Cyscience: emerging technologies for Rural PD

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Abstract

This project utilized emerging technologies such as mobile broadband videoconferencing along with web-based software and materials (http://www.cyscience.com.au) to enhance the provision of science and mathematics in rural and remote schools in Northern Queensland. The paper tracks the role of technology in the development and implementation of the CY Science project. It will explore how technology enabled a successful classroom project to evolve into a regional program and beyond. It will look at technology as a creative tool for teachers as well as its benefits and shortcomings as a means of teacher professional development. The project involved the distribution of 202 inquiry based science kits and utilized different methods of accompanying professional development to over 60 schools, primarily across northern Australia. The findings of the SiMERR National Survey into Science, Maths and ICT education in rural and regional Australia (Lyons, Cooksey, Panizzon & Parnell, 2006) concluded that "science teachers in provincial and remote areas indicated a significantly higher unmet need for a broad range of professional development activities than did those in provincial cities or metropolitan areas" (p. vi). This study investigates and reports on the existing research literature, the perceived benefits of the project to teachers' satisfaction with professional development and tracks the changes to classroom practice that teachers and key stakeholders attribute to participation in the project.

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Literature Review

While much is made of the crisis in maths and science education in Australia, it is in reality a crisis that is felt internationally (Ogawa, Loomis & Crain, 2008). The benefits and promise that science and maths hold for society transcend cultural and national boundaries. For the remote and regional indigenous Australians that are participants and partners in this project, the maths and science education crisis has its own context. Achieving parity with non-indigenous Australians in health and longevity, in part depends on indigenous children becoming competent and interested in science and maths for sufficient numbers to graduate as health professionals for their community or to boost numbers in other related professions.

The vital importance of science in so many facets of our lives, has led to much research on science education. Bybee (2006) reports education organisations are developing "sophisticated approaches to designing, developing and implementing innovative curriculum materials. The time, effort and expertise of professional curriculum development groups stand as an important innovation from the Sputnik era" (p. 13). It was the loss to the Russians in the first leg of the space race that led to much American research into science education and how to improve it. The result was a new approach to science education, centred on inquiry based learning that replaced more traditional textbook based curriculum from the 60's and 70's. Some commentators would argue that the uptake of inquiry based learning in schools, although widely endorsed by many, has again fallen off in recent years and those hoping for more widespread adoption have been lamenting Sputnik's unfinished business.

Inquiry based learning programs model actual scientific thinking and processes and involves the gathering of evidence and data to solve problems and construct new concepts. It requires students to be active participants in the learning process and often involves hands-on experiments and investigations (Anderson, 2002; National Research Council, 2000).

Bredderman (1982) found in a meta-analysis of 57 studies involving 13, 000 students, an average improvement on science process tests of twenty percent for students using new inquiry based learning programs compared to traditional textbook programs. It was also found that the effect on disadvantaged students was significantly greater. Shamansky, Hedges, Woodworth and George (1990) reported on the new science curriculum and found similar improvements in achievement, process skills and attitude to science. More recently Schroder, et al. (2007) classified innovative teaching strategies such as questioning, manipulation, inquiry and collaborative learning strategies. In this meta-analysis of sixty-one studies, it was found that these strategies had a significant positive impact on student achievement.

Bredderman's 1982 meta-analysis of inquiry based programs, used the work of Smeriglio and Honigman (1973) to distinguish *old* programs (didactic teaching with textbooks) and *new* programs that had the following features:

- They are activity oriented, reflecting direct psychomotor experiences.
- There are no texts for students, only teacher manuals and guidelines.
- They contain "kits" of materials for students.
- They have been tested in the classroom, modified and retested.
- They provide in-service training for teachers.
- Psychological principles of cognitive growth and development have been used as guidelines.
- They are process-oriented.

All these features accurately describe the CY Science project which would be classified as a *guided inquiry program* (Anderson 2002; Cronin-Jones, 1991; Keys & Kennedy 1999). It is *guided* because of the high level of structure and guidance the teacher provides to the students as part of the program.

