

SCIENCE TEACHING – THE COMMON THREAD

Lembo, K. & John, S.

Kay Lembo

klemb1@eq.edu.au

Southern Queensland Science Centre of Innovation & Professional Practice

Department Education & Training

Queensland, Australia

Sue John

JohnSF@cardiff.ac.uk

School of Earth & Ocean Sciences

Cardiff University

Wales, United Kingdom

Abstract

There are many organisations and institutions committed to the successful and worthwhile delivery of teacher continual professional development and all recognise that collaboration and the sharing of best practise is essential in that delivery. The partnership between the director of the Southern Queensland Science Centre of Innovation & Professional Practice (SCIPP) government organisation and Cardiff University UK at first seems the most unlikely of partnerships – there is no connection other than science education. Universities tend to work at their own speed, and have the reputation of either only interested in research. Teacher interaction is only sought when it comes around to student recruitment.

This unlikely working relationship was established at the last NSSE conference in November 2006, and at first glance these two entities seemed only have science education in common. However, the science teacher's learning and development is fundamental to both their organisations. SCIPP's is an initiative funded by the Queensland government as part of its *Science Education Strategy 2006-2009*, its key focus is to develop and deliver innovative teacher development opportunities by establishing partnerships with the University of Southern Queensland and other organisations. Whilst Cardiff University is committed to deliver a wide range of teacher learning experiences, by linking teaching and research staff and science teachers.

Science Teaching – The Common Thread

Introduction

The current economic, political and social climate, are undergoing rapid change and organisations are facing greater challenges and pressures as well as opportunities in response to these changes. All organisations, educational included, need to ensure not only the long-term effectiveness and viability but also the efficient use of available resources. This must all be done while interpreting and adapting to the ever changing environment of formal education. A core competency that is seen as supporting this is the ability of the organisation, and its members, to learn and in order to create ‘learning organisations’, current educational philosophies highlight the need for collaboration, cooperation and teamwork (Millet 2001).

While there are varying definitions of a ‘learning organisation’ (Senge 1996; Starkey 1996; Hitt 1995), a number of similar traits and practices have been recognised. Learning organisations generally have a strong, shared strategic vision and facilitate both individual and organisational learning through innovation, creative problem solving, experimentation and knowledge sharing/transfer. National and International research acknowledge the demands on schools and teachers are becoming complex, with the need for support and involvement of teacher input into all levels of the education sector and is vital to high quality teaching and preparing students for current society. (Organisation for Economic Co-operation and Development (OECD) 2005, Skilbeck & Connell 2004)

The establishment of partnerships, with regards to the education sector, is often used to support their ability to learn. At a national level, the desirability of partnerships are promoted in reports such as, the Ramsey Review (2000) and more recently by the Queensland’s Minister of Education Professional Development Agenda (Welford 2009) that while

.....creative approaches to learning..... are already occurring. Training and arts organisations are key partners with many Queensland schools, and these partnerships provide a fertile ground for the creation of new ideas, processes and ways of learning....however, to provide these opportunities in our diverse locations across Queensland, our workplace culture needs to encourage employee innovation that improves efficiency and performance, and continually works towards achieving the best outcomes for our students and adult learners.

There are different types of partnerships in education: partnerships among schools and universities, partnerships among schools, universities and local communities, partnerships among schools and private firms or corporations. Traditionally partnerships between schools and universities have traditionally been formed by linking research to school practice and researchers to teachers. However, the ability to establish and maintain effective partnerships between schools and universities is often plagued with a lack of understanding and underlying preconceived ideas of status and motivation. Sirotnik & Goodlad (1988) expresses this situation as

The norms, roles and expectations of educators in each of these realms could not be more different, for example, the regimen of time and space in school versus the relative freedom of these precious commodities in the universities selling: an ethic of inquiry in the university versus an ethic of action and meeting the immediate needs in the schools....These two cultures are very different and it is hard to fit them together in productive, long-term, useful ways.

Background to the Partnership

This partnership started just the same as many other chance conference conversations – the sharing of information, to know more about an idea and how to make it work in their own environments. In November 2006 both authors were representing their previous science-based organisations Toowoomba Technology, Mathematics and Science Centre of Education (TTMSCE) and SETPOINT Wales. During the conversation it became very obvious very quickly that these two disparate government funded organisations had the same educational aims, which were:

- To increase the scientific literacy of the local and regional communities
- To encourage more young people to aspire to careers in science
- To improve/enhance the overall quality of science education.

