CONTS

Flash technology opportunities and challenges for 'high stakes' assessment: A conversation between different stakeholders.

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The paper is a report based mostly on a panel discussion that considered the dilemma presented by Flash application technology and its availability in the examination setting. The opinions expressed are mostly those of the two authors with some input from participants. Principally we identified the divergence between where we want to go with technology ideally, and where we can go with technology practically. A central theme that resulted in this conversation is that those "other" subjects using handheld technology, long left out, must now necessarily be brought into the conversation as important stakeholders.

C.J. Sangwin (2002) has recently illustrated that much of the current conversation surrounding the use of technology is at least four centuries old, when the first argument over the use of slide rulers in teaching took place.The arguments of today, pro and con, are identifiably similar to those of William Oughtred and Richard Delemain, rival inventors of the slide rule. It is an embarrassing fact that "education is the only business still debating the usefulness of technology" in this new century (Stesing, 2003).

This strongly suggests to the authors, that the conversation of whether to use technology should be abandoned. Instead an earnest conversation of how to take advantage and direct appropriate use of technology now needs to be undertaken and must include all stakeholders, within and outside of education, and this conversation must include other subject areas.

Were we want to Go

Mathematics "consists of concepts. Not pencil or chalk marks, not physical triangles or physical sets, but concepts, which may be suggested or represented by these physical objects." (Hersh, 1998, p.15) As a consequence, mathematics education should be about learning and applying these concepts. Mathematics education is also amidst an ongoing change in the use of new technologies in the classroom and as Kaput recognises:

> The computational medium alters the growth of mathematical content, changes which content is important and for whom, changes the means by which it can be known, taught or learned, changes the socio-cultural milieu in which teaching and learning occur and in which the institutions of education live, changes the relations between schooling and living … (Kaput, 1998)

Within the context of the rapid development of technology and the development of a conceptual understanding of mathematics, which is more than about the learning of procedures and rules, there needs to be a recognition that school mathematics should also consist of more than the use of, and testing of, such procedures and rules. It is at this point that a conflict arises. Whilst technology is developing at a rapid pace, educational systems are slow to evolve especially in the context of 'high stakes' assessment at the end of high school. If we wish to adopt new technologies and new ways of doing mathematics in schools then high stakes assessment is one of the most significant influences (Barnes, Clarke, & Stephens, 2000).

Flash Applications

Whilst the graphics calculator and handheld Computer Algebra System (CAS) are recent developments in school mathematics, it is the inclusion of flash memory applications (APPS) into these tools that have provided the greatest opportunities, and also the greatest challenges, for mathematics educators. Authors, such as Waits and Demana, have recognised that "Flash Technology means that calculator functionality can expand as curriculum needs change." (Waits & Demana, 1998) Thus, technology provides mathematics educators with opportunities for the enhancement and personalisation of the hand held technology to meet local goals.

It is the power of the flash memory that provides both the opportunities and challenges for mathematics educators, and opportunities for students include the use of, or to write their own application to further their understanding of mathematical concepts. The challenge however, is the sense of 'fairness' where some students have access to an application that other students do not have, an issue that becomes particularly important when dealing with 'high stakes' assessment used for certification purposes.

However, it is not the flash applications that are at fault here, it is the way in which examination boards operate their mathematics assessment programmes. Examination boards cannot continue to modify examinations and examination questions to meet every new technological innovation, therefore maybe it is time to reconsider examinations. That is, if examination boards are to continue to try and create a 'level playing field' by ensuring that everyone has the same tools then the board will always be trying to catch up to the latest development in technology. If however, they focus their mathematics assessment regimes on concepts and allow students to have access to all resources they wish to have such as books, notes, graphics calculator, CAS etc then assessment will become about finding out what the students' know and not what routine procedure they can, or cannot do, that is

> One of the primary goals of the changes that AP Calculus has undergone in the past several years is to move away from testing of rote manipulation and toward problems that probe an understanding of the fundamental concepts (College Board, 2003)

Flash applications can support this development in assessment, and thus banning of such applications will hinder their use as a cognitive learning tool throughout school mathematics and limit much of mathematics assessment to the completion of routine procedures and tasks.

Where we can go

Jennifer Lee points out that fancy calculators draw wide praise but raise some serious ethical questions (1999). On the pragmatic side, we need to recognize that APPS are among many different technological possibilities that have been with us for at least a generation. While Waits & Demana (2000, p. 61) describe flash memory as "perhaps the single most significant advance in calculator technology that has huge ramifications for the future of calculators in mathematics classrooms", examiners quickly raise the question: "What is, in the end, really possible here?" Given even the best intentions in the development of an assessment regime, is it really possible to claim an unlimited use of technology in examinations?

What is the problem, really?

