

The Evaluation of the Success in Numeracy Education Program¹

Doug Clarke

Australian Catholic University
d.clarke@patrick.acu.edu.au

Max Stephens

University of Melbourne
m.stephens@unimelb.edu.au

Gerard Lewis

Catholic Education Office
glewis@ceo.melb.catholic.edu.au

Ann Downton

Australian Catholic University
a.downton@patrick.acu.edu.au

The Success in Numeracy Education professional development program was designed to address national goals for numeracy in Catholic primary schools in Victoria. Key components in the program included clinical interviews in Number, the use of growth points and growth point activities, rich assessment tasks in Space and Measurement, the extensive training of Focus Teachers from each school, and regular support from Numeracy Resource Officers. Staff from Australian Catholic University (Melbourne) were invited to evaluate the success of the program in terms of student outcomes and teacher professional growth. The major sources of evaluation data were student assessment interviews, teacher questionnaires and teacher, Focus Teacher, principal and Numeracy Resource Officer focus discussion groups. A picture emerged of great variation across content domains in student understanding, and similar variation between schools in terms of implementation and commitment to the program. Clear advice was offered by focus groups on possible directions for enhancing the program.

In the late 1990s and early in the 2000s, a number of major research-based professional development programs in early years' mathematics were initiated by departments of education, Catholic Education Offices, and Associations of Independent Schools around Australia.

Although differences exist between the programs in size, scope and focus, there are many similarities. Many of the common features of three such programs discussed by Bobis, Clarke, Clarke, Gould, Thomas, Wright, and Young-Loveridge (2005) apply to the Success in Numeracy Education (SINE) program, developed by the mathematics education team at the Catholic Education Office (Melbourne). These include:

- *The development and use of research-based frameworks.* The programs drew upon research in young children's mathematical learning (e.g., Clements, Swaminathan, Hannibal, & Sarama, 1999; Fuson, 1992; Mulligan & Mitchelmore, 1995; Wright, 1998; Young-Loveridge, 1997), and communicated this research to teachers in a form that was useable.
- *The use of task-based, one-to-one assessment interviews.* A growing consensus on the limitations of pencil and paper testing in mathematics (Clements & Ellerton, 1995) provided part of the impetus for the use of interviews with young children in mathematics. Although expensive in terms of teacher's time, the use of these interviews enables an understanding of what children know and can do in mathematics in general terms and for the teacher's own students, and informing planning. "The frameworks and interviews have also assisted to move the focus of professional development from the

¹ We acknowledge gratefully the role of our colleagues (Marj Horne, Pam Hammond, Amy Basile, and Anne Roche) in the evaluation process.

notion of children carefully reproducing taught procedures to an emphasis on children's thinking, with teachers as researchers" (Bobis, et al., 2005, p. 50).

- *Ongoing, reflective professional development.* Professional development programs have moved gradually away from the one-shot model (Clarke, 1994), and teachers are increasingly regarded as reflective practitioners (Doyle, 1990). A generally accepted desirable feature of professional development programs is the involvement of all staff teaching mathematics at the relevant levels. The implementation of the Victorian Early Numeracy Program by the Department of Education and Training and the SINE program however involved a "train-the-trainers" model, where numeracy coordinators participated in a professional development program and were then expected to "train" the staff back at their schools, as they worked in *professional learning teams* (Johnson & Scull, 1998). Such train the trainers programs can lead to a "watering down" of the professional development received by initial participants, and this is discussed in a later section in relation to SINE.

Other common features across the three programs mentioned by Bobis et al. (2005) include positive changes in student achievement and positive changes in teacher knowledge and practice. These aspects are discussed in relation to SINE in later sections. In the following section, the structure of the SINE program is discussed, including key roles and content of the program.

An Overview of the SINE Program

Success in Numeracy Education (SINE) is the major numeracy program being implemented in Victorian Catholic schools. It is a whole-school approach designed to assist teachers to identify the mathematical knowledge and skills of the children they teach and to develop teaching approaches to support successful learning by all students.

The SINE program was first piloted in 1999 and targetted teachers and students from Preparatory Year to Year 4. This area was especially well supported by research charting children's development in early number through growth points (e.g., Gervasoni, 2000; McIntosh, 1994; Pearn & Merrifield, 1992; Steffe, vonGlaserfeld, Richards & Cobb, 1983; Wright, 1998). Since then, SINE Prep to Year 4 has been implemented across catholic schools through the Catholic Education Commission of Victoria (CECV). In the Melbourne Archdiocese, for example, by the end of 2004 about 230 out of 256 schools had participated in SINE Prep to Year 4.