As is the nature of the beast of government-funded initiatives the aims, objectives, and roles, along with funding routes, have now changed. The first author changing from TTMSCE to the Southern Queensland Science Centre of Innovation & Professional Practice (SCIPP) The second author, moving from SETPOINT Wales to the School of Earth& Ocean Sciences Cardiff University via project managing SETPOINT Somerset. Although the institutions and the names have changed, the common aims remain constant.

Initial conversations between the two authors centered on a UK volunteer programme called Science and Engineering Ambassadors¹, a UK wide government initiative to increase the level of interest in science and engineering subjects in UK schools. The recruited volunteers were practising scientists and/or engineers recruited from science and engineering-based companies, to provide role models to school pupils to encourage them to consider a STEM based career. This required the volunteers give their time freely once a year, as either straightforward career talks or as part of a long term project in providing practical support to

¹ Now called STEM (Science, Technology, Engineering and Mathematic) Ambassadors

a science teacher in their niche field - thus supporting the Confederation of British Industry call from the House of Lords in June 2006 ‘ on the teaching of science in schools and recommended ...’[that the] Government should focus on making links with active scientists in business to come into the classroom and enthuse children...’. Such links were also in alignment with Hargreaves (2005) and were “identified as one of the key areas where greater collaboration between education scientists and practitioners is required to promote excellence and raise standards.”

On returning to Queensland this programme was then incorporated into the existing ‘Work-Shadow a Scientist’ project established at Toowoomba State High school where students were placed with a scientific organisation for one day a week over a ten week period. Students would assist scientists with daily tasks, which allowed students to enhance their own skills and knowledge, as well as gaining a greater depth of understanding into the role of science in their everyday lives.

Over the course of the conference further social and professional discussions were held, with the benefits and challenges of school-university-business collaborations being the main focus. During this time it also became clear that not only did the authors have the same aims of science education, but they also had to consider the same social/ economic/ cultural pressures when offering science education opportunities to both teachers and pupils. As both authors had these shared values, establishing this ‘partnership’ was an easy step. The common vision, shared goals, responsibilities and roles which are noted as crucial for the successful formation of a partnership since they provide a common definition and ground for the different participants, as well as overcoming differences between school and university organisational cultures was already developing. (Abma, Fischetti & Larson 1999).

The Institutions

Southern Queensland SCIPP

The Southern Queensland Science Centre of Innovation & Professional Practice (SCIPP) was established as part of an innovation of Education Queensland's - *Science Education Strategy 2006-2009*. This strategy had four components: establishing six SCIPP linked with their local University; placing four senior science officers in industry locations; supporting the teaching of Primary Science through the implementation of Primary Connections, which consists of a series of science resource modules to support teachers with their classroom teaching; and acknowledging and sharing effective teaching and learning in Science. The Southern Queensland SCIPP is partnered with the University of Southern Queensland and supports teachers in the 173 rural and remote schools spread across the 429 714 square kilometres that constitutes the Darling Downs Southwest (DDS) region.

Cardiff University

Cardiff University founded in 1883, is one of the leading universities in the United Kingdom, alongside the likes of Oxford and Cambridge with a vision to be a world leading university. Cardiff has thirty one thousand applications for four and a half thousand student places. Cardiff does not only concentrate on under and postgraduate is education also the leading provider for adult education through its Centre for Lifelong Learning offering over 700 different courses, delivered in the community. It is now delivering a portfolio of employer driven professional training programmes. The University is at the forefront of community engagement in the United Kingdom, leading one of the Beacons for Public Engagement which aims to build on the existing work done with the formal education sector and open the university up still further to the public.

The Partnership

Through a previously gained international professional development scholarship, and planned visit to another university in England in 2007, an invitation was extended to visit with the Cardiff-based presenters. During this ten day visit a range of workshops being undertaken by the organisation were attended and visits to local scientific venues arranged including local science museums and science fairs.

In 2008, an invitation was sent for a reciprocal visits with a two-fold purpose. The first being to attend the Australian Science Teachers Association Conference (CONASTA58) to gain a greater understanding of issues facing Australian education sector, as well as investigate new ideas being shared between teachers, universities and other scientific organisations. The second being to present workshops to teachers in the Darling Downs Southwest region regarding various issues facing the science education in the United Kingdom, to discuss the CREST science program and to share resources.

