency for breadth of learning. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B25-1 participants generally feel guidance is sufficient to provide breadth of learning in the statistics and probability branch.

Table B25-1 Statistics and Probability Branch Guidance for Breadth of Learning				
		N	Mean	Std. Deviation
Q33_2ai	Stat & Prob - Overall, to what extent do you think the current guidance for statistics and probability in the Mathematics Skills Framework provides sufficient breadth of learning?	140	2.55	.939

Table B25-2 indicates cumulative percents of the likert scale ratings to the respondents of the guidance sufficiency for providing breadth of learning. Subsequent columns combine the ratings into overall sufficiencies i.e. percent of respondents who indicated either a 1, 2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. As can be seen 52.1% of the respondents indicated a strong sufficiency of guidance provided to teachers for breadth of learning.

Table B25-2: Statistics and Probability Branch Topic and Skills Sufficiency Questions Percent Responses & Cumulative Ratings										
	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q33_2ai	10.0	42.1	35.0	8.6	4.3	0.0	87.1	12.9	52.1	4.3

Appropriateness of Statistics and Probability Branch Topic Inclusion (Tables B26-1 & B26-2)

Table B26-1 depicts respondent's answers to this question: 'In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each topic is for inclusion in the framework?'.

Mean responses are based on the 6 point rating scale NFER used for agreement/appropriateness. A rating of 1 indicates strong appropriateness with the statement and a rating of 6 indicates strong inappropriateness of the inclusion of the topic in this MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates appropriateness, whereas a rating of 4, 5, or 6 indicates inappropriateness. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

As you can see in table B26-1 teachers and heads of school who responded to the survey indicated high levels of appropriateness (between 1 and 2) of the inclusion of the statistics and probability branch's topics in the MYP framework. Standard

deviation and conditional probability with 2.56 and 2.31 mean responses respectively have the highest means approaching 3, the cut off for 'appropriate' inclusion in the MYP framework.

Table B26-1 Appropriateness of Statistics and Probability Branch Topics for MYP Mathematics Skills Framework

In terms of providing sufficient breadth within middle years mathematics learning, how appropriate do you think each current topic is for inclusion within the framework?

Survey Question		N	Mean	Std. Deviation
Q33_2aii_1	Stat & Prob S&E - Graphical analysis and representation	134	1.78	.961
Q33_2aii_2	Stat & Prob S&E - Population sampling	133	2.14	1.074
Q33_2aii_3	Stat & Prob S&E - Measures of central tendency / location	134	2.03	1.069
Q33_2aii_4	Stat & Prob S&E - Measures of dispersion	134	2.33	1.279
Q33_2aii_5	Stat & Prob S&E - Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	134	1.94	1.067
Q33_2aii_6	Stat & Prob E - Standard deviation	134	2.56	1.329
Q33_2aii_7	Stat & Prob E - Conditional probability	133	2.31	1.226

Table B26-2 indicates cumulative percents of the likert scale ratings of respondents responses to appropriateness of number branch topic inclusion in the MYP Mathematics Skills Framework. Subsequent columns combine the ratings into overall appropriateness i.e. percent of respondents who indicated either a 1,2, or 3 (appropriate), or a 4,5,6 (inappropriate) on the likert scales. For example, 47.8% of respondents gave graphical analysis a highly appropriate rating, indicating strong appropriateness for inclusion. On the lower end only 24.6% of respondents gave a highly appropriate rating to standard deviation. However subsequent columns point out that over 52% of respondents still felt this topic was within an appropriate inclusion for the MYP skills framework (giving a rating of 1,2).

