# Research summary

## *Use of technology in secondary mathematics*

**Extracted from a research report prepared for the IB by:**

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# Introduction

This study aims to provide insight into the use and integration of technology into the curriculum, classroom practice and learning in secondary mathematics courses. The report includes a literature review of a comprehensive range of empirical studies on the use of technology in senior secondary mathematics education as well as a comparison of the IB's intended and implemented Diploma Programme (DP) mathematics curriculum with the intended and implemented curriculum from six different countries. These six countries (Australia, England, France, The Netherlands, New Zealand and Singapore) provide national variation, some very important innovations in the use of technology, and are all OECD countries. The report contains sections on: curriculum, types of technology used, learning, student skills and competencies, pedagogy and assessment. The objective of this comparative study is to examine the role of digital technology in the six countries to inform the IB's review of mathematics curriculum in the DP.

# Summary of findings

**Curriculum**

Curriculum documents for mathematics published by the IB and all six countries mention technology as an explicit element in the mathematics curriculum. There are differing views in the documents on the level to which technology should be integrated into the mathematics curriculum.

There seems to be a gradual movement in some countries towards more focus on modelling and applications, at the cost of complex, calculations carried out by hand. Some initiatives go beyond this gradual change. Although Scandinavia was not within the remit of the study, some Scandinavian countries do (partial) examination sessions in which students use computers with a focus on modelling and applications. This will certainly impact curriculum and teaching practices.

**Types of technology used**

The most commonly referenced technology in the documents published by the IB and all six countries is the graphic display calculator. In two countries, calculators with symbolic manipulation facilities are used/referred to and there is some experimentation with the use of such calculators in other countries as well. In mathematics lessons, computer labs are not uncommon and there has been a rise in class use of laptop/tablet computers in recent years. The use of video clips and online courses has also been increasing. The availability and use of interactive whiteboards by teachers varies from regular to occasional between the six countries. Teachers in all countries use internet resources to find and share content.

**Learning**

The impact of technology on student learning is difficult to measure due, in part, to differences of opinion among mathematics educators as to what "learning" means, particularly between those who see technology as a medium to communicate mathematics to students and those who see technology as a means to enhance students' mathematical understanding. However, a review of the literature suggests qualified success. One review of graphic calculator use states that they can aid students' understanding of concepts. A second review of all technology use reports that technology is making a modest improvement in students' learning of mathematics. Research consistently shows that the organization of classroom resources is a crucial factor and that student learning is sensitive to small differences in the way computer-based tasks, work on paper and whole-class teaching are used.

**Student skills and competencies**

Technology introduces new skills that students must master, such as, setting up suitable scales on a graphic display calculator and making mathematical rather than simply visual links between geometric objects in geometry software. Apart from skills in using technology, students need to acquire skills in interpreting displays and making connections between numeric, symbolic and graphic/geometric mathematical

representations. Without these skills students may, for example, accept a graphic image uncritically, without attempting to relate it to other symbolic or numerical information.

**Pedagogy**

Although the teacher is key to the successful use of technology in the mathematics classroom, incorporating technology into teaching remains a challenge for many teachers. Additionally, the amount and type(s) of technology used in classrooms varies a great deal. Reasons for this include teachers' perceptions of the nature of mathematical knowledge and how it should be learned and teachers' understandings of the principles, conventions and techniques required to teach mathematics using technology. Research suggests that teachers want professional development that models planning and pedagogy so they can meaningfully integrate technology into their lessons in ways that help students learn mathematical concepts (Goos, Bennison 2008). In addition to attending training courses, collaborative work to develop resources and classroom approaches are important as such work aids teachers' critical reflection on their practice and their professional development.

**Assessment**

The IB and all six countries use high stakes examinations that permit the use of technology in at least some of the examination papers. All allow graphic display calculators and some allow calculators with symbolic manipulation. None allow internet use or printing. There are differences with regard to marking and grading procedures, examinations being set centrally or in the school, lists of approved technology (or not), the need to clear memory (or not) and whether questions are chosen that expect or allow the use of technology. A study which included IB examinations concluded that there have not been major changes in the examination questions due to technology.

Research literature on technology-assisted assessment is sparse, particularly with regard to formative assessment. Studies on e-assessment are in their infancy but point to the need for guidelines to avoid simply assessing what current technology enables. Studies on summative assessment point to several challenges to incorporating technology, including: focusing on a single tool with the expectation that the student will be able to use this tool; disadvantaging lower attaining students by offering fewer points for examination questions that require more basic skills; and the difficulty of designing "good" technology assessment tasks.

# Recommendations

Based on the findings of the study, the authors recommend that the IB focus on two issues during the review of the DP mathematics curriculum.

**Tools and resources**

The authors suggest that the IB may be placing too great an emphasis on the use of graphic display calculators. Tool use should be seen in the context of the resources available in classrooms. A challenge for the IB is to consider a wider range of tools and resources available for DP mathematics, such as: traditional mathematical tools; techno-mathematical tools with capabilities for algebra, geometry and calculus; traditional resources such as textbooks; and digital/internet-based resources for teaching and learning. While IB staff have an obvious role in taking this process forward, it is important that IB World School teachers actively participate in finding solutions to these challenges.

**Pedagogic practices and professional development**

The quality of IB teacher support materials and workshops appears to be very high, however, the IB should consider whether additional support may be necessary for the integration of technology into DP mathematics. The success of technological integration requires access to technology, the development of

technological knowledge and assisting teachers to develop modes of organizing classrooms for student learning. This study points to the benefits of collaborative work between teachers in this endeavour.

A model that has garnered some success is structuring professional development as a community of inquiry that is based in everyday classroom practice and in which all participants are co-learners. Additionally, knowledge, classroom practices and resources should be developed, shared and evaluated by the group. Given the geographical distance between IB World Schools, online communities can be set up to facilitate such communities of inquiry.

# References

Goos, M and Bennison, A. 2008. "Surveying the technology landscape: Teachers' use of technology in secondary mathematics classrooms. *Mathematics Education Research Journal*. Vol 20, number 3. Pp 102–30.

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

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