The Common Goal

Teacher Professional Development

Teacher professional development is recognized as an important aspect in enhancing teaching and learning in schools (Ingvarson et al 2005) with educational effectiveness literature clearly identifying the connections between quality teachers and their professional development. There is also agreement within research literature regarding the features of effective professional development, which are linked to improvements in students' learning. (Meiers & Ingvarson, 2005)

The level and range of teacher involvement in professional development has been an issue that both organisations and authors have encountered. While research has attempted to

understand some of the underlying factors surrounding employee involvement, Lawler III (1986) had identified four key elements

- power
- information
- knowledge/ skills
- rewards

which underlie the range of professional development and support offered. It makes sense that these elements must be used in conjunction with each other to gain the maximum benefit. At the school work-face, individual employees have a degree of freedom that allows for individual approaches to task completion, as long as certain objectives/outcomes are achieved, for example curriculum requirements.

The information, knowledge / skills elements, regarding the access to relevant information, are the easiest to continue to address staff training which incorporates a range of media, either face to face or electronic for developing individual confidence. The costing/pricing elements of training programmes on already hard pressed school budgets has meant that schools may not be able or sometimes willing to delegate funds for this area of staff development. Additional problems often arise when teachers see themselves as teachers and not as learners, so their ability/reluctance/ self consciousness with respect to learning can have a negative impact on the interactions between schools and universities.

It is in relation to the last element – reward, which in the writers’ opinion needs the greatest improvement. Many teachers and non-teaching staff often carry out tasks beyond the expectations of their position description, yet there are currently little if any incentives for them to do so. While the literature distinguishes between intrinsic and extrinsic rewards (Tushman & Nadler 1996) there is currently no difference in remuneration regarding either the level of qualification, be it at under or postgraduate level or the amount of extra-curricular

activities undertaken. Given these circumstances there is not much incentive for staff to improve their professional knowledge base, or for them to undertake additional duties, such as co-coordinating an after schools science club. Both of these activities could improve not only their individual school's knowledge base but also their effectiveness as an organisation within their own community. While it has been shown that extrinsic rewards cannot be used as a sole motivator of employees (Robbins et al 1998) it can assist and meet the needs of individuals at particular times.

Whilst both countries' education authorities openly acknowledge the need for teachers to undertake professional development to maintain and enhance their skills, the mechanisms for support are quite different. In the United Kingdom the case for teachers' professional development is complicated, as the countries of Northern Ireland, Scotland and Wales are all devolved nations independent of the London based Parliament, each with their own budgets to be spent as the nations wish. Teachers in Wales can apply for vouchers for their chosen route of development. On the surface this is a very good idea - a course of personal development that meets the needs of both school and teacher. However, these vouchers are only available on application on a 'first- come-first-served' basis. This being the case the most organized of teachers achieve the greater chances of funded professional development opportunities.

In Queensland, professional development is centrally funded and supported by the state's Department of Education & Training, with individual schools receiving funding based on student enrolments. The department's 'Developing Performance Frameworks' and annual 'Professional Development Agenda' (Queensland Government 2009) outline key areas that are considered a priority and associated 'in-house' development programs; however, individuals are also encouraged to identify their own specific professional development priorities. Individual teachers are required to discuss and apply for upcoming professional

development activities through negotiation with heads of department, deputy principals and/or principals.

With the cost of teacher supply costs in excess of 250 pounds sterling and 350 Australian dollars there may often be reluctance by head teachers, governors, principals to send teachers to develop their knowledge skills, particularly if the school has budgetary issues or it is not seen as a key priority for their school. There is an added impasse in the United Kingdom given that there is often an additional cost science training days being in the region of 175 – 200 pounds sterling.

Workshops and School-based Activities

Mobile Planetarium

This was originally a SETPOINT Wales initiative to utilize an under-used resource of the Planetary Science Department of the University of Glamorgan. The mobile planetarium was only used when a senior lecturer was available to deliver shows which were usually for one morning a week for 25 weeks a year. SETPOINT Wales approached the university with a project plan that not only used the resource in local schools, it brought in a small income that allowed the SETPOINT to be able to offer a small number of ‘free’ presentations to less well off schools, and it played to the strengths of SETPOINT staff. Over the academic year the planetarium was used every Tuesday in local primary and secondary schools. Wales has a Welsh Language policy; over time these presentations were also available to first language Welsh schools. The programme was developed into a professional development workshop which allowed teachers to hire the planetarium and deliver the educational activities themselves independently from the academics.

After witnessing the effectiveness of the planetarium as a focused learning centre, as well as the usual astronomical purposes, upon return to Queensland, an older planetarium was found to be at a local primary school and increased awareness and teacher training workshops

have been held. However, this resource is yet to be utilized in the DDS region to the extent as used by the Welsh co-author.

