BUILDING SUSTAINABLE EDUCATION IN SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION IN WESTERN AUSTRALIA

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ABSTRACT

This paper describes three case studies that were part of the *Australian School Innovation in Science, Technology and Mathematics (ASISTM)* project supported by the Australian Government to foster innovation in schools and develop the innovative capacities of students, by promoting teaching that engages students in science, mathematics and technology. Data were collected and analysed to demonstrate the effects that such projects have on student and teachers in the city, regional and remote Western Australia. Building sustainable educational solutions in science, mathematics and technology is a critical part of ASISTM project initiatives and need to be supported. The ASISTM project model provides a support mechanism to encourage schools to develop collaborative partnerships with other educational institutions, organisations and the wider community to bring 'real life' learning into the classroom. It also has the opportunity to promote the teaching profession to school students and Teacher Associates who work on these projects.

Keywords: ***Sustainable education, science and mathematics, technology***

1. INTRODUCTION

A critical part of the Australian Government *Boosting Innovation, Science, Technology and Mathematics Teaching (BISTMT)* initiative has been to provide, over the seven-year period of the Australian School Innovation in Science, Technology and Mathematics (ASISTM) project, $33.7 million in funding to cluster initiatives throughout Australia. To date over 350 innovative ASISTM projects have been funded through this initiative see website http://www.asistm.edu.au/asistm/ . These school based projects focus on improving teaching and learning in schools in the areas of science, technology and mathematics. A successful model has been developed where ASISTM projects are collaborative partnerships between schools and non-school organisations, including universities, business, education organisations and community groups (see Figure 1).

Each ASISTM project had a Project Coordinator, who on behalf of a cluster of schools and non-school organisations, managed the project which was a collaboration between schools and non-school organisations capable of contributing expertise or resources to their project such as in the case studies documented here:

- the tertiary education institution Curtin University of Technology;
- science, technology and mathematics organisations and Government environmental organisations;
- teacher and principal professional organisations; and
- industry and the broader community.

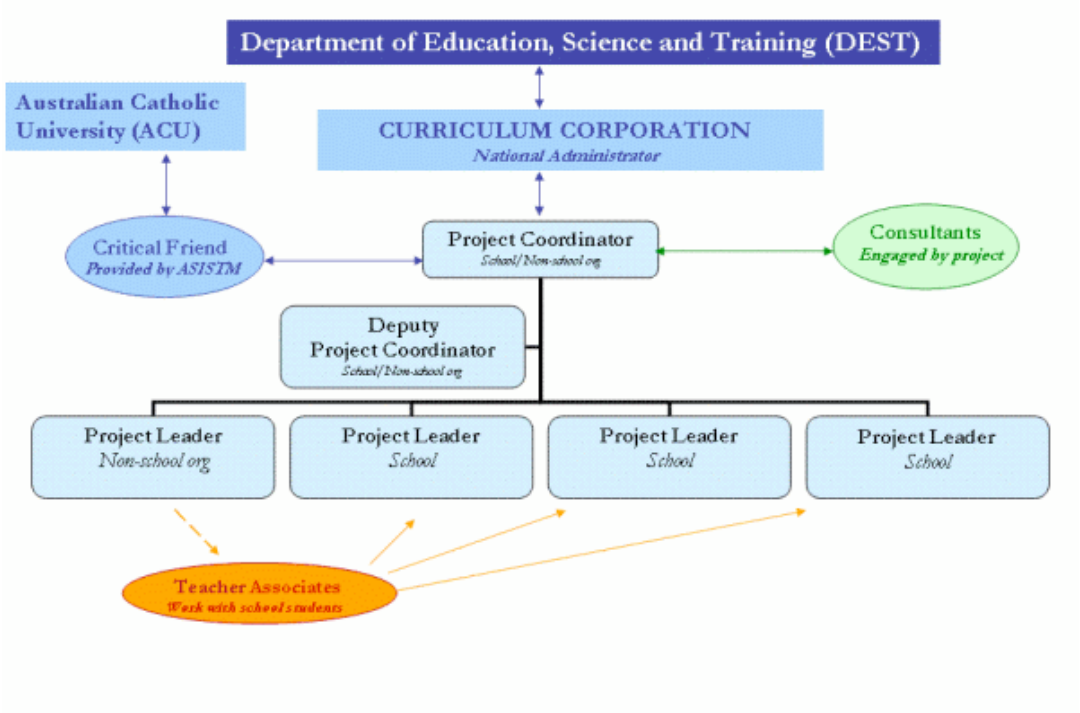

Figure 1: The ASISTM Model

All case studies documented here were schools facing special challenges, for example regional and remote schools, or schools with high proportions of Indigenous or disadvantaged students.