Comparisons of the CY Science curriculum with other inquiry based programs reveal innovations and methodology unique to CY Science. This is due to the trans-disciplinary approach to science and maths taken and because the curriculum is based around a series of newly conceived and developed experiments which are fully resourced with all the consumables required for students to conduct the experiments. It is asserted that technology played a major role in the innovations present in CY Science.

Inquiry learning has become the science teaching standard endorsed by education authorities, universities and administrators in every state and territory in Australia as well as many other countries (Goodrum, 2006). Despite this mandate and the potential for significant improvements in student achievement, inquiry learning is uncommon in classrooms, and for more than forty years, it has been largely ignored by teachers.

An Australian 2001 review of high school science paints a picture of a dominance of traditional didactic teaching along with students' perception that science is not relevant or engaging (Goodrum, Hackling & Rennie, 2001). This impression is found elsewhere (Rudolph, 2002; Stake & Easley, 1978) and as this American paper reported, "Instead, historians document that school science has remained surprisingly unchanged, despite considerable research, funding and policy targeting science education reform" (Tressel, 1994 cited in Ogawa, et al., 2008, p.270).

A matter of great concern is that Australian primary teachers appear to be avoiding teaching enough science; didactic or inquiry based. A TIMMS study found that only 5% of teaching time in Australian classes was devoted to science, putting it in the bottom one-third of countries participating in the study. The result of this has been the stagnation of science achievement of Australian children while many other nations continue to improve (Thompson, 2006).

The reasons for the failure in uptake of inquiry based learning programs lies with the inability of teachers, schools, education authorities and universities to implement and sustain this form of learning in classes. As one researcher succinctly puts it; “The successful implementation of innovation is generally considered to require a degree of change, capability and motivation not typically found in schools” (Hughes, 1975, as cited in Ogawa, et al., 2008, p. 273).

Specifically, the failure of many schools to deliver inquiry based programs is due to the inability of teachers to effectively implement the new teaching techniques and class management skills needed for successful and productive inquiry learning experiences (Anderson, 2002; Beck, Czerniak & Lumpe, 2000; Marx, Blumfield, Krajcik & Soloway, 1994). The management of resources required for inquiry learning increases teachers’ workloads, and the perceived slowness of curriculum coverage also contribute to teachers’ non-acceptance (Anderson, 2002; Biddle, 1979, Luft 2001).

Teacher Professional Development

An important agent for change towards more inquiry based teaching is teacher professional development which is perhaps the most complex and challenging area in the field of education (Tytler, 2007). Even a demonstrated clear relationship between professional development and improved student performance is elusive. Shymansky (2004) concurred when he wrote “we have no choice as professional educators but to continue to study those connections, lest we admit that we are only stabbing in the dark with our professional development promises and practices” (p. 778).

What is well understood is the ineffectiveness of short term professional development (Hoban, 1992, as cited in Tytler, 2006) and the need for sustained, culturally changing professional experiences within the school context (Joyce & Showers, 1995, as cited in Tytler, 2006). It is argued that eighty hours of professional development is required before teachers will show a statistically significant change in teaching practice (Johnson, Kahle, Fargo 2006; Supovitz & Turner, 2000) and this mitigates against the popular short term professional development models.

Much research has been done on the ability of professional development to shape and change teacher practice and it supports the conclusion that changing a teacher’s practice from didactic teaching to inquiry based is a difficult, long term process. Jones and Elick (2006) argued that “true reform consists of systemic change of the many complex and inter-connected factors that must begin with the science teacher in the local context” (p. 493).

Technology

Technology provides us with innovative and ubiquitous opportunities to enhance work and learning and for many of us it has had significant effect on practice. “We are witnessing a blurring of the distinctions between learning, work and play as mobile computing devices are omnipresent, and an ‘always on’ culture facilitated by broadband Internet capacity is a reality” (McLoughlin & Lee, 2008, p.10).