Content and Structure of Program

Four content strands form the basis of SINE Prep to Year 4 program: Number, Measurement, Space, and Reasoning and Strategies. The program consists of five days spaced over several months during which participants carry out assessments of students, trial and report on teaching activities. This aspect of SINE may be characterised as an action-research phase. Two teachers, Focus Teachers from each school are nominated to participate in the program. An outline of the five-day program is as follows:

Day 1: introduction to SINE, Number strand, Growth points in number, preparing for a clinical interview, what is a 3-year Numeracy Plan?

Day 2: reporting and reflecting on clinical interviews, applying growth points to interview data, teaching activities to support growth points, developing a 3-year Numeracy Plan.

Day 3: reporting and reflecting on use of growth point teaching activities, identifying children at risk and developing teaching plans for these children, reasoning and strategies.

Day 4: Measurement and Space (theory and research background, relation to Curriculum and Standards Framework – CSF II, rich assessment tasks).

Day 5: meeting with principals to discuss 3-year numeracy planning, reporting on teaching activities using Space and Measurements tasks, relating samples of work to CSF II, supporting school-based professional development using SINE materials, implementing SINE at school.

Between sessions, tasks are set for participants to carry out in their home schools and to report on at the following session. After the first session, for example, participants have to carry out a clinical interview in Number, of about 15 minutes, on a sample of about six students selected by the teacher across the whole range of levels of understanding.

Clinical Interviews

One-to-one interviews enable teachers to probe students' understanding of number using a series of staged questions which are adapted according to children's individual responses. Since many schools find it difficult to interview all students, screening tests in number were developed for Years 1 to 6. Using information provided by these screening tests, clinical interviews can then be targeted to specific children.

Focus Teachers are trained in scoring and recording the interview, and in relating students' responses to interview questions to growth points in number. Having identified students' stages of development, SINE Prep to Year 4 provides teachers with a range of resource materials (CECV, 2004), including growth point activities which are designed to move students forward from whatever stage they are at. Teaching plans are developed for whole class teaching, small-group instruction or one-to-one teaching. These three strategies are used by teachers implementing a SINE numeracy session.

Many SINE Prep to Year 4 schools now put aside teacher release time at the start of the school year to allow screening tests and one-to-one interviews to be carried out from Prep to Year 4 (and in some cases to Year 6). In some schools, time is made available to interview all students from Prep to Year 4 using a clinical interview. One of the challenges for SINE schools is to integrate this kind of rich assessment information with other forms of assessment, such as results of state-wide assessment through AIM (Achievement Improvement Monitor), and ongoing assessments by teachers.

Implementing SINE Prep to Year 4

A key goal for SINE Prep to Year 4 is to have Focus Teachers work with their schools to develop a three-year Numeracy plan. This plan is intended to provide a coordinated focus for the improvement of teaching and learning in mathematics, supported by the provision of classroom resources, school-based development using SINE resources, and the integration of assessment information and reporting to parents.

Support for SINE in the Melbourne Archdiocese is provided by the Catholic Education Office (CEO) through its Numeracy Resource Officers (NROs), who are experienced SINE teachers released one day per week to work with other district schools, and through network cluster meetings. These are full-day meetings conducted by CEO numeracy staff and NROs with a keynote talk followed by networking to discuss implementation, and workshops to demonstrate use of SINE resources for teaching and learning. CEO Melbourne also provides funds to SINE schools, currently equal to 0.1 EFT per school, to support numeracy coordination and to facilitate teacher release to implement assessment, especially one-to-one clinical interviews in number.

Two further SINE programs have been developed. SINE Years 5 and 6 commenced in 2001 and has so far reached over half of schools in the Melbourne Archdiocese. In 2002, the Catholic Education Commission of Victoria commenced a pilot program in middle years numeracy, SINE Years 5 to 8. After 2004, SINE Years 5 and 6 will be phased out, leaving SINE Years 5 to 8 to be the principal program for upper primary and junior secondary years. Both programs have a strong focus on aspects of Number that are critical for students in the middle years. Researchers have played a key role in the development of SINE resource materials and in the presentation of sessions.