Table B26-2 Cumulative Percents of Appropriateness of Statistics and Probability Branch Topics for Inclusion in the MYP Mathematics Skills Framework

	1 Highly appropriate (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all appropriate (%)	1 Appropriate (1-3) (%)	2 Not appropriate (4-6) (%)	1 Appropriate (1 & 2) (%)	2 Not appropriate (5 & 6) (%)
Q33_2aii_1	47.8	32.1	17.9	0.0	0.7	1.5	97.8	2.2	79.9	2.2
Q33_2aii_2	32.3	34.6	24.1	5.3	3.0	0.8	91.0	9.0	66.9	3.8
Q33_2aii_3	38.8	30.6	23.9	3.0	3.0	0.7	93.3	6.7	69.4	3.7
Q33_2aii_4	32.1	26.9	28.4	4.5	5.2	3.0	87.3	12.7	59.0	8.2
Q33_2aii_5	42.5	32.1	19.4	1.5	3.7	0.7	94.0	6.0	74.6	4.4
Q33_2aii_6	24.6	27.6	29.1	8.2	6.7	3.7	81.3	18.7	52.2	10.4
Q33_2aii_7	29.3	31.6	28.6	3.0	4.5	3.0	89.5	10.5	60.9	7.5

Statistics and Probability Branch Guidance Sufficiency for Promoting Student Depth of Understanding (Tables B27-1 & B27-2)

Teachers were asked the extent to which they agreed with a statement about the statistics and probability branch's guidance sufficiency for depth of student understanding. Mean responses are based on the 6 point rating scale used for sufficiency. A rating of 1 indicates fully sufficient and a rating of 6 indicates not at all sufficient. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficient guidance, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated . As you can see in table B27-1 participants generally feel guidance is sufficient to provide depth of understanding in the Statistics and Probability branch given it's mean of 2.51.

Table B27-1 Statistics and Probability Branch Topic Depth of Understanding

		N	Mean	Std. Deviation
Q33_2aiii	Stat & Prob - Overall, to what extent do you think the current guidance for Statistics and probability in the Mathematics Skills Framework provides sufficient depth of learning?	138	2.51	1.020

Table B27-2 indicates cumulative percents of the likert scale ratings of respondents answers to the Statistics and Probability branch topics guidance for depth of understanding. Subsequent columns combine the ratings into overall sufficiency i.e. percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. For example, 39.9% of respondents indicate a close to fully sufficient rating for the statistics and probability branch's guidance for depth of understanding. However 10.9% of respondents do indicate low sufficiency of the number branch's guidance provision of depth of learning rating this question at 4,5, or 6.

Table B27-2 Number Branch Topic Guidance for Depth of Understanding

	1 Fully sufficient depth (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient depth (%)	1 Sufficient depth (1-3) (%)	2 Not sufficient depth (4-6) (%)	1 Sufficient depth (1 & 2) (%)	2 Not Sufficient depth (5 & 6 (%)
Q33_2aiii	13.0	39.9	36.2	6.5	2.2	2.2	89.1	10.9	52.9	4.4

Statistics and Probability Branch Topic Guidance for Depth of Understanding (Tables B28-1 and B29-2)

For each topic area in the statistics and probability branch, teachers were asked to rate the depth of understanding suggested by the written guidance. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. A rating of 1 indicated greater depth for a topic was needed, a rating of 2 indicates 'appropriate' depth, and a rating of 3 indicates 'insufficient depth'. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B28-1 indicates most topics were rated 'appropriate depth' for the guidance given to provide student depth of understanding.

Table B28-1 Statistics and Probability Branch Topic Guidance for Depth of Understanding

For each topic area, please rate the depth of understanding suggested by the written guidance

Survey Questions		N	Mean	Std. Deviation
Q33_2Aiv_1	Stat & Prob S&E - Graphical analysis and representation	131	1.98	.392
Q33_2Aiv_2	Stat & Prob S&E - Population sampling	130	2.01	.440
Q33_2Aiv_3	Stat & Prob S&E - Measures of central tendency / location	131	2.00	.328
Q33_2Aiv_4	Stat & Prob S&E - Measures of dispersion	128	1.99	.444
Q33_2Aiv_5	Stat & Prob S&E - Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	131	1.98	.438
Q33_2Aiv_6	Stat & Prob E - Standard deviation	131	1.95	.524
Q33_2Aiv_7	Stat & Prob E - Conditional probability	129	1.98	.507

Table B28-2 gives the breakdown of individual number branch topic responses to the question of guidance appropriateness. It indicates for example that 10% or more respondents rated population sampling, standard deviation, and conditional probabilities guidance as insufficient for promoting depth of understanding.

