RESEARCH SUMMARY

The integration of technology in the International Baccalaureate Diploma Programme

Summary developed by the IB Research Department based on a report prepared by

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Background

This study examined how digital technology is being used in IB World Schools in the United Kingdom (UK) to support teaching and learning in the Diploma Programme (DP) curriculum areas of mathematics and sciences. The study aimed to: 1) document teacher and student technology adoption, comfort and skills; and 2) identify examples of good practice of technologies in context to enhance learning in DP sciences and mathematics courses and to inform IB policy and teacher practice.

Research design

This research reflects work undertaken in 40 different schools, 16 state and 24 private, from across Scotland, England and Wales. The fieldwork strategy aimed to document both the extent and the character of ICT use around science and mathematics subjects. To achieve this, the researchers used surveys and interviews. The first survey (Technology in science and maths) was administered to classroom teachers of those curriculum subjects (n=120). The second survey (ICT provision in your school) was addressed to the person(s) in the school most familiar with ICT provision (n=26). Follow-up interviews were conducted via telephone with 12 of the survey respondents. Observations of classroom technology integration and analysis of school documentation were conducted in seven case study schools. These schools included both state and private schools and were located in England, Scotland or Wales (see Table 1).

School identifier	Type of school	Location
C	State	England
D	State	England
F	State	Wales
I	Private	England
J	Private	Scotland
M	State	England
N	State	England

Table 1. Case study schools

Findings

Planning, implementing and integrating technology in schools

While technology planning and infrastructure were consistently good, the practices within the technology infrastructure were highly variable. Thus integration occurred along a continuum ranging from what could be categorized as "high confidence", meaning a seamless use of technology to enhance students' learning in appropriate and creative ways, to "lower confidence", where technology was used more for the transmission of information and involved more generic tools.

Additionally, it should be notated that DP science and mathematics curriculums are found in a variety of institutional contexts. As such, IB practitioners are often adapting to the technical affordances and constraints of policies formulated within the wider context of a host institution.

Hardware infrastructure: Network provision

The survey data reveals that in the majority of responding schools, students and their teachers can access a wireless network. Moreover, no school that provided a wireless network reserved its use exclusively for teachers.

Software infrastructure: Learning platforms

The ICT survey results showed that over 80% of responding schools used a virtual learning environment (VLE), course management software (CMS) or learning management system (LMS). When asked to specify which system was in use, 12 different systems were mentioned. While the majority of the case study schools used Moodle, two schools used ManageBac.

Access infrastructure: Bring your own device

School observations indicated that a "bring your own device" (BYOD) policy in schools was one of the main indicators of successful technology planning and integration. Almost all schools surveyed have some form of BYOD provision although many schools had restriction policies concerning the use of students' own devices. In general, Diploma Programme students (and others their age in

mixed curriculum schools) were allowed to use their own devices although restrictions were in place for younger students.

The increasingly global availability of mobile devices such as smartphones and tablet computers as well as effective WiFi access suggests that the potential of these devices for collaborative learning, learning outside the classroom and learning through inquiry and exploration can be maximized. Although some concerns were expressed regarding playful multitasking with these personal devices, distraction was not regarded as a major challenge to creative application, especially for DP students.

BYOD policies may also have some benefit for student differentiation. Technology was regarded as a way of supporting students' individual learning needs, especially in schools with well-integrated BYOD policies, allowing students to adapt and customize their own technologies for learning.

Implementation: Whole-school strategy

In the survey and interviews with ICT professionals, a factor which emerged as key to successful technology integration was the importance of a whole-school strategy. In three cases, schools had developed highly distinctive ICT strategies. At School F and School J the strategy could be described as one of "open-mindedness" with efforts being made to provide staff and students with the digital tools to enable them to become successful teachers and learners without being restricted to an Apple or Windows operating system.

Implementation: Knowledge sharing

A major challenge of technology implementation is filling the knowledge gap. The study highlighted various means of drawing on the knowledge of other professionals and modes of sharing, including continuous professional development (CPD), the online curriculum centre (OCC) and social media.

There are clearly opportunities to make use of technology itself to address training and support needs. For example, some schools had put in place forms of online training via their VLE. Additionally, some teachers made use of external websites where practice was discussed and resources exchanged. These sites included the OCC, which could continue to be a useful source of examples. Finally, teachers might be encouraged to see the potential of social media as a means of linking with others in the profession.