The School Leaders and the Teacher Associates were an integral part of the ASISTM projects. The Teacher Associate was engaged to work with students acting as a role model and helping the teachers to inspire and motivate students by bringing their 'real-life' experiences into the classroom. Their subject-related knowledge was able to help inform and shape students' science, technology and mathematics learning experiences providing examples of how relevant learning can relate to a wider context beyond the classroom. Critical Friends mentored and guided the Project Coordinators and provided valuable evaluation data on each ASISTM project.

Such additional strategic funding and the structural support provided through the ASISTM model is critical for Australian schools to succeed in supporting future science, mathematics and technology teaching and learning. With the absence of funding many of these learning experiences in schools are not possible such as providing Teacher Associates and excursions. Such expertise and extra curricula activities are not those that many schools can support or sustain in every day practice (Davies, 2006; Tyler, 2007; Tytler & Symington, 2006).

2. THE CASE STUDIES

The ASISTM funding supported three Western Australian school-based projects described here each with a Project Coordinator (n=3); a Critical Friend (n=3); School Leaders (n= 17); teachers (n= 24); students (n = 315); Teacher Associates (n= 21); consultants (n=10) and partner organisations (n= 9). Each case study was set up to support over 12 to18 months science, mathematics and technology teaching and learning.

Case Study One

The project Sustainability in Education: Building Long Term Solutions for Seven Western Australian Schools aimed to enhance the teaching and learning of science, technology and mathematics through a focus on environmental awareness and sustainability. Through adopting an 'advocacy in action' approach in which students participated in environmental advocacy events linked to science, technology and mathematics, school-designed curricula were developed through integration across learning areas and through connections to local environmental sustainability issues. Teachers from a cluster of seven schools worked with Curtin University students, lecturers and consultants from Government environmental agencies to develop curricula that embed skills, knowledge and values related to 'sustainability'.

Project Activities

- Each school developed and participated in an 'advocacy in action' project;
- Schools produced case study resources and online materials;
- Use of Teacher Associates including an Engineer, an Architect and an Environmental Scientist to bring real life examples into the classroom; and
- Professional development was provided for teachers within cluster schools, rural schools and other schools through the outcomes of the project.

The schools presented their projects to the science community in Perth in July 2007 at the *World Conference on Science and Technology Education: Sustainable, Responsible, Global*. The school projects included: examining a daily 'environmental footprint' to promote sustainable practices in water, energy, pollution and recycling; examining the effects of air pollution and the use of alternative energy sources; developing a portable water quality testing 'suitcase' of scientific materials; developing healthier living through mind, body and spiritual aspects of environmental awareness; reducing school waste; inventing products and processes to solve particular environmental problems; and developing online materials and resources for sustainability themes.

Case Study Two

The project *Plants for People Multimedia Pilot Project – A New Paradigm* aimed to enhance the teaching and learning of science, technology and mathematics through a focus on the traditional knowledge of plants, ecological systems and natural resilience that are emphasised in Indigenous communities. Thus, while aiming to improve science, mathematics and ICT learning outcomes for Years 6-9 students, the project also aimed to foster a greater understanding and valuing of Indigenous culture, and increased self-esteem and cultural pride for Indigenous students. Five schools that represented regional as well as remote locations within Western Australia participated in the project. All the schools had high enrolments of Indigenous students. A network of Indigenous and non-Indigenous Teacher Associates assisted teachers.

Project Activities

- The Indigenous and non-Indigenous Teacher Associates assisted teachers from the schools to design multimedia learning activities to develop knowledge and understandings about Indigenous sustainability principles and practices;

- Development of CD materials for lessons on building a school Noongar Garden based on the Noongar six seasons;
- A literature survey of Noongar plant uses was developed as part of the CD resource; and
- Professional development for the teachers involved, to support them in their implementation of the teaching materials.

Case Study Three

The project TSTV – Travelling Science Television aimed to enhance the teaching and learning of science supported by technology through the use of the Primary Connections – Linking Science with Literacy Project (*http://www.science.org.au/primaryconnections/index.htm*). Primary Connections provides a comprehensive approach to the development of scientific literacy and aims to improve students' learning outcomes in both science and literacy. This was achieved through an integrated professional learning program and supporting rich curriculum resources that enhance teachers' confidence and competence for science teaching. Five Catholic Education schools (three in regional and remote locations and two in the Perth metropolitan area), CEO teachers and consultants, and Curtin University pre-service teachers as the Teacher Associates.

Project Activities

- The teachers participated in professional development activities to learn about social constructivism and use the ***Primary Connections – Linking Science with Literacy*** resource materials;
- The students from each school produced an audio-visual show that demonstrated discoveries from their science classes;
- Schools used *MyInternet* and the *Centra 7* video conferencing systems to communicate their exciting science discoveries and create and explain local science via their 'TV' show; and
- Communication during the project was between the students, teachers and Teacher Associates at the university (pre-service teachers) via video conferencing and other electronic means, further extended the use and capabilities of using technology in the classrooms.