This paper examines the application of a variety of technologies to build the capacity in teachers to deliver sustained, inquiry based learning programs. Technology pervades the CY Science Project through the process of curriculum design and manufacturing as well as providing new ways to communicate curriculum ideas to teachers. “It is imperative to acknowledge that technologies are intricately related to many other elements of the learning context (such as task design) that can shape the possibilities they offer to learners, how learners perceive those possibilities and the extent to which learning outcomes can be realised” (McLoughlin & Lee, 2008, p.11).

The question this paper poses is whether an inquiry based program (CY Science) shaped by technology, will lead to greater acceptance by teachers and improved science outcomes for children.

Context

The CY Science project has mostly engaged schools in the Far North Queensland State Government Education Region. It is a vast area in north–east Australia, almost as big as Victoria and Tasmania combined with a population of only 230 000 with 117 000 of those living in the main city of Cairns. Almost 12% of its inhabitants are Indigenous and they make up around 60% of the inhabitants on the vast Cape York Peninsula.

There are two distinct indigenous groups within the region, indigenous mainland Australians and Torres Strait Islanders whose proximity to Papua New Guinea has strongly influenced their culture. There are 6000 Torres Strait Islanders living in the Torres Strait. They are serviced by 18 different schools on the many inhabited islands. A further 42 000 now live outside the Torres Strait, mostly in North Queensland.

CY Science was developed within the Queensland Education Department, at Woree State High School and with the support of James Cook University and the Australian Federal Government. It grew out of an after school maths and science excellence program that was delivered to over one thousand children from 30 schools in Cairns over a three year period.

It was in the planning of this program that a trans-disciplinary maths and science approach was developed as the basic template for the lessons and later for the CY Science Kit. These lessons centred on conducting a science-like activity chosen simply because it was engaging, visual and “good fun” and therefore likely to be a source of motivational and positive science experiences for students. The experiments were then designed to provide data that could be gathered and analysed, adding a powerful element of reflection and a strong link to the curriculum. Often the most effective way to do this was to repeat the activity multiple times changing one variable and measuring its effect on another variable.

An example is an experiment called ‘slime circles’. Children find polymer slime extremely interesting and are always very keen to ‘engage’ with it. The CY Science Kit provides all the ingredients, apart from water, to make over six litres of quality polymer slime. One experiment it is used in, investigates the size of the circle slime makes when left on a table. The greater the volume of slime, the bigger the slime circle it forms. This relationship can be graphed using a spreadsheet and then students can begin to determine the volume of slime not by measuring volume directly but using the size of the slime circle and the graph and therefore using mathematics to solve a real world problem. This process of measuring and graphing known amounts (standards) to determine an unknown quantity is fundamental to scientific inquiry and used across the world constantly. However it appears to be seldom taught in schools, perhaps due to the fact it is trans-disciplinary and does not fit neatly into either established structures of maths and science.

Building on the success of the after-school program, a travelling science show was developed and staged for 24 schools in Far North Queensland. The science show provided many opportunities to discuss science teaching with teachers in rural, regional and remote areas. Anecdotal feedback from teachers and administrators from the schools visited was that teachers would perform more experiments with their classes if they had the skills and were easily able to access the resources. This corresponds with the evidence gleaned from the literature review (Anderson 2002; Beck,Czerniak & Lumpe, 2000; Marx, Blumfield, Krajcik & Soloway, 1994). This teacher feedback contributed to the development of the CY Science Kit.

See the following description of CY Science Kit is from the project’s website, www.cyscience.com.au:

“CY Science (see why science) is a government initiative to support the teaching of science. We provide teachers with the resources needed to conduct meaningful and exciting science investigations.

The CY Science Kit supports you in delivering amazing whole-of-class experiments with step-by-step instructions, colour photos and student worksheets.

The CY Science Kit provides 20 hours of science that is fun, easy to teach, inquiry based learning. It is a transdisciplinary approach to teaching science with a strong focus on mathematics that allows children to understand and model the work of real scientists."