Table B28-2 Statistics and Probability Branch Topic Guidance for Depth of Understanding			
	1 Greater depth than needed (%)	2 Appropriate depth (%)	3 Insufficient depth (%)
Q33_2Aiv_1	8.4	84.7	6.9
Q33_2Aiv_2	9.2	80.8	10.0
Q33_2Aiv_3	5.3	89.3	5.3
Q33_2Aiv_4	10.2	80.5	9.4
Q33_2Aiv_5	10.7	80.9	8.4
Q33_2Aiv_6	16.0	72.5	11.5
Q33_2Aiv_7	14.0	74.4	11.6

Statistics and Probability Branch Topic Guidance for Planning Appropriate Learning for All Students (Tables B29-1 and B29-2)

For each topic area in the statistics and probability branch, teachers were asked to rate the written guidance provided to plan appropriate learning for all students. Respondents were asked to rate on a three point scale if greater depth was needed in guidance for each of the number branch topics. Mean responses are based on the 6 point rating scale NFER used for sufficiency. A rating of 1 indicates strong sufficiency with the statement and a rating of 6 indicates strong insufficiency of the inclusion of the topic in the MYP Mathematics Skills Framework. NFER established inferences from the six point ratings; A rating of 1, 2, or 3 indicates sufficiency, whereas a rating of 4, 5, or 6 indicates insufficiency. N equals the number of respondents who completed this item in the questionnaire. Standard deviations are also indicated .

Table B29-1 indicates a close to strong sufficiency for most of the topics in providing enough written guidance to help teachers plan appropriate learning for all their students with means of 2.

Table B29-1 Statistics and Probability Branch Topic Guidance for Planning Appropriate Learning				
Does the written guidance provide you with sufficient detail to allow you to plan appropriate learning for all students?				
		N	Mean	Std. Deviation
Q33_3_1	Stat & Prob S&E - Graphical analysis and representation	125	2.73	1.146
Q33_3_2	Stat & Prob S&E - Population sampling	125	2.90	1.146

Q33_3_3	Stat & Prob S&E - Measures of central tendency / location	124	2.75	1.116
Q33_3_4	Stat & Prob S&E - Measures of dispersion	122	2.75	1.147
Q33_3_5	Stat & Prob S&E - Probability of an event. Probability of independent, mutually exclusive and combined events. Probability of successive trials	124	2.73	1.105
Q33_3_6	Stat & Prob E - Standard deviation	124	2.85	1.148
Q33_3_7	Stat & Prob E - Conditional probability	124	2.79	1.114

Table B29-2 indicates the cumulative percents of the likert scale ratings of respondents answers to the number branch topics written guidance for planning appropriate learning for all students. Subsequent columns combine the ratings into overall sufficiency ratings i.e. the percent of respondents who indicated either a 1,2, or 3 (sufficient), or a 4,5,6 (insufficient) on the likert scales. Interestingly and in comparison to the mean scores, many topics show that over 10% of the respondents indicate that insufficient guidance is supplied to plan appropriate learning.

Table B29-2 Cumulative Percents Number Branch Topic Guidance for Planning Appropriate Learning

	1 Fully sufficient guidance (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 Not at all sufficient guidance (%)	1 Sufficient guidance (1-3) (%)	2 Not sufficient guidance (4-6) (%)	1 Sufficient guidance (1 & 2) (%)	2 Not Sufficient guidance (5 & 6 (%)
Q33_3_1	12.8	32.0	36.0	8.8	9.6	0.8	80.8	19.2	44.8	10.4
Q33_3_2	8.8	29.6	37.6	11.2	12.0	0.8	76.0	24.0	38.4	12.8
Q33_3_3	11.3	32.3	37.1	9.7	8.9	0.8	80.6	19.4	43.6	9.7
Q33_3_4	11.5	32.8	37.7	7.4	9.0	1.6	82.0	18.0	44.3	10.6
Q33_3_5	10.5	33.1	41.1	4.0	10.5	0.8	84.7	15.3	43.6	11.3
Q33_3_6	9.7	30.6	37.9	10.5	9.7	1.6	78.2	21.8	40.3	11.3
Q33_3_7	9.7	32.3	39.5	7.3	10.5	0.8	81.5	18.5	42.0	11.3