The five schools produced programs of work and used technology to showcase their quality primary science teaching and curriculum units. This audio visual production was made available online for each contributing school to use, as well as for other schools participating in the *Primary Connections – Linking Science with Literacy Project*.

3. METHODOLOGY

Qualitative and quantitative data were gathered from each of the case study schools in the form of a student survey evaluating science, maths and technology for the Year 5-6; Year 7-9 and Year 10-12 students involved in the projects; and interviews were conducted with the teachers to answer the research objectives:

1. What were the students' perceptions of maths, science and technology classes, teaching and learning; and

2. Did the ASISTM project help teacher's improve maths, science and technology teaching?

4. FINDINGS AND DISCUSSION

The results from the survey and interview data are discussed with the outcomes provided for each case study. Table 1 provides the demographics of the case studies. Of the 315 students surveyed, 48% were female and 52 % were male with the majority of students (68.9%) studying in Year 7 (118) and Year 6 (99). Of the student cohort 11% (33) were aboriginal and four students were Torres Strait Islanders.

Table 1: Demographic Information of Case Studies (n=315)

GENDER

	n	%
Male	152	48
Female	163	52

ARE YOU ABORIGINAL OR TORRES STRAIT ISLANDER PERSON?

	n	%
No	278	88
Yes, Aboriginal	33	11
Yes, Torres Strait Islander	4	1

YEAR LEVEL

	n	%
5	45	14.3
6	99	31.4
7	118	37.5
8	26	8.3
9	0	0.0
10	1	0.3
11	19	6.0
12	7	2.2

Table 2 presents the survey questions given to 315 students participating in the case studies to answer "*What were the students' perceptions of maths, science and technology classes, teaching and learning*?" Students were asked to rate 12 questions to assess their perceptions of maths, science and technology. The majority of students enjoyed their classes and the learning of maths, science and technology and believed that it was important for them to do well in maths, science and technology.

Three additional questions were asked of the Year 7 to 12 students (n=278). Over half of the Year 7-12 students felt the maths, science and technology that they were learning would be useful when they left school and they looked forward to studying maths, science and technology next year. Not as many students felt they would like a job involving maths, science and technology with in fact 22% rating they did not want a job in this area. Of the 171 Year 7-12 students, 23% rated their aspirations of becoming a teacher and of those 39 students only 18 would like to become a teacher of maths, science and technology see Table 3.

Table 2: Perceptions of Mathematics, Science and Technology (n= 315)

	SA %	A %	D %	SD %
I'm encouraged to try new ways of thinking and doing things at school	36	61	1	2
My school is a place where there are lots of new ideas and activities happening	51	44	4	0
My Mathematics, Science and Technology teacher(s) show(s) me new ways of looking at and doing things	40	55	4	1
In my Mathematics, Science and Technology classes we often decide on our own ways to solve problems	23	61	14	2
In my Mathematics, Science and Technology classes we are encouraged to ask lots of questions	33	50	15	2
In my Mathematics, Science and Technology classes we relate what we are learning to everyday life	30	57	12	1
I enjoy what we do in Maths, Science & Technology classes	54	37	6	3
I enjoy giving things a go in Mathematics, Science and Technology, even if I don't know if they will work	53	40	6	2
I enjoy coming up with new ways of doing things in Maths, Science & Technology	43	45	9	3
It's important to do well in Maths, Science & Technology	65	31	3	1
Maths, Science & Technology are useful in real life	67	29	3	1
I usually do well in Maths, Science & Technology	32	55	10	3
Extra Questions asked of Year 7-12 students (n= 278)				
The Mathematics, Science and Technology I am learning will be useful to me when I leave school	34	26	2	0
I look forward to studying Maths, Science & Technology next year	19	32	9	1
I would like a job that involves using Maths, Science & Technology	15	24	15	7

Table 3: Teacher Aspirations for Years 7-12 Students (n= 171)

I WOULD LIKE TO BE A TEACHER

	n	%
Yes	39	23
No	132	77

IF YES, I WOULD LIKE TO BE A TEACHER OF MATHS, SCIENCE & TECHNOLOGY

	n	%
Yes	18	46
No	21	54

Case Study One Project Outcomes

The project *Sustainability in Education: Building Long Term Solutions for Seven Western Australian Schools* aimed to bring about real improvements to the teaching and learning of science, technology and mathematics in Western Australian schools. As a part of Round 2 funding the group of seven schools came together and developed seven 'advocacy in

action' sustainability case studies. As the title of the project suggests the aim was to build long term solutions for the seven schools. All seven schools have been able to build and refine ideas from each other's 'advocacy in action' projects and have developed their own sets of resources and materials as a result of this ASISTM project. Each school expressed an ongoing commitment to the "sustainability in education" theme and that they will continue to use the materials and project ideas in the coming years as a part of the Western Australian Education for Sustainability (EfS) project.