It took a period of six months to complete the kit to a required standard before it could be trialled with teachers. The use of the internet was critical in the design and the manufacture of the CY Science Kit with almost everything created and sourced on line. Many ideas were influenced from websites and video clips from many countries. Access to these resources and the ability to trial experiments with classes were two important factors in the development of the CY Science Kit.

Trials

The CY Science Kit has remained unchanged but the type of teacher professional development offered has varied. There are four methods that have been trialled, each with particular strengths and weaknesses.

Video conferencing holds much potential for remote and rural delivery of professional development and the twenty teachers from four schools who participated found the professional development to be a valuable and enjoyable experience that was later transferred into classroom practice.

Most recently the *CY Science Show* has been developed and trialled with over 2500 students at five schools. The aim of the show is to entertain and educate the children while explaining to the teachers present, how the CY Science Kit can be used. It is done by making the experiments in the kit 'super-sized' and demonstrating them to up to three hundred children and teachers at each show.

The Department of Education, Employment and Work Place Relations (DEEWR) and Education Queensland provided funding for the delivery of one hundred and thirty science kits and accompanying professional development for forty-three schools with a focus on indigenous schools. The format was to send a facilitator to a school with up to four science kits, depending on the size of the school. The kits would be given to up to four teachers during a fifteen minute briefing before school started. The teachers would take the science kits back and run a science fair for their own class in their classroom. The facilitator would move between the four classes assisting and providing support for the teachers. The teachers kept the kits and were able to complete another twenty hours of experiments at a later date. While this is perhaps the optimum method for training teachers to use the kits it has a significant drawback that seems to relate to teachers sharing of resources and ideas. It has been found in some schools that although the science kits are being used to great effect in a particular classroom, there is no sharing of this information between the teachers. It is for this reason that the larger science show was developed to reach larger numbers of teachers.

CY Science Kits can now be purchased online and 30 science kits have been sold to 12 schools across Australia. No additional professional development was sought by these interstate schools because it is not mandated because the program was designed to stand alone with sufficient instruction given in the experiment manual. Anecdotal evidence is that teachers are able to navigate their way through the program without additional professional development. The addition of video instructions to the website in 2010 will hopefully facilitate the on-line professional development program further, however, as most teachers need convincing, there will be a range of professional development strategies explored, with a more refined model developing over time.

The CY Science website registers over 100 visitors each month. Teachers once needed to access the website to download the CY Science Experiment Manual but in 2009 a CD of the manual was included in the kit as well as being available online.

Data Collection

The data mostly concerns the initial impressions of teachers. Long term tracking of the use of science kits will be completed 2010.

The evidence collected describes a well accepted and appreciated program. The facilitators reported:

Report by Facilitator 1

"Every school was extremely welcoming and appreciative of the resources that I delivered. The teachers were impressed with the 'ease' of delivering the experiments. Some teachers talked about how certain experiments would be, or had been, relevant to topics in their yearly curriculum planners. The teachers in remote areas were not only impressed with the resources available via the kit but also at having a facilitator come to the school and help introduce the kits to them and the students.

The students were excited and enthusiastic about the Science Fair and certainly welcomed me into their classes. All the students were eager to be involved in the experiments and there was no shortage of student volunteers to help with the experiments. All students were positive in their discussions with me about the experiments and many asked if I could come back again and do more science with them. When I explained that the kit contain ingredients to do lots of other experiments they were very pleased with this and looked forward to doing this at a later date with their teachers.

In my experience the kits were most positively received in the smaller community schools were there were multi levels in the one class, usually grades 4 to 7. The teachers were pleased with the adaptability of the experiments to suit the different age and learning levels of the students.

The teachers all indicated that they would continue to use the kit and would also use the web site to gather information and knowledge on the experiments. In one case, before I left the school, I went to say goodbye and thank you to a class for participating in the Science Fair, and the teacher actually had a page from the web site projected on to the whiteboard and was discussing the science involved with the students."

Report by Facilitator 2

"The initial response to the program from the staff at the schools was often one of trepidation due to the requirement for them to run the Science Fair in their classroom. However, this always turned to very confident enthusiasm as they realised that the science kit was so straight forward to use and required really minimal background scientific knowledge

In every class I visited (over 80) I found the students enjoyed the program and all students reported back that they liked science and wished to continue studying science in the future.

