

Educating Effective Global Citizens.

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Paper for delivery in association with Power Point Presentation: *Educating Effective Global Citizens*

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Introduction:

The quality of science, mathematics and technology education among our youth is fundamental to the success of Australia and all nations, in the 21st Century. It is also vital toward developing a balanced world view and an appreciation of what actions need to be taken to ensure a sustainable future for all. However, never has there been so much debate and literature dedicated to determining the problems associated with creating a science-literate population and developing strategies to solve them. The discourse includes such aspects as; engagement of youth in the process of learning, setting of a balance between knowledge and skills, training and retention of effective teachers, increase in public awareness of science and its value to society, to mention but a few.

Our daily newspapers frequently bring to our attention some very disturbing details. Recently, on March 10th, the Australian newspaper reported: "A groundbreaking review of the mathematics and statistics disciplines at school and university by the Go8 found that *the state of the mathematical sciences and related quantitative disciplines in Australia has deteriorated to a dangerous level, and continues to deteriorate*". Professor Cheryl Praeger, a mathematics professor based in W.A. warned that *Australia risked becoming a Third World country if it failed to move quickly to arrest the decline in mathematics*. We need to note that it is not just the area of mathematics itself that is suffering but all related disciplines in the sciences that are underpinned by strong capabilities in mathematics. On March 17th the Australian again reported a warning from Australian Research Council Federation fellow Peter Hall that *the "massive drift" away from senior mathematics in high school had to be arrested if universities were to produce anything approaching the required number of graduates in quantitative disciplines* (the sciences and engineering).

The problem of educating our youth toward becoming effective global citizens has two obvious challenges; the engagement of students at a time when interest seems to be dwindling and the invigoration and support of teachers so that they can inspire quality learning. Both of these problems are well documented in educational literature and interestingly, it has been a common suggestion that inquiry-based education, where students undertake science projects into issues of personal, local or global relevance, could be the key to engagement. It is by teasing out the contributing factors toward development of these local and global problems and by trialling possible solutions, that students can develop a sense of ownership over their learning and a sense of responsibility toward their fellow man. Subsequently, inquiry-based learning in the sciences has the potential not just to engage our youth in learning, but also to start them on the pathway toward demonstrating effective citizenship.

Engaging students and making classroom science more relevant:

The need for student engagement and increased relevance of science to students' lives have been documented by Goodrum et al (2001) who cite their lack in the middle years as possible reasons for declining uptake of the sciences in senior cycle. One of the recommendations of this report was that: "*the*

Commonwealth fund a national science education project for the compulsory years of secondary schooling that will produce quality curriculum resources and an integrated quality professional development program. Both the resources and program will demonstrate how student-centred inquiry can be taught in ways that achieve learning outcomes that contribute to scientific literacy”.

The publication of such materials and a committed approach to their usage across all states and territories would, in my opinion, be a solid move in the right direction. Engagement in curiosity-driven investigations, where students pursue projects of their own choices, undertake practicals of their own design and analyse data that is self generated, has the potential to considerably increase student self-efficacy. In fact, if the research were written up appropriately, accompanied by a display poster and spoken to with proficiency at a suitable forum (science fair, etc) then the sense of accomplishment experienced by the student in sharing the fruits of his/her labour, would undoubtedly lead to further self-efficacy. This concept of increasing student self-efficacy is explored by David Palmer (Teaching Science, 2004) where he suggests that there is a direct relationship between self-efficacy and effort – people with low self-efficacy about an activity will tend to avoid that activity, while those with high self-efficacy will make vigorous and persistent efforts and are thus more likely to succeed. He suggests that repeated successes at performing such tasks (termed “performance accomplishments” (Bandura, 1977)) make students realise that they can achieve success, so they will make further efforts. Subsequently, success can be seen to breed motivation.

Another article (Teaching Science, 2007) sees Russell Tytler report on the Australian Education Review, which he penned for the Australian Council for Educational Research (ACER), to bring to the public ideas voiced by national and international speakers at an ACER conference, in August 2006, dedicated to a review of science education in Australia. Upon analysis of the contributions from the conference and a wide literature review, Tytler argues that we need a new and fresh approach to school science if we are to recapture the imagination of students and do justice to the enormous range of ideas and practices of contemporary science. The review identified seven strands within which a ‘re-imagining of science education’ needs to occur. It is interesting to note that commentary on each of these strands include the need for; inquiry, catering for student interest, representation of contemporary science, investigations which flow from students’ own questions, promotion of interest and curiosity, science in authentic settings, assessment of investigative abilities. Were such a re-imagining to occur, he suggests, then it would need to be supported by a concerted (and probably national) effort to develop appropriate teaching and learning, curriculum approaches and resources that deal with science in contemporary settings, emphasising analysis and interpretation of evidence.

Clearly, there is a lot of commonality in current scientific literature where the need for independent research is advocated as an area of study and as an assessable component of Australian science curricula. It is good to note that the draft consultation version of new Australian Curriculum, released for review in February of this year, is acting upon this expressed need. The Science curriculum framework, which outlines a scope and sequence for learning in the years from Kindergarten to Year 10 is organised around three interrelated strands; Science inquiry skills, Science as a human endeavour and Science understanding. By denoting equal importance to each strand, the Curriculum is, for the first time in Australian Science education, emphasising the importance of developing sound inquiry skills among our youth. Given the scientific basis for so many of our global problems and the need for our youth to become effective problem solvers, inclusion of inquiry in the Australian Science Curriculum has not happened a minute too soon.