This project has enabled a set of teaching resources in the form of seven case studies to be developed for schools, and for students to have the opportunity to work with an Engineer, an Architect and an Environmental Scientist, thus increasing their interest in science and technology related careers. The Environmental Science, Engineer and Architect Teacher Associates were able to talk about sustainability from a career perspective, further inspiring students in science and mathematics and how important these are and to think about further study options. This was particularly important for the Aboriginal students who had not considered Environmental Science as a career. It was observed that many students had not even heard of an Environmental Scientist before, and due to this project they were talking about becoming Environmental Scientists.

Case Study Two Project Outcomes

The project *Plants for People Multimedia Pilot Project – A New Paradigm* enabled the support and production of resources for teachers and students in regional and remote Western Australia. The CD produced allows teachers and students to better understand and develop knowledge and understandings about Indigenous sustainability principles and practices. The activities supported student learning of science and mathematics through technology including: creating a garden based on the six Noongar seasons; collecting wattle seeds and making wattle seed bread; using plants to dye silk; a field trip to a local dam to learn about Noongar culture; and using plants for medicinal purposes. The impact of the project has been to foster a greater understanding and valuing of Indigenous culture. At the same time increased self-esteem and cultural pride have been engendered in Indigenous students as well as produce a set of valuable resources.

Case Study Three Project Outcomes

The project *TSTV - Travelling Science Television* enabled students and staff at five geographically separated primary schools to participate in regular video conferencing sessions that allowed the development of a collaborative network for students, teachers, and pre-service teachers. Outcomes of the project have included increased knowledge about constructivist learning, increased use of video conferencing for collaboration, and the development of a collaborative network of regional primary science teachers (see website http://www.cswan.wa.edu.au/home/tstv/). The virtual private network (VPN) of the Catholic Education Office in WA was used in this project, providing an exemplar model for using the network, but also linking regional and city schools through a common topic of science. This project has illustrated that communications via online technologies can be successfully used for promoting learning between regional and remote schools. Using the *Primary Connections – Linking Science with Literacy* resources as a context allowed teachers and students to develop then showcase their completed Science units of work in the form of a video based TV show.

Teachers were very positive about the opportunities the ASISTM projects allowing them to participate in maths, science and technology activities with the additional funding, support and professional learning. The success of these projects is summed up by comments made by School Leaders:

"I am so glad I did this as I never wanted to do science before...now I love doing science with my class".

"The integrating of technology was very successful. Using the Interactive Whiteboards with the computers was very effective. The project had a huge impact on the way I teach science and how I feel about teaching science. It has really opened my eyes to the possibilities; it used to be a learning area that I was afraid of teaching. The opportunity to collaborate with my colleagues about the project was great, three heads together was brilliant. One teacher was strong in science and literacy, another was strong in maths and technology. We all brought something to the table."

"This is a low socio-economic area so the funding to buy the resources we needed in the project was appreciated. Also parents cannot afford the expense of excursions, but this project allowed us to take the kids on excursions and gave us valuable opportunities to bring people in"

"We got a lot out of the opportunity to establish links with professionals in that field. The scientists that came to the school were relevant to the field, and that was valuable."

5. CONCLUSION

While these ASISTM projects have had diversity in their foci and locations, there have been similarities in their outcomes, including: development of valuable resources for teachers and students; the sharing of successful learning activities for students in science, mathematics and technology; increased participation by teachers in their own professional learning; and the development of professional networks drawing on wider community partnerships. Each project has enabled the support of student learning to solve particular environmental problems and to showcase high quality science, mathematics and technology teaching and curriculum for geographically separated schools. These projects have included opportunities for teachers and students to better understand and develop knowledge and understandings about sustainability principles and practices fostering a greater understanding and valuing of Indigenous culture. Teacher Associates have been able to contribute to the practical 'real life' aspect of the activities that have served as models for school curriculum development that is relevant to a school's unique social and geographical context.

While the ASISTM tests revealed that only a few students (18 out of 171) participating in these ASISTM projects would want to become teachers, an unexpected positive outcome was the Environmental Scientist Teaching Associate, who was in her final year of study at university, was considering undertaking a Graduate Diploma in Education because she so enjoyed her experience in the schools with the students that she would now like to become a teacher.

Through the outcomes of the ASISTM projects they illustrate the advantages of the need to build sustainable educational partnerships with schools. Two of the schools are continuing

in subsequent ASISTM projects bringing their ideas and experiences into the final ASISTM project round in 2008.

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