

President

Professor Robin Batterham AO FREng FAA FTSE

Committee Secretary  
Senate Education, Employment  
and Workplace Relations Committee  
PO Box 6100  
Parliament House  
Canberra ACT 2600

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Dear Secretary,

### **Teaching and Learning: Maximising our Investment in Australian Schools**

The Australian Academy of Technological Science and Engineering (ATSE)<sup>1</sup> welcomes this opportunity to contribute to the Senate Inquiry of Teaching and Learning- *Maximising our Investment in Australian Schools*.

ATSE would like to respond to the terms of reference and provide some comments on the role of inquiry-based science education techniques in teaching and learning of science, technology, engineering and mathematics (STEM) in Australian Schools, which is one of ATSE's highest priorities, and the practical measures ATSE is taking in the area.

#### **1. The effectiveness of current classroom practices in assisting children to realise their potential in Australian schools**

ATSE is primarily concerned with science and mathematics teaching and learning in secondary schools. ATSE notes that many students do not see science as being relevant to their lives, as illustrated by Glen Aikenhead (2006, "*A recurring evidence based criticism of traditional school science has been its lack of relevance for the everyday world*"<sup>2</sup>). Many school students fail to make direct connections between school science and the world of technological and engineered products and systems around them. ATSE schools science & technology (S&T) program has core initiatives aimed at enhancing teacher capability and student learning experience as well as a number of extracurricular programs promoting careers in S&T and engineering. Our flagship intracurricular schools S&T program is the Science and Technology Education Leveraging Relevance (STELR)<sup>3</sup> program which has been developed to inspire interest in science, technology, engineering and mathematics (STEM) in students in Years 7 to 10, initially through the highly relevant context of Global Warming, Climate Change and Renewable Energy Resources, and lately through the context of Sustainable Living Through Science and Technology. Other career focussed activities run across a number of states include:

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<sup>1</sup> The Australian Academy of Technological Sciences and Engineering (ATSE) is an independent body of 800 eminent Australian engineers and scientists driving technological solutions for a better Australia. ATSE was established in 1976 with the mission to promote the application of scientific and engineering knowledge to the future benefit of Australia. ATSE is one of four learned national Academies, which have complementary roles and work together both nationally and internationally.  
[www.atse.org.au](http://www.atse.org.au)

<sup>2</sup> Aikenhead, G. (2006) *Science education for everyday life*. New York: Teachers' College Press

<sup>3</sup> ATSE STELR Project <http://stelr.org.au/about-stelr/>

- **Queensland:** Wonder of Science (WOS) and the Young Science Ambassador (YSA) program- where Year 6-10 students engage in challenge projects aligned to the curriculum and which emphasis STEM careers
- **Western Australia:** Eminent Speaker Program- where leading scientists, technologists and engineers visit secondary schools giving talks to inspire children towards STEM related careers
- **South Australia:** Participation in the Science and Engineering Challenge and run a Science Teacher of the Year Award
- **New South Wales:** Teaching Science & Technology K-6: A focus on literacy and numeracy and Scientists' Stories- a parent and student evening held every year
- Extreme Science Experience (held across all states)- where 300 students across 40 schools participate in a hands on experience day where they get "up close and personal" to award winning leaders in applying science of economic and/or social and/or environmental benefit

ATSE believes that awareness needs to be raised of the opportunities in careers underpinned by school science and mathematics and that school students should be able to engage practically with scientific ideas. Therefore, the STELR website displays the career profiles of young people from a range of professions that are working, for example, in the renewable energy industry. Students can research these careers and case studies of related projects to discover the study pathways necessary in order to achieve these career aspirations.

Many teachers at Years 7-10 lack both the scientific background and contemporary knowledge to effectively teach and engage students in physical and chemical sciences in Years 7 to 10. If a school does have qualified physics and chemistry teachers they are usually deployed at the senior level (i.e. Years 11 to 12). In response to this, ATSE provides professional learning workshops where teachers can increase their scientific knowledge. Furthermore, the STELR program:

- produces curriculum packages on relevant Physical Sciences, Chemistry and Earth and Space Science that map into the Australian Science Curriculum,
- provides comprehensive teacher support materials,
- offers online and phone support for teachers and
- employs retired physics and chemistry teachers to visit schools and act as mentors for teachers to provide advice on running investigations, provide advice on running inquiry-based lessons and to run cluster meetings.

*"About 70% of chemistry teachers for Years 11 and 12 have three or more years of tertiary education in chemistry....54.1% of physics teachers in Years 11 and 12 have at least three years of university physics study....44% of teachers of general science in Years 7 to 10 have two or more years of tertiary education in science."- OCS Health of Australian Science (2012)<sup>4</sup>*

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<sup>4</sup> Office of the Chief Scientist (2012), *Health of Australian Science*, Commonwealth of Australia

## **2. The adequacy of tools available for teachers to create and maintain an optimal learning environment**

ATSE has interpreted “tools” in this term of reference to refer to both equipment and pedagogies. ATSE recommends that science laboratories be resourced with sturdy, robust up-to-date equipment. Furthermore in the scientific teaching of students, they should be given skills that enable them to make evidence-based decisions from investigations they conduct in the laboratory. In response ATSE’s STELR program contains up-to-date equipment packs which fully support STELR curriculum materials in schools and can be used at other year levels within the school. The equipment is purpose designed to suit the activities and Australian-manufactured. ATSE also recommends that school mathematics teaching be supported by good quality software that expands students’ horizons and understanding of the everyday relevance of mathematics.

## **3. Factors influencing the selection, training, professional development, career progression and retention of teachers in the Australian education system**

ATSE, through the evaluation of its program STELR Stage One Project carried out by Curtin University in 2010, reported that a large number of:

- teachers of general science in Years 7 – 10 had not been trained in how to run practical scientific classes
- students in Years 7 – 10 had not conducted many scientific practical activities
- teachers are afraid to run scientific practical classes

ATSE’s STELR program responds to these issues in the following ways:

- if taken up by a school, they must commit to sending two teachers to be trained in the pedagogy of inquiry-based learning and to carry-out STELR inquiry-based activities
- the curriculum materials are written with the inexperienced science teacher in mind
- participating teachers are provided with assessment rubrics
- the sequence of activities in STELR participating classes progressively builds up inquiry-based science skills until students (and teachers) are able to conduct open-ended inquiry activities where students ask the questions, select equipment, carry out the investigation, gather and analyse data and draw conclusions

As recognition of STELR’s work in this regard, thirteen universities currently use STELR as an example of a high quality inquiry-based science resource in their teacher education programs.

In summary, ATSE strongly recommends that all practising science teachers in schools should receive in-service training in inquiry-based science education techniques. Inquiry-based methods for science teaching must also be part of the curriculum for pre-service primary and secondary teachers. ATSE also recommends that science and mathematics teachers, and those with responsibilities to provide career advice to students, are well briefed on the contemporary and prospective roles and opportunities in science, technology, engineering and mathematics.

A major challenge for Australia is to be prepared for the knowledge economy. A scientifically literate and capable society is needed now more than ever to give citizens/voters the science understanding and skills necessary to make informed, evidence-based decisions when

evaluating new, emerging or contentious science issues. This means we need an enhanced uptake of STEM studies.

ATSE trusts that these comments are helpful as to the teaching and learning of STEM subjects. ATSE would welcome the opportunity to present the STELR program and some of the teaching materials that have been developed for this program to the members of the Senate Education, Employment and Workplace Relations Committee and are pleased to discuss this matter further.

Yours faithfully

Robin Batterham  
President