With oppressive demands on staff time, it will be important for school management to cultivate more informal and just-in-time methods of knowledge sharing. The most effective forms of inspiration, encouragement and support come from trusted colleagues although they need not be part of the same institutional community.

Perceptions of enablers and challenges of technology integration in DP science and mathematics courses

Enablers and challenges to ICT use

As the figure illustrates, no single issue was seen as creating an insurmountable barrier to using ICT for teaching and learning. However, three issues were raised as causing more problems than others: school space organization, school time organization and the pressure to prepare students for tests and exams.
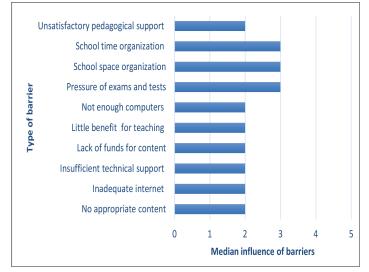

Figure 1. Barriers to the use of ICT in teaching and learning (Teacher survey n=120)

The case study observations highlighted a number of other enablers or challenges to ICT use.

- **Time:** When asked explicitly about challenges to the integration of technology in sciences and mathematics, many teachers said that time was the main obstacle. Allowing more time within the DP science and mathematics curriculums for students to engage with inquiry-driven uses of technology may have the potential to enhance the pedagogical experience of students.

- **Money:** Government cuts have impacted state-funded IB World Schools, and the costs of integrating handheld graphic calculators, systems such as IBIS and ManageBac and electronic resources for learning may continue to be a significant challenge to schools offering the DP in the UK.

- **Professional development:** Formal CPD opportunities were rare, and this may be an area for consideration and potential development by the International Baccalaureate Organization and by individual IB World Schools. Additionally, informal CPD opportunities and knowledge sharing occasions are crucial for teachers to feel competent in using necessary technologies.

- **The syllabus:** In some cases, the DP science and mathematics syllabuses were considered the driver for technology integration throughout a school or department. Teacher interviews showed that by explicitly requiring technology use, the curriculum has the power to change not only how IB students learn, but how wider school communities adapt and change their pedagogical practices. One challenge of the DP was the intense and heavy workload involved for students to be successful in the programme, which restricted time for ICT use and experimentation.

Teacher survey responses about the use of technology

Two parallel questions in the teachers' survey addressed the issue of what types of teaching and learning activities occur around and through technology (Table 2).

This data shows that, for most of the respondents, technology frequently supports their teaching activities. It is not surprising that browsing for information/resources on the internet is very common, with most teachers reporting doing this either daily or weekly. The other activity that technology seems to support is permitting teachers to communicate directly with their students; the majority of teachers reported doing this daily or weekly.

Another survey question asked teachers to rate the frequency with which they or their students used a variety of hardware or software. Traditional computers were by far the most frequently used technology with many teachers reporting daily use and almost every teacher using a laptop or desktop computer in their classroom regularly. The second most frequently used technology, the interactive whiteboard, was used daily by 40% of teachers, although nearly 30% never used it at all.

Teachers' uses of technology in the classroom

Presenting lesson content

Teachers reported using technology to present ready-made content-driven information. In some cases, the examples given simply replaced "old technology" such as books or blackboards with contemporary ICT such as e-books and interactive whiteboards.

Other examples of ready-made content-driven materials discussed by teachers included web-based scientific simulations such as those produced by PhET[1] or VPLab[2] as examples of "virtual and remote laboratories". From the teachers' and students' perspectives, being visually engaging, these ICT-based materials have the advantage of helping

students to understand more abstract principles and multi-dimensional concepts. Their use in IB World Schools allows students to engage with a wide range of experiments and observations that may otherwise be constrained by physical and budgetary factors.

Producing lesson content

Teachers also discussed producing ICT-based materials for expository purposes. One teacher, for example, recorded all his IB mathematics lessons and made them available on the school's virtual learning environment (VLE) for students who had either missed lessons or wanted to review specific content. In other cases, teachers made screencasts or recordings using tablet computers, which again could be uploaded to the VLE to allow students to revisit particular lessons or topics.