The Evaluation of the SINE Program

Participants in the Study

The proposed evaluation model involved a stratified random sample of fifty schools by zone and years of involvement in SINE. However, of the initial set of 50 schools selected, 24 declined the invitation. Several of these schools indicated their lack of progress with the implementation of SINE as the basis of their decision. Although these schools were replaced by others, at the point at which it was too late in the process to seek more schools, the total remained at 47, an adequate number for the purposes of the evaluation. It is arguable that the final sample of 47 schools may be slightly more “advanced” in their implementation, on average, than the original sample of 50.

For each school, the principal, the two Focus Teachers, a randomly-selected teacher from each year level (Preparatory – Year 4) were chosen. A similar random sampling process was then used to select four students from the grades of the selected teachers. Table 1 summarises the number and type of participant and the data collection instruments used.

Table 1

Participants, Numbers, Sampling Method and Data Collection Instruments for Evaluation

Participants	Numbers and sampling method	Relevant data collection instruments
Central CEO staff	4 (key developers of SINE)	Questionnaire; focus group discussion
Numeracy Resource Officers (NROs)	11 (all—one per zone)	Questionnaire; focus group discussion
Principals	47 (one per sampled school)	Questionnaire; focus group discussion with 11 invited principals (one per zone)
Focus Teachers	84 (two per sampled school, where available)	Questionnaire; focus group discussion with 11 invited Focus Teachers (one per zone)
Teachers	208 (five per sampled school; one at each of Years P-4, where available)	Questionnaire
Students	1010 (approximately 20 per school)	Assessment interview (from Early Numeracy Research Project)

The questionnaire response rate was excellent: Numeracy Resource Officers (100%); Principals (95.7%); Focus Teachers (94%), and Teachers (85%).

The Early Numeracy Research Project interview was used to collect data relating to students’ understanding in Counting, Place Value, Addition and Subtraction,

Multiplication and Division, Length, and Properties of Shape. This instrument was chosen because it provided an independent assessment tool with known benchmarks on student understanding and skills, drawn from ENRP Trial Schools and their matching Reference (“control”) Schools (Clarke, Cheeseman, Gervasoni, Gronn, Horne, McDonough, Montgomery, Roche, Sullivan, Clarke, & Rowley, 2002). Data were also collected on affective aspects of children’s mathematics learning, as perceived by teachers, as part of the survey data.

Evaluation Questions

The following questions guided the evaluation:

- Q1. What were the stated and perceived *goals* of the multi-stage professional development program according to presenters and participants at all levels?
- Q2. What were the short and medium-term *outcomes* of the multi-stage professional development program as perceived by presenters and participants at all levels?
- Q3. What *strengths* and *limitations* of the professional development program were perceived by presenters and participants?
- Q4. To what extent have the *key program features* been *implemented* for Numeracy at the school level, and with what level of alignment with that which was intended?
- Q5. What are the major *components* of the role of Numeracy Resource Officers as enacted in the SINE Program? What *strategies* have Numeracy Resource Officers developed to implement the program, and what *benefits* and *challenges* do they see in the role?
- Q6. What are the major *components* of the role of Focus Teachers as enacted in the SINE Program? What *strategies* have Focus Teachers developed to implement the program, and what *benefits* and *challenges* do they see in the role?
- Q7. How does the achievement of children in schools that have implemented the SINE Prep to Year 4 Program compare to those who were involved in the Early Numeracy Research Project in trial and reference schools respectively?
- Q8. What *perceptions* do teachers have of their children’s achievement in 2003, as compared to previous years, in both cognitive and affective aspects?

Some Key Findings

Only some findings (and therefore only some research questions) are discussed here.

Program goals and successes. All respondent groups clearly identified the enhancement of mathematics teaching practice, including the use of a clinical interview to identify and monitor student learning, as the *major perceived goals* of SINE. Other common goals included a united vision of mathematics teaching and learning at the school level, and the use of assessment data to inform planning. These goals were matched closely by the *perceived successes* of SINE by *all groups of respondents*.

Perceived changes in teaching practice. The major changes in teaching practice identified by Focus Teachers and other teachers related to their greater focus on assessment gathering (including enhanced recording and monitoring), their use of a structured mathematics lesson, and a greater focus on meeting individual needs. The longer teachers were in SINE the more valuable they felt SINE had been to their teaching. Principals pointed to increased personal mathematical knowledge, leadership skills, and increased enthusiasm and motivation as a result of SINE.

Focus Teachers and Numeracy Resource Officers (NROs). The major roles of Focus Teachers (as perceived by respondents to questionnaires) included liaison with school leadership teams, presentation of professional development, providing support for teachers, and working with parents. Challenges faced included varying support from principals and

colleagues, time to carry out the role, and necessary knowledge to deliver the professional development confidently.