A serious challenge is that the availability of flash memory renders it very difficult to tell what capabilities a particular calculator provides to its user (Kissane, 2000). Let's take a look

at the use of the Flash Application Periodic and its impact on an examination question. One outcome statement in the current IBO standard level chemistry syllabus (IBO, 2001) reads as follows:

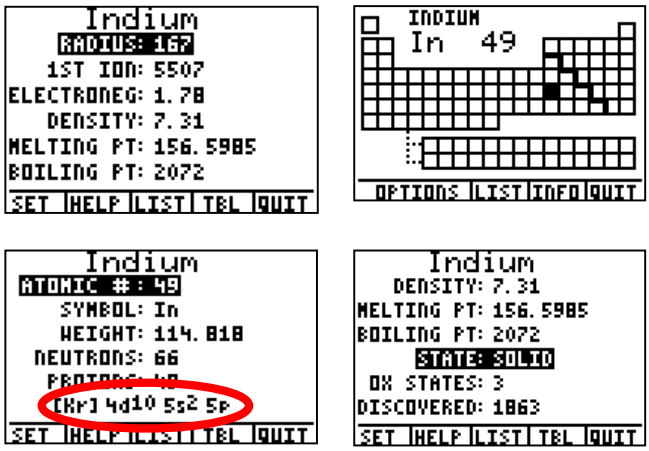
- Students must be able to state the electron arrangement using their understanding of the information provided in the periodic table.

A question on a recent chemistry examination paper reflects this outcome statement:

- Question: State the electron arrangement of Indium. (Printed periodic table is provided to student)

  Markscheme (solution): $1s^2 2s^2 2p^6 3s^2 2p^6 3d^{10} 4s^2 4p^6\ 4d^{10}\ 5s^2\ 5p$ or [Kr] $4d^{10}\ 5s^2\ 5p$

- Screenshots from the APPS "Periodic" on a TI-83 SE plus:



Should this question be inappropriate ONLY because the calculator gives the answer? One could suggest that the question does not test "chemistry thinking". But recall the outcome statement "Students must be able to state the electron arrangement using their understanding of the information provided in the periodic table". We want students to access and understand as much technology as we can "afford" in the classroom for learning and assessment, but we know that the same technology is creating some major difficulties in assessment, especially in terms of equity or fairness. It would be understandable to ban such an APPS, especially as such an APPS does not really add value in teaching.

Mathematics has seen some fairly radical core changes in what we teach over the last decades, the "new maths" program for example. Science subjects, on the other hand, seem to have remained fairly traditional in their offerings, perhaps because the nature of the subject has less room for maneuvering than mathematics. Many subjects using calculators in examinations are still over reliant on "rote manipulation" type assessment regimes. Implying that these subjects have serious issues to consider in terms of examinations if a shift in the assessment regimes is not achieved. Yet, can these subjects be completely open to unlimited use of technology in examinations? The pragmatic reality, for examination boards, is that students can use only one calculator for their examinations and any subject that permits the use of technology in examinations should consider the stake holders in deciding the level and type of technology for use in examinations.

Some believe that the answer lies in technology free examination components. But this seems only to transfer and concentrate issues to components that do permit technology. Numerous technology free examination components may also defeat the purpose of using technology in teaching by exposing students to an assessment environment (non calculator) that does not

match the student's learning environment (calculator). Students learning with technology at their side should have almost continuous access to technology in order to match both the learning and assessment.

Another danger of making changes in curriculum to match technological limitations might be what some have criticized as the "dumbing down" of science. In the journal *Education in Chemistry*, Paul May (2004) has suggested that making science questions fully "accessible" in a calculator free environment results in a significant "dumbing down" of the subject. Further, May argues that basic mathematical skills are having a deleterious affect on the quality of chemistry teaching in university programs. What is learned and examined [calculator free] does not reflect practical mathematics in real world science.

Change the curriculum to match the ability of technology? NO!

We believe that what is needed is intelligent use of the technology to explore and gain a deeper understanding of the subject matters, i.e. using technology as a cognitive tool, and the resulting appropriate inclusion in assessments. Do we need to make changes/modifications in curriculum to match appropriate opportunities because of technology? The answer is a resounding yes! Dan Kennedy's insight into the decision making at the College Board in and around 1989 puts it quite well "If calculators did not make a difference, there was no reason to allow them; if they did make a difference students should not be allowed to use them". Indeed, educators make the demand to use/include technology in examinations **because** technology does have an impact on what students can do. Technology will have an impact on how well students do on examinations (Burrill, 2003; Leng, 2003; and others) and therefore, some limitations will be necessary to ensure a 'level playing field' in examinations. It is not a choice of using or not using.

Most subjects using technology in examinations other than mathematics have yet to realize either the challenge or opportunity of technology. How these other subjects deal with this challenge will ultimately shape how mathematics educators will advance the use of technology in learning and how we will understand both the opportunities and limitations of technology.

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