3. Descriptive Statistics – ANOVA tables

This section of Appendix B presents the ANOVA tables for questions from the teacher survey related to perceptions of the Mathematics Skills Framework. As with the questions presented previously, teachers were asked the extent to which they agreed with the following statements. A 6 point rating scale was used for these questions. A rating of 1 indicated strong agreement with the statement and a rating of 6 indicated strong disagreement. The ANOVA tables

Questions in the teacher survey were analysed by region to assess whether there were any significant regional differences in practitioners' answers. Participant responses from three regions IB Africa, Europe and the Middle East (IBAEM) IB Americas (IBA) and IB Asia-Pacific (IBAP) were compared. Analysis of Variance (ANOVA) tests were carried out to identify if there were any significant differences between the group means. Table and page numbers reference the analysis written in NFER's main report 'Evaluation of the IB Middle Years Programme Mathematics Skills Framework.

School perceptions of the IB MYP Mathematics Skills framework Table 3.24 (p. 51): One-way ANOVA results

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
IB MYP Mathematics prepares students well for external assessments within the middle years (e.g. statutory state / national tests)	Between Groups	15.630	2	7.815	4.780	.009
	Within Groups	941.607	576	1.635		
	Total	**957.237**	**578**			
IB MYP Mathematics prepares learners well for further study	Between Groups	19.026	2	9.513	6.279	.002
	Within Groups	871.125	575	1.515		
	Total	**890.151**	**577**			

Source: NFER (2017)

How are schools and teachers using the MYP Mathematics skills framework for planning?

Table 3.25 (p.51): One way ANOVA results

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
The topics and skills in the Number branch provide me with enough information to plan for effective mathematics learning	Between Groups	17.901	2	8.951	6.696	.001
	Within Groups	763.214	571	1.337		
	Total	**781.115**	**573**			
The topics and skills in the Algebra branch provide me with enough information to plan for effective mathematics learning	Between Groups	11.042	2	5.521	4.054	.018
	Within Groups	779.090	572	1.362		
	Total	**790.132**	**574**			
The topics and skills in the statistics and probability branch provide me with enough information to plan for effective mathematics learning	Between Groups	9.976	2	4.988	3.895	.021
	Within Groups	723.614	565	1.281		
	Total	**733.590**	**567**			

Source: NFER (2017)

Identifying suitable content and making links between topics and skills

Table 3.26: One way ANOVA results

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
The framework allows me to identify appropriate subject content for each year group	Between Groups	12.654	2	6.327	4.612	.010
	Within Groups	613.266	447	1.372		
	Total	**625.920**	**449**			
When planning it is easy to make links between topics and skills in different branches	Between Groups	10.669	2	5.334	4.229	.015
	Within Groups	715.235	567	1.261		
	Total	**725.904**	**569**			

Source: NFER (2017)

Year-on-year progression

Table 3.27 (p. 53): One way ANOVA results

ANOVA

The framework allows me to plan for effective year on year progression

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.937	2	5.969	4.435	.012
Within Groups	767.040	570	1.346		
Total	**778.977**	**572**			

Source: NFER (2017)

How schools and teachers perceive IB Support

Table 3.28 (p. 53): One-way ANOVA results

ANOVA

Consider the additional support from the IB. To what extent do you agree that IB provides useful support .

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.331	2	10.666	5.775	.003
Within Groups	884.594	479	1.847		
Total	**905.925**	**481**			

Source: NFER (2017)

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