School Support Science Kits

Irrespective of school level, size or location, the need for access to a greater variety of physical resources is always an issue. Both authors are currently sourcing and compiling a variety of resource materials that enhance the teaching of science through increased hands-on activities. There are many underused or obsolete resources in many scientific industries, research centres and university departments that have been utilised and obtained for school use. As in the case of the School of Earth & Ocean Sciences, Cardiff University, the most underused resources were the rock and mineral samples and fossils that have been collected over time by either research students or undergraduate students. Through the authors' current positions, these 'resources' and others have been promoted through a variety of workshops and are then available to teachers as a classroom resource. Many of these samples would have been thrown away as the Universities and organisations felt that they were not being used and so not required.

Exploring the World of Sand

The School of Earth & Ocean Sciences has a considerable teaching and research stock of fossils, minerals, rock samples and sand from different parts of the world. The exchange and collection of samples enhanced through this international partnership. The associated workshop links geography, observations skills through examining the sand particles either using hand lenses or under microscopes. More importantly it gives pupils the chance to work in one of the School's teaching laboratories for an afternoon.

After School Astronomy

Astronomy lends itself to worldwide sharing of information and resources, with schools now gaining remote access to telescopes based throughout the world. Based on the partnership

established, schools in Wales and in Queensland have joined in sharing their images and experiences. Further enhancement of this interaction is intended to be shared with UK based students, regarding the project undertaken by students at a Toowoomba high school and the construction of a 10 inch Dobson Telescope from locally sourced material for under 800 Australian dollars.

British Geological Seismology Project

This is a project run by the British Geological Society to establish a network of secondary schools worldwide to monitor earthquakes. To participate in this project a stable internet connection in the school is essential, and a seismometer, costing around 900 Australian dollars. There are now two Welsh schools in the network, with a connection to schools in Australia.

Curricular and Co-curricular resources

The awareness and sharing of curricular material has been a major benefit and component of the partnership. The exchange of resources that are part of the Australian Academy of Sciences 'Primary Connections', the British Association for the Enhancement of Sciences 'CREST Investigations' and Institute of Physics 'Do try this at Home' Activity cards have not only been the foundation projects but also the most widely received and utilised by local teachers in both countries. These will also form the basis for upcoming international teacher workshops.

Reflection on Partnership

The establishment of international partnerships within and between academic circles is considered to be of vital importance for the sharing of ideas, research and of common issues. This type of partnership between an externally funded science teacher and a science communicator within a university is a rare commodity; however, it is one that is of vital importance to today's global citizen. The collaboration has and continues to expose teachers

to international perspectives and international projects that give their pupils a chance to experience and obtain knowledge of global issues that are outside of their local environment. The more outside contacts the students and teacher achieve, the better this enables both learners to make better informed decisions and opinions about the world in which they live.

Challenges

Not only do the teachers and students gain from this collaboration but it has also been a learning opportunity for the authors. The similarity for the authors are the previously discussed issues including low level of achievement, participation and interest in science topics, and the challenges that these attitudes pose.

Other issues encountered include the cost of transporting physical resources from one country to the other – the resources have been easily available but the cost of posting, customs duties, Australian quarantine regulations have made some workshops impossible, particularly the importation of sand. The difference in the academic year, most of the UK has a three term year², starting in September finishing in July, Queensland has a 4 term year following the calendar year starting in January finishing the following December, has presented minor challenges when coordinating school-to-school projects.

There have been two major challenges. Firstly, the lack of direct dialogue, the face-to-face daily or monthly contact with each other. Along with this there is the nine to ten hour time difference, meaning such collaborations would have been nearly impossible before the advent of email. Secondly, the lack of accessibility funding, that researchers automatically have to be able to maintain this contact. Equity in organisational funding needs to be addressed if educational sectors are serious in their intent to develop such academic, scientific and educational partnerships.

² Some areas of the UK are experimenting with 6 term years

Conclusion

The learning experiences of both authors throughout 2007 to 2009 have provided the authors with new insights into establishing relationships with and links between schools, universities and scientific organisations. This partnership has enhanced the outcomes of what either the SCIPP or Cardiff University would have achieved independently, and been able to sustain teachers' knowledge and to ensure teachers' continued engagement in effective modes of on-going teacher learning. As both authors' positions cease in the coming year teachers now have to be very active agents in analyzing their own practice in the light of professional standards and their students' progress with regards to the standards for student learning.

It will then be up to the teachers who have already established their own 'international partnerships' to keep to the ideals of a learning organisation '*... where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together...*' Senge (1990)

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