DEAKIN UNIVERSITY

Building Productive Partnerships for STEM Education

Evaluating the model & outcomes of the Scientists and Mathematicians in Schools program 2015

A report from the Deakin University team:

Professor Russell Tytler (Project Leader)
Professor David Symington
Dr. Gaye Williams
Dr. Peta White
Associate Professor Coral Campbell
Dr. Gail Chittleborough
Mr. Garrett Upstill
Dr. Elise Roper
Ms. Nicola Dziadkiewicz

STEME Research Group
Re-imagining futures in Science, Technology, Environmental and Mathematics Education

EXECUTIVE SUMMARY

The Scientists and Mathematicians in Schools (SMiS) program is a major Australian initiative funded by the Australian Government Department of Education and Training in conjunction with CSIRO, which delivers the program through a national SMiS program team. The program involves volunteer science, mathematics, engineering and technology (STEM) professionals working in partnership with teachers in primary and secondary schools to engage students in quality learning in the STEM disciplines. Since its inception as Scientists in Schools in 2007 it has expanded to formally include Mathematicians in Schools and more recently ICT in Schools. Up to June 2015 it has brokered in excess of 4600 individual teacher-STEM professional partnerships and the program represents a major innovation in the national STEM education scene.

Since 2007 the program has been evaluated three times, leading to affirmation of the success of the model in terms of outcomes for students, teachers and the STEM Professionals, and recommendations for expansion. The evaluations have informed the development and expansion also of the SMiS program team which arranges the matches of the STEM professionals and teachers, provides support and advice for partnerships through project officers in each state, and organises workshops, online support and a website.

SMiS can be viewed as one of a suite of models of partnerships between STEM professionals and schools, which have achieved increasing prominence as concern with lack of engagement of students in STEM subjects and futures increases.

A number of key strengths characterise SMiS as distinctive amongst these initiatives: first, the partnerships involve a collaborative arrangement between an individual STEM professional and a teacher; second, the partnerships are flexible enabling response to local contexts; third, the partnerships are ongoing; and fourth, the program has significant national reach.

This evaluation

This assessment distinguishes itself from previous evaluations in its intent to probe more deeply into partners' experiences in order to:

- identify the affordances and challenges of the model and provide advice concerning improving its operation and its effectiveness to enable it to continue to lead practice, and
- provide an economic assessment of the return on investment of government resources into SMiS.

The assessment methodology included:

- analysis of previous evaluations,
- utilisations of data sources and literature around STEM participation and partnerships,
- surveys of STEM professionals, and teachers, in existing, closed and withdrawn partnerships,

- interviews with selected members of the SMiS team, and
- interviews with STEM professionals, teachers and students to construct partnership case studies.

The questions driving the evaluation are:

1. What are the outcomes for students, teachers, and STEM professionals as a result of the Scientists and Mathematicians in Schools program?
2. How is the Scientists and Mathematicians in Schools Program changing students' and teachers' engagement with, and knowledge and understanding of STEM practices?
3. What are the similarities and differences among the partnerships developed by teachers and scientists, teachers and mathematicians, and teachers and ICT professionals?
4. What are the strengths of the Scientists and Mathematicians in Schools model? What significant attributes of the SMiS model are highlighted when considering an overview of a range of initiatives involving STEM professionals, including university and industry working with schools?
5. In what ways could the Scientists and Mathematicians in Schools model be implemented which would result in it being ahead of leading practice and which would enhance program outcomes and impact?

Outcomes for students, teachers and STEM professionals (Qs1 and 2)

Both teachers and STEM professionals identified substantial benefits from the partnerships for students, and themselves.

For students the data point to a range of very significant benefits in increasing engagement with science, mathematics and ICT learning and reasoning, increased interest and enjoyment and knowledge and confidence in STEM subjects, awareness of how scientists and mathematicians think and work, increased appreciation of STEM professionals as people, and knowledge of, and enhanced attitudes towards, STEM pathways and careers.

Judgments of student outcomes were mainly based on informal/ anecdotal evidence. However a solid minority of teachers claimed evidence that involved judgments of the quality of student work. The SMiS team could usefully explore ways that evaluation of knowledge outcomes, improvements in inquiry and problem solving capability and attitudinal changes might be supported to help teachers and STEM professionals conceptualise appropriate outcomes.

For teachers the outcomes were improved motivation and engagement in science and mathematics teaching, the enjoyment of working with STEM professionals, increased engagement of their students, improved teaching processes and, for primary teachers especially, increased confidence with teaching.

For partnerships in primary schools there was evidence of substantial benefit flowing to the school more widely as an outcome of the partnership, involving improved teaching, and increased profile for STEM.

For STEM professionals the outcomes included enjoyment of promoting their commitments and knowledge to a new generation of students, increased understanding of, and confidence in, promoting public understandings of STEM, and gaining an alternative perspective on their own work.

The nature of the partnerships - similarities and differences (Q3)

A key feature of the SMiS model is the flexible, negotiated nature of the partnership, and partnerships vary considerably across dimensions of focus, time commitment, structure, and relation to the curriculum.

Some partnerships involve quite focused activities over a short period of time, recurring annually, while others involve considerable ongoing time commitment of both STEM professionals and teachers with the mode of engagement adjusting and growing over a period of years as both partners learn how to frame benefits emerging from their respective expertise.

In many cases, particularly with primary schools, the activities extend to multiple teachers or even the whole school, an additional benefit of the open nature of the model.

Curriculum is an important consideration in framing the partnership focus. The findings suggest significant variation in the nature of partnerships at different grade levels, and between the different subject areas, in the ways in which curriculum features in the partnership focus. A strength of the model is its flexibility to accommodate these contextual differences.

