Submission on the ACARA consultation draft senior secondary Australian Curriculum (for Mathematics & Science)

Open Source Industry Australia Ltd

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About OSIA

OSIA is the national body representing the open source software industry in Australia. It exists to further the cause of both free and open source software (FOSS) in Australia and to support its members to improve their business success in this growing sector of the global information and communication technology (ICT) market. It also provides authoritative and consistent information about open source software. For further information, see the OSIA website at http://osia.com.au.

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1 Observations

OSIA welcomes the Commonwealth Government's initiative to help State & Territory authorities standardise senior secondary school curricula across Australia.

However, OSIA is concerned to note the conspicuous absence of Computer Science from the subjects covered by the *Science* & *Mathematics* learning areas outlined in the consultation draft.

We note that the *Curriculum Design Paper* (version 3) provides for Information and Communications Technology (ICT) as a general capability, to be addressed across all subjects. This general capability, as described in the Paper, covers only the *use* of ICT.

Clearly, in the 21st century, incorporation of some end-user treatment of ICT in most secondary subjects is likely to be beneficial to all students, regardless of whether or not they intend to pursue a career in the that field. But it is concerning to see that come at the expense of any treatment of the *principles that underlie* all ICT – i.e. Computer Science (CS) – in stark contrast to the sound treatment provided for the physical/natural sciences.

We note also the inclusion of the *Technologies (ICT and Design & Technology)* learning area, as described in *The Shape of the Australian Curriculum* (also version 3). Whilst there is little information available about plans for this learning area at present (the *Shape* document points out its development is scheduled for Phase 3), the ICT (cf. CS) nomenclature traditionally indicates a focus on the effective *use* of ICT, rather than how and why it works.

In order for Australia to continue to support a thriving computing industry (and of particular interest to OSIA, a thriving open source software sector), it is important to ensure that the next generation of Australians have every opportunity to gain a thorough grounding in the underlying principles of computer science, not just the skills necessary to use the technologies produced by the sector.

OSIA takes some solace in noting the inclusion of several foundation topics in the draft curricula for the *Physics*[1], *General Mathematics*[2] and *Specialist Mathematics*[3] subjects, which any student of computer science would find invaluable.

However in the absence of a CS subject in its own right there does not appear to be an opportunity for students to build upon those topics to gain an understanding of the fundamental principles of computing.

1.1 External observations

Whilst not directly related to the consultation draft, it is nevertheless worth mentioning the importance of those who *teach* computer science in our nation's schools themselves having the benefit of a sound computer science education. The same of course is true for all subjects taught, but there is a particular need to highlight it for computer science, as it is a relatively new discipline, having arisen less than a century ago and having been recognised as a science in its own right for but a few short decades.

In an ideal world, every secondary school subject would be taught by a teacher with tertiary qualification in that subject, in addition to in education. But we're well aware that that is not yet the case universally for even the most mature of subjects and that to require that across the board immediately would perversely lead to less educational opportunities being on offer to today's students.

However, it is clear that in computer science, as with any other subject, being taught by educators with *some* domain-specific expertise at a depth greater than the topics on the curriculum is likely to have a marked positive effect on the quality of learning outcomes for the students.

Anecdotal evidence, at least, suggests that this is more of an issue in computer science than in other, more mature, subjects.

[1] Basic electromagnetism in Units 1 & 3
[2] Linear algebra & graph theory in Units 1 & 4
[3] Permutations & combinations, deduction & induction in Unit 1; linear algebra & graph theory in Units 2 & 3

2 Implications

There have been a plethora of articles published over the last year or two about flagging enrolments both in ICT subjects at the secondary level and in ICT & Computer Science courses at the tertiary level. From OSIA's perspective, the reasons for this, at least as far as secondary school subjects are concerned, are quite clear:

1. Existing secondary school ICT subjects are not pre-requisites for tertiary computing courses, nor even for tertiary ICT courses. As a result, any computing that may be taught in them is likely to be re-taught in the first year of a tertiary computing course (whereas if there was sufficient computing content for the subject to be made a pre-requisite for entry into tertiary computing courses, CS students could start university on equal footing with students of the other sciences).

   With students being limited now more than ever before in the maximum number of subjects they can enrol in during their matriculation year, even those bright students who have already decided to apply for admission to a tertiary course in computing are unlikely to take those subjects in high school (why would they spend two years on a cursory treatment of a subject which they know they'll get a more thorough treatment of, presumably from first principles, during their first year at university?).

2. Existing secondary school ICT subjects are seen as "soft" options. Brighter students naturally gravitate towards:

   (a) those subjects that tertiary courses tend to require as pre-requisites (for their preferred degree, if they've chosen one already, or in many cases, for a set of multiple careers paths they have yet to choose between at that early stage, in order to postpone the choice until they have to lodge their uni applications); then with whatever options they have left over

   (b) those subjects the successful completion of which (with high marks) is likely to carry greater gravitas.

   With students in some States now limited to taking only 4 subjects in matric (half the maximum of only 20 years ago), and ICT relegated to "soft" option status, it's difficult to see how any student planning on going on to any vaguely science-related tertiary course could choose a combination other than English, Mathematics, Physics & Chemistry.