Tytler recognises that science teachers would need to be at the forefront of any re-imagining of science education and recommends intensive training initiatives for both the delivery and assessment of these courses reflecting the wider purposes of science. This is very much in keeping with the recommendations of Goodrum et al. who suggest on-going professional development to help teachers to deliver science in ways that promote improved learning outcomes and increase scientific literacy. They voice the need for a strategic plan for on-going professional learning to keep teachers abreast of continual change in science and science education.

Supporting science teachers to meet the challenges of engaging students in the 21st Century

Before addressing the subject of support for science teachers it seems logical to suggest that this support be focused in two directions; toward pre-service teachers during university education courses and toward in-service teachers in an on-going professional learning capacity.

In a detailed report on the use of inquiry at classroom level, Mark Windschitl (Journal of Research in Science Teaching, 2004) follows the progress of 14 pre-service science teachers, who, while in training, undertook their own empirical investigations simultaneous with undertaking coursework on 'inquiry as an instructional process'. The students kept a reflective journal throughout the process, in which they recorded details of, not just investigative procedures, but of the confusion, second thoughts, false starts, etc., associated with the investigation. Despite the support provided by their coursework, participants in this pre-service study saw their own inquiry projects as 'difficult', especially in the initial stages of developing a question and designing a methodology and this seemed to reinforce their desire for a highly structured version of scientific method for use in the classroom. Windschitl makes a number of recommendations regarding instruction of scientific method for pre-service teachers, but these could be equally applied to in-service teachers who are about to embark on this inquiry process. They are as follows:

- . Teachers should attempt to use inquiry, since while appreciating the complexity of the process, participating teachers did report an advancing of their understanding of the procedures involved in experimentation
- . Teachers should immerse themselves in background reading on the subject of their inquiries
- . Teachers should learn to argue claims in science and engage in such arguments with students
- . Beginning teachers of inquiry should be placed under the mentorship of cooperating teachers, in whose classrooms model-based inquiry is practiced
- . For programs which cannot provide an enquiry experience, or teachers who cannot facilitate such experiences, content courses taught within the context of inquiry, should be developed.
- . As a preparation for the inquiry process, teachers could be assigned to work in laboratories or in the field, with scientists, for an extended period of time.

In relation to providing support for in-service teachers to become equipped in the skills of teaching enquiry, it has been recognized by Goodrum et al (2001) that *"lack of time and opportunity to share ideas, collaborate, reflect, evaluate, adequately prepare and participate in on-going professional development ...limits opportunities to increase skills"*. This is further reinforced by Peter Fensham (2006) who recognises that, however weak or strong their background in science studies, many science teachers are seriously deficient in *"having any science stories to tell, in communicating within and from science, in knowing science as a way of thinking, and in applying science in real-world applications"*. He suggests

that none of these aspects have been emphasised in their school or undergraduate science studies, theoretically they could be rectified, but would require “*very comprehensive and continuing professional development, involving partnerships between organisations with practicing scientists and the education system*”.

A case study of inquiry-based Science curriculum: Marist Regional College, Burnie

Undertaking inquiry projects in purposeful, real life contexts is part of the teaching philosophy in the Science Faculty at Marist Regional College. It is our belief that "creative problem solvers" are the key to Australia's future. We need people who can think on their feet and who can look at problems from a variety of angles. Our program is designed around engaging local science experts as mentors for secondary students and then using some of these students to mentor primary students. In this way, we are proving that there is no boundary to learning about science. By incorporating independent research, scientific thinking, literacy, mathematics and information technology, science investigation becomes an integrated "whole school" activity, directed according to the interests of individual students.

Our program takes advantage of the school's location, which is perfect for the study of science. As we look around us, we can see potential for research investigations everywhere, from our freshwater creeks, extensive coastline, native and plantation forests, geological mines and agricultural lands, to name but a few. No matter what area of science a student is interested in, we can always find a test location worthy of the effort and some experts willing to help.

Over the years we have found that undertaking successful science projects gives our students a real sense of accomplishment while developing problem solving strategies, improving their perseverance and learning the importance of keeping on-going documentation. The depth of students' learning is greatly enhanced by "exploration and application" and when complete, the work is shared with science experts, university researchers, industry personnel and the interested community at the annual Science Research Fair, Tasmanian Science Talent Search and numerous national and international competitions.

Many of our former students have gone on to launch careers in Science. Now, some of these have volunteered to mentor the current crop of students, act as judges at the Science Fair or sponsor prizes. In providing this "rich learning program" we have been greatly supported by the local community and we are ever-grateful for all assistance received. It is always warming to see that those who have been through the scientific process are happy to "answer the call" to assist in the development of the next generation of young scientists.

Conclusion.

It is important that we, as concerned adults and as educators, recognise the degree to which Science underpins our understanding of global sustainability issues. It is equally important that we adopt educational frameworks which promote such an understanding among our young people. It must be impressed upon our youth that future problem solving will need to occur not just at local level, but nationally and, with regard to some issues, internationally. Global cooperation will be necessary and we, as

individuals, as communities, and as citizens of our own nations, have obligations to one another both locally and globally. Understanding these obligations is an important part of global citizenship.

This message is being directed to us from many quarters. In March of this year, in her annual Commonwealth Day message to the 54-member nations, the Queen highlighted the important role that science and technology plays in giving people a better quality of life. She urged Commonwealth countries, including Australia, to help young people take advantage of cutting-edge technology to improve their lives: "*It is vital that their potential to build on the exceptional scientific expertise that exists in member states is also fully supported through education and social development. The Commonwealth understands this, and should continue to aid and encourage our young people to participate in the exciting new opportunities that lie ahead, in the knowledge that progress is something which must be sustained and shared by all*".

Engaging Science curricula and enthusiastic teaching are starting points in this direction.

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