Facilitating inquiry-driven learning

Learning through inquiry is a central tenet of the DP curriculum, and thus a familiar mode of knowledge building for DP teachers and students. The findings suggest that technology is becoming a means by which inquiry can be fully embedded into the science and mathematics curriculums. PhET, VPLab and other similar simulation websites offer plentiful opportunities for engaging in inquiry-driven learning in DP science curriculums. Through these simulations, students can form and test hypotheses and develop a questioning and critical approach to scientific study. Graphic display calculators (GDCs) offer another opportunity for inquiry learning. A number of teachers valued GDCs for providing students with a way to explore and experiment with different mathematical functions:

… it helps my students explore without fear and what I mean with that is … the graphical calculator environment it is like a playground and whatever you type in the handheld will do and it will do it correctly so you can experiment and try a few things out without fear of getting it wrong and you will get answers that may surprise you and challenge your thinking. (Maths teacher, School J)

[1] https://phet.colorado.edu/

[2] http://www.colpus.me.uk/vplab/

Activity	Never	Occasionally	Monthly	Weekly	Daily	Missing
Browsing the internet to find learning resources for students	3%	8%	16%	39%	35%	0%
Browsing the internet to find information yourself	1%	8%	10%	32%	49%	0%
Digital communication with a wider community of teachers	14%	33%	15%	20%	18%	1%
Digital communication with parents	16%	36%	26%	18%	5%	0%
Digital communication with students	4%	22%	18%	38%	19%	0%
Posting homework for students	25%	26%	11%	26%	12%	1%
Using ICT to collect feedback and/or assess students' learning	32%	38%	12%	15%	3%	0%

Table 2. Frequency of teachers' usage of ICT activities in preparing or teaching (Teacher survey n=120)

Where there is scope for further adoption of technologies in this realm, schools and parents should be strongly encouraged to do so. Technology-aided inquiry-driven learning is both accessible and commonplace, and is in accordance with the DP principles and policies for student development in the 21st century.

Students' uses of technology in the classroom

Using own devices to support learning

In one case study school which had a strong, fully operational BYOD policy for students in the DP, students were observed using their own devices in multiple ways to support their learning in class. These included:

- **Accessing the VLE/LMS/CMS to download resources for use in the lesson:** In instances where teachers had uploaded resources for the lesson into the VLE/LMS/CMS, students were observed accessing these materials on their own devices during the lesson. This allowed them to view these resources easily and to benefit from the hyperlinks provided in the materials which took them to further resources.

- **Accessing third-party online resources, such as databases and quiz software:** Integrated BYOD approaches enable hassle-free access to a wealth of learning resources available online.

- **Using tablet computers to take photos of whiteboard screens and books:** Students were frequently observed using their own devices to enable them to see displayed resources more effectively, or to retain a permanent record of the resource. Teachers reported that this is a use of technology which is particularly helpful for students with special educational needs (SEN), however, the researchers observed these actions in students across the board.

- **Inquiry-driven learning and technology integration:** The authors present a number of examples of how students' own devices (including GDCs) can support inquiry-based learning. For example, in one case, students used their personal mobile devices to record a biology experiment which would allow them to revisit this activity for future reference.

Conclusion and recommendations

Technology integration in the DP science and mathematics curriculums was a feature of all the schools which participated in this study. Hardware and software infrastructures were generally robust and the importance of maintaining strong systems was a given in all of the schools.

Throughout this study, the researchers have sought to identify innovative pedagogical practices, integrating technology use. Although the study uncovered much excellent practice, overall few of the practices could be called highly innovative. However, this must be understood in relation to both the considerable pressures under which teachers are working and the limitations of the study. Although a large sample of 154 IB World Schools were initially invited to participate in the survey, we only received a 26% response rate. Additionally, IB World School teachers work under time pressures and must meet the requirements of local assessment regimes. The full report highlights areas where more innovative development in the use of ICT might be possible, notably, collaborative learning, inquiry learning, digital construction, gaming and simulation. The study also indicates that the IB tradition of community-building could be more fully pursued through the communication potential of new technology.

The main tenet underpinning this work is that while the technology available for use in educational contexts is fast developing in quantity and quality, the pedagogy driving the technology must remain at the forefront. The authors suggest that technology should act as a "carrier" or "vehicle" for the potent interactions of teaching and learning. This is not to deny the distinctive opportunities arising from adopting new technology, as, often, digital tools provide a more economical or comfortable solution for creating the desired interactions. However, innovation and implementation should always be driven by pedagogy.