The proposed transition from current ICT subjects to the new *Technologies* learning area, and all that that seems to entail, appears more likely to exacerbate that problem than to alleviate it.

2.1 Global trends

It is instructive to note that the United Kingdom appear over the last year or so[4] to be moving in the opposite direction to Australia on their treatment of computing in secondary education.

Both the *British Computer Society*[5] (in the UK) and the *Association for Computing Machinery*[6] (in the United States) have called for stronger CS curricula in high schools, and – at least in England and Wales – the relevant authorities appear to be heeding those calls.

It would be sad indeed for Australia to be left behind.

Programmes like the soon to commence trial re-introduction of Computer Science to the senior secondary curriculum in some Victorian schools[7] are to be commended, but are no substitute for a nationally consistent senior secondary CS subject.

[4] See, for example, http://www.zdnet.com/it-centric-gcse-on-way-to-boost-kids-coding-skills-3040154601/
[5] See http://academy.bcs.org/category/16234 and http://academy.bcs.org/category/16655
[6] See http://csta.acm.org/Curriculum/sub/CurrFiles/CSTA_K-12_CSS.pdf
[7] See http://www.theage.com.au/it-pro/business-it/high-schools-to-trial-uni-computer-science-in-y12-20120719-22c99.html

3 Recommendations

3.1 Recommended approach — a Computer Science subject in the Science learning area

From an industry perspective, to help assure a bright future for the sector in Australia, OSIA sees a clear and pressing need to re-introduce computer science to the senior secondary curriculum, as a subject in its own right, alongside the more traditional physical/natural sciences.

Computer Science, as an academic discipline, has fought long and hard to be recognised as a "real" science.

Today, it is recognised as such by the vast majority (if not all) of Australia's tertiary institutions. OSIA calls for ACARA to extend that recognition across the secondary education sector.

The distinction between "soft" and "hard" subjects is not just academic snobbery.

When it comes to computing, that difference tends to translate to the difference between teaching *principles* and teaching *to products:*

A "hard" (CS) subject would be one in which the *fundamental principles* of computing were taught, leading to learning outcomes which stay with the student for life, and can be applied naturally to any of the technologies of tomorrow.

A "Soft" (ICT) subject would be one which involved teaching *to specific products.* This has two major drawbacks (in addition to being insufficient to achieve pre-requisite status with tertiary institutions).

Firstly, by the time those students enter the workforce, the products they were taught to use at secondary school will already be obsolete.

Secondly, if a subject taught in this manner is to be assessed by a standard examination, the specific products taught would likely need to be the same across all schools, leading to a generation of Australians matriculating with a thorough grounding in *only one particular set* of ICT products. Experience has shown that, particularly in the software arena, fostering of such mono-cultures tends to lead to a stifling of innovation – an outcome diametrically opposed to the central aim of education in technology.

Both tomorrow's industry and today's students would be better served by the availability of a "non-soft" Computer Science (not ICT, nor "Technologies") subject in the senior secondary curriculum.

Such a subject should aim to teach fundamental CS principles, just like any of the other "real" sciences, rather than settling for a treatment of the periphery, which is never likely to attract pre-requisite status from the universities, and therefore never likely to attract substantial enrolments, especially from high achievers.

3.2 Alternative approaches

3.2.1 A Computing subject in the Mathematics learning area

The terms "Computing" and "Computer Science" have been used somewhat interchangeably to date. Both names imply a study of the fundamental principles (as opposed to IT, ICT, or just "Technologies", which suggest a study of the applications).

Whilst "Computer Science" has for some time been recognised as a science in its own right, "Computing" has traditionally been seen as a branch of Mathematics – both classification schemes have their merits.

If Computer Science cannot be established as a subject within the *Science* learning area, perhaps Computing could be established as a subject within the *Mathematics* area of learning (perhaps with a greater emphasis on those aspects of the discipline more usually associated with the field of Mathematics).

3.2.2 CS/Computing topic(s) within the Specialist Mathematics and/or Physics subjects

OSIA's preferred approach would be to see Computer Science in the Australian Senior Secondary Curriculum as a suitably robust subject in its own right, within either the *Science* or *Mathematics* learning area, as outlined above.

However, we are aware that in order to preserve the proposed schedule for introduction of a national curriculum, that may pose some difficulties. In the event that such difficulties prove insurmountable, we feel compelled to mention as an alternative, compromise approach, the re-introduction of Computer Science / Computing topics to existing subjects within the *Science* and/or *Mathematics* learning areas.

This alternative approach is clearly sub-optimal, but nevertheless would be a distinct improvement over the current proposal.

It is difficult to see how sufficient "room" could be made in the proposed *Specialist Mathematics* and/or *Physics* subjects for a thorough treatment of the fundamentals of computing, and such a treatment would not sit particularly comfortably with the majority of topics in any of the other proposed subjects in the *Science* or *Mathematics* learning areas.

Furthermore, doing so carries risks of its own – principally, that computing could easily end up marginalised, as has happened when similar approaches have been adopted in the past.

However, if computing has to be incorporated into some other subject, far better that the subsuming subject be Mathematics or Physics (which are at least taught with some academic rigour) than something as nebulous as "Technology".