Public submission made to the Review to Achieve Educational Excellence in Australian Schools

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Summary

Computers can help students make transformational leaps in educational achievement.

This can be integrated into school curricula if students can take final exams on computers.

Main submission

This submission addresses two of the questions:

What can we do to improve and how can we support ongoing improvement over time?

Are there any new or emerging areas for action which could lead to large gains in student improvement that need further development or testing?

- What are they and how could they be further developed?

The Calculus for Kids project has shown Year 6 students can demonstrate learning achievements at first year undergraduate level. This significant learning achievement was made possible by:

- Ensuring every student had a computer for each lesson
- Providing professional mathematics software
- Giving teachers a day of professional learning
- Developing a set of multi-media learning materials.

It is our contention that similar significant gains in learning achievement could be made across the curriculum and probably for many other age groups.

The Calculus for Kids project was deliberately designed to use computers in the transformation of curriculum. The intervention used multi-media learning materials to assist teachers and Year 6 (aged 11-12 years) students understand the principles of integral calculus. They used Maple mathematics software to solve real-world problems using these principles, employing conventional mathematics notation on their individual computers. Between June 2010 and April 2016, it was implemented in 23 classes at 19 schools involving 434 students. Two methods were used to calculate effect sizes of 22.19 (pre-test/post-test Cohen's d) and 1.17 (age-maturation). Positive gains were also found in students' attitudes, particularly in Technology confidence.

Calculus for kids was funded by the Australian Research Council and was conducted in Tasmania, Queensland, Victoria, South Australia and New South Wales. The students were selected to be in Year 6, generally the final year of primary school (changes in Queensland meant the Year 7 cohort moved from primary to secondary school during the period of the research). The mean age of students was 12 years, with the youngest 10 years and the eldest nearly 14.

Teachers of participating schools were brought to Launceston for a day of training in the multi-media learning materials and the Maple software. They returned to their schools to deliver 12 lessons, after which the students took a test based upon first year engineering degree integral calculus exam. During the test students solved real-world problems by constructing equations using integral calculus. They used their computers to calculate the values of these equations.

The National Assessment Program – Literacy and Numeracy (NAPLAN) tests use nationally validated items to ensure calibrated results (Australian Curriculum, Assessment and Reporting Authority, 2015b). For the pre-test measures, we used these national calibrated numeracy test results (NAPLAN) from each school, which are publically available MySchool, 2017). The common post-test was derived from the university first year engineering degree integral calculus examination. The national professional engineering body, Engineers Australia, re-accredits all engineering degrees at least every five years. This provides assurance the questions were at the correct level, and gave validation to the construct validity of the post-test, and that the items were of the correct standard. The post-test scores were mapped onto the calibrated first year engineering bachelor’s course, and therefore to Years 12/13 (Fail/Pass) on the notional national numeracy year level scale (university entrance occurs after Year 12) (National Assessment Program, 2016). We used Cronbach’s alpha to calculate the reliability of the post-test. It came to 0.796, giving an acceptable value of reliability. Boys and girls did equally well in Calculus for Kids (Chin et al., 2016).

This is not an isolated example. Our companion project Science-ercise has been conducted in a smaller number of schools, but shown similar results. Year 6 classes were equipped with Excel template spreadsheets and studied parabolic motion, the dual-nature of light (quantum mechanics) and special relativity. These students showed they were perfectly able to understand the principles involved, and with the computer to perform the complex calculations, demonstrated learning achievements well above their chronological age.

This diagram shows how computational thinking can extend across the curriculum.

Conventional School Curriculum

Mother tongues

in local language Art Geography History Mathematics

Religion Science Sport/PE

Computer Science /Informatics

Computing/Digital Technologies

Computing and associated theories studied as a separate subject

IT/ICT - the applications and connectivity used by students to enhance learning in all subjects

Information Technology - the hardware and operating systems operated by people in educational contexts.

Are there barriers to implementing these improvements?

If yes, what are they and how could these be overcome.

Australia should take a leaf from the book in Finland. That country has implemented its Abitti project. Abitti has commenced putting university entrance examinations in schools onto computers using a BYOD approach. Students become familiar with the process in Year 9 & 10, and carry on taking their exams in university.

In Australia, the OLT has funded the eExam project. An eExam (e-exam) is a timed, supervised, summative assessment conducted using each candidate's own computer running a standardised operating system. Such examinations have advantages over paper-based exams, and can include new multi-media, simulation and software test items which give higher validity in respect of professional work practice.[

Australia should consider a national project to take forward the work of NAPLAN online, and transform curricula through the final examinations being held on BYOD computers. Pedagogically, this would be best using a custom operation system, not a multiple choice response system.

References

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