In senior secondary science classes the partnership often has a very distinct topic focus. At the primary and lower secondary levels, the flexibility of the model is utilised, and the partnership can enrich and lead curriculum practice with significant support in particular for the Inquiry Skills and Science as a Human Endeavour strands of the science curriculum.

In mathematics, where the curriculum is more highly organised and a central feature of practice in primary schools, mathematicians were often called upon to help design and implement problem solving and inquiry activities.

In both subjects the program exposed students to authentic models of thinking and working in the discipline.

While there were too few responses to the survey from ICT teachers and professionals to draw conclusions, it seems likely that over time these partnerships could be generative in supporting significant and authentic ways of working with digital technologies.

The strengths of the model (Q4)

The model is distinctive from other STEM partnership arrangements in three particular aspects; the individual and collaborative nature of the partnerships, their flexibility in responding to local contexts, and their ongoing intent.

The flexibility of the partnership arrangements, supported by the SMiS program team, allowed distinctive activities and programs to develop that drew on partners' strengths, accommodated local needs and made use of local resources.

Many of the partnerships explored in the study had a history over 3 and up to 7 years, and partners described the development of relationships, and initiatives, that morphed over time in response to growing understanding of what the STEM professionals could offer and what activities were particularly productive.

The study showed the potential for STEM professionals to bring to the partnerships a set of knowledge, skills and perspectives that are distinctly different to what the teachers themselves can offer. Teachers brought strengths in curriculum and teaching expertise. The collaborations in many cases opened up enriched learning opportunities for both partners, and for students.

The model has significance in bringing together school and professional practice communities to develop an experienced curriculum with a strong focus on STEM inquiry and reasoning.

Return on investment in the SMiS program

Analysis of the nature of SMiS partnerships demonstrates outputs and outcomes for students, teachers, and STEM professionals that represent a strong return on investment for the program.

First, SMiS leverages considerable volunteer STEM professional resources to address the important national problem of student engagement. For the partnerships reported on in the survey, each partnership represents an estimated annual commitment of $1250 from the Australian Government Department of Education and Training and CSIRO. This funding input leverages however the equivalent of almost three times this amount through the commitment of STEM professionals dedicated to improving STEM teaching and learning in schools.

Each science partnership involves on average an estimated 192 student interactions each year, amounting to 326 000 annual interactions across the program currently. Scientists spend on average 29 hours in contact at schools per year, 13.5 of which are spent working with small groups or individual students, representing focused learning experiences.

Second, to deliver the outcomes of the program by alternative means would be expensive. For instance, using proxy measures to estimate the cost of a subset of equivalent outcomes by other means yields $3700 per partnership for enhanced student enthusiasm for STEM learning, $1080 for increased STEM knowledge, and another $4000 for equivalent teacher development.

Third, the outcomes of the program are substantial, and significant. Teachers involved in the partnerships engage in significant professional learning through planning with the STEM professional and working with and observing their interactions with students. These professional learning opportunities and activities are consistent with current thinking about effective teacher development as being action oriented, collaborative, and grounded in local practice.

The types of experiences and learning for students brought by STEM professionals, focusing as they do on authentic practice and offering role models of thinking and working in the disciplines, are consistent with current thinking concerning best practice in supporting engagement with learning in science and mathematics and student choice of STEM futures.

Outcomes for STEM professionals include increased commitment to educating future generations, and skills in interpreting their practice for a wider audience.

Fourth, there are valuable longer-term impacts attributable to the SMiS program because of its distinctive and central role as a STEM outreach activity. The impact of the SMiS program relates to its status within Australia as emblematic of the incorporation of contemporary STEM practice into school curricula, its focus on ways of thinking and working in the STEM disciplines, and its alignment with contemporary directions in science, mathematics and ICT curricula.

Discontinuation of the program would represent a significant loss to innovation in contemporary thinking in STEM teaching and learning. Continuing and scaling up the program would open the possibility of establishing in Australia a significant new direction in teaching and learning in STEM subjects.

Forging ahead of leading practice (Q5)

The SMiS program can legitimately claim to be a major feature of the school-STEM community partnership landscape in Australia. This evaluation has shown that the model underpinning SMiS is distinctive through its capacity to adjust to local context, and the depth and longevity of the partnerships that can develop.

The flexible and negotiated nature of the program however brings with it challenges, and this study revealed problems with some partners not understanding their roles, not appreciating the potential of the program, and finding it difficult to undertake the negotiation and understandings needed to make the partnership work. Almost one quarter of partnerships are 'withdrawn' before starting joint activity.

SMiS partnerships involve professionals from quite different communities of practice learning to understand and appreciate each other's perspectives, and the 'border crossing' that is required needs patience and support. Both STEM professionals and teachers describe key aspects of partnership sustainability as involving willingness to be flexible, a capacity to understand each other and develop a shared view, and a commitment to develop a quality relationship focused on making the partnership work.

Matching partners thus becomes understood as a key aspect of setting up sustainable partnerships. The SMiS team has developed an impressive variety of processes – personal contact, workshops and resources, and on-line supports – to support the matching of partners and support of ongoing partnerships. However, the pressure of numbers and the complexity of providing support for the varied personal and professional relationships that are initiated mean there are inevitable tensions between the need to initiate new partnerships, and the need to support them at key points.

There is an opportunity, if SMiS continues to grow to be a major influence on innovative STEM practice in schools, to more systematically articulate and support the needs of partners to understand the roles that are implied by such partnerships and the potential experiences and expertise that can be productively brought into them. If resources could be effectively developed to do this, SMiS has the potential to become an even more significant catalyst for major innovation in school STEM curricula in Australia and beyond.

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