Overall I found the kits extremely well received and believe they will be well used and a valuable resource in all the schools."

A survey completed and returned by eighty-nine teachers out of the 130 teachers involved showed:

- 99% of teachers enjoyed participating in the CY Science Project.(one neutral response)
- 97% of teachers thought their students enjoyed the program (one teacher thought their students did not like it, one was neutral)
- 99% thought it was a positive learning experience.
- 99% of teachers would use their science kits again with their classes. (one neutral response)
- 50% of teachers said it caused them to change their attitude to maths and science.
- 69% of teachers thought their students' attitude to maths and science had changed.

Teachers were also asked to comment on the C.Y. Science project with sixty teachers responding. Comments are overwhelmingly positive. The following selection of comments are from ten teachers from a wide variety of large urban, remote, indigenous and one teacher schools:

“Students enjoyed all the experiments thoroughly. Also had positive feedback from parents”

“Students enjoyed each experiment and it has changed their attitude towards maths and science!!!”

“Students were engrossed and asking interesting questions. These experiments will be useful when teaching maths – measuring time, recording etc and the teaching of science eg variables etc.”

“Excellent activities and resources (materials look great). I will continue to use these resources.”

“Really great experience for a remote school with very limited resources.”

“Fantastic. Students commented on how good it was and asked if they could do it again.”

“Both myself and the students enjoy science and maths already however I have been finding it hard to mix the two. This opened my mind a little.”

“Thanks. A terrific hands on resource that is most appropriate to multi age classes.”

“A good introduction to the idea of science being enjoyable.”

“Thankyou for the wonderful science kits! I will be sure to use them. The children loved participating in the experiments.”

This data is consistent with that collected during the four years of the project in its different forms. There are over 250 parent, 300 student and 150 teacher surveys completed during this time about different aspects of the inquiry based programs. Over 97% of this was positive with plenty of anecdotal evidence of the programs having an important positive impact on children.

Conclusion

This paper is a starting point for further research on the impact that CY Science has on increasing inquiry based learning in classes and the role of ICT in this process. The project has the potential to provide robust quantifiable data for further study, particularly if interest from educators continues to increase as it has done, affording a good size population to study across a diverse range of rural communities. Technology’s influence on the way we work and learn is profound and its importance in rural education, in particular, is increasing. It offers new opportunities to tackle old problems. It presents curriculum designers with more information, resources and ideas than ever before. Technology delivers grassroots power, allowing small teams, working within the schools and local education authorities, to design, test and refine curriculum and implementation and produce something, hopefully fundamentally different; new curriculum designs that enable the teaching of inquiry based programs to all children. Early in the paper, a question was posed that targeted the influence of ICT on the program’s effectiveness in terms of teacher acceptance and student outcomes. The two main ICT components were the provision of professional development through videoconferencing over 3G mobile networks and the development and use of a companion website for the program. The survey results indicated that teachers’ attitudes towards using inquiry based learning were positively affected and interview results indicated a positive attitude towards the role of videoconferencing in this process. On the negative side, very few teachers attended (virtually) all the sessions on offer. This is possibly reflective of the wide variety of PD available within the ‘PD in a Box Program’, of which CY Science was only one of many types of PD sessions available. In 2010, several schools will be chosen that involve teachers who choose to concentrate on CY Science PD, rather than being one of the wider program the involves numerous PD offerings. User statistics indicated a healthy level of access to the website at http://www.cyscience.com.au and interview data showed a positive attitude to the features that were available, such as the online manual and image galleries. Further research is needed in 2010 using a scale to determine what user attitudes are towards each available component on the website. The results so far provide some support for further refining the ICT aspects of the program and for the continuation of the data collection and analysis in the upcoming years of the program deliver. Perhaps the strongest evidence for the use of ICT is the uptake of the program in schools that are in areas that were too remote to be included in the earlier delivery of the program.

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