The major role of the NROs was seen as liaising with the Catholic Education Office and networking with schools to keep schools informed on latest developments in SINE. Major challenges in the role included meeting the needs of schools and Focus Teachers given one day per week time allocation, and varying levels of principal support. Where an NRO was able to work closely with a school, the feedback regarding their contribution was very positive.

SINE implementation at school level. The Three-Year Numeracy Plan was regarded positively by respondents, as it enhanced whole-school impact, goals and target setting, raised profile and awareness of mathematics, provided direction for program development and planning, supported the change processes, and focused the professional development.

Having a clearly affirmed Three-Year Numeracy Plan endorsed by the principal and leadership team was seen by NROs as vital. They also noted that schools where principals had a strong understanding of SINE and provided on-going support were advantaged when compared to other schools.

The degree of implementation in a given school tended to depend on the enthusiasm and confidence of the Focus Teachers and the support provided by the school leadership team. Having Focus Teachers that were enthusiastic, confident, motivated and clear in their direction provided obvious benefits. Take up levels of schools that were trained in the program in 2002 and 2003 were seen as probably stronger than earlier cohorts. Schools trained earlier often demonstrated limited ongoing development.

SINE professional development at school level. All groups of respondents noted positive features including building up teachers' confidence, knowledge of mathematics, knowledge for teaching and assessment and the repertoire of activities and strategies.

Limitations in the school-based professional development included the varied experience and skills of Focus Teachers, and the reluctance of some to present to others, given their lack of confidence or limited leadership skills.

Other common concerns included the following:

- *Lack of funding* for resources, professional development and teacher release.
- *More time* needed to meet, share ideas and activities, observe colleagues, and discuss findings when implementing the program.
- *More ongoing, frequent professional development* for classroom teachers (including cluster meetings) needed, as provided for CLaSS (the Melbourne CEO's literacy initiative).
- *SINE was not sufficiently varied* in order to consider teachers who had previously experienced extensive professional development as well as those with limited experience.

Professional development program for Focus Teachers. A common concern was the amount that was packed into the five day initial program. Suggestions to support Focus Teachers included increased opportunities to network with other Focus teachers, more "refresher courses" on SINE, and more opportunities for "successful schools" to share their insights. NROs suggested greater input from mathematics education researchers in their professional development, and assistance with leadership and negotiation skills.

Student attitudes, confidence and other affective aspects. All groups of respondents were highly positive regarding student affect. Of particular note were increased ability to verbalise, question, reflect, and use the language of mathematics, increased student

enjoyment and interest with mathematics, and increased confidence. The responses provided a picture of vibrant mathematical learning communities, with students engaging in worthwhile mathematics, with a positive and enthusiastic spirit.

Student assessment interview data. Data from the Early Numeracy Research Project provided known benchmarks of growth points achieved by students from Prep to Year 4 in ENRP Trial and Reference schools, which could be compared with SINE school data.

Comparing ENRP Catholic schools with SINE schools, there was a generally consistent pattern, with SINE schools' mean growth points falling within the range of ENRP data: usually better than ENRP Reference schools, but not quite as high as the children whose teachers were involved in ENRP throughout. In the case of Properties of Shape, the SINE schools were well below both Trial and Reference schools.

When SINE schools were compared to *all* ENRP schools, the results were mixed. For the Number domains, SINE children were generally between ENRP Trial and Reference schools, but for Length and Properties of Shape, the differences were considerably in favour of both groups of ENRP schools.

Given the relatively low funding to SINE schools compared to ENRP schools, these results showed that, in the case of the Number domains, SINE had made a difference. The next question of interest was whether a longer school involvement in SINE led to a higher level of student achievement.

Surprisingly, and of some concern, was that, except for Year 2 in Counting, the amount of time a school has been in SINE did not appear to have impacted significantly on student achievement, as measured by the Early Numeracy Interview. In any effective program, one would assume that the longer the school has participated, the greater the effect, but in the case of student learning, this is not evident.

It would seem to support the observation of many Numeracy Resource Officers that schools who were involved in the early stages of SINE appeared to have not sustained their commitment to the program, leading to a conclusion that for a variety of reasons, these schools consider that mathematics had been "done".

Recommendations

Recommendation are summarised as follows:

- *Resourcing:* CEO (Melbourne) increase the funding to the SINE program, including increased time fractions for NROs and Focus Teachers, increased whole-school (P-4) professional development in clusters, and increased release time for one-to-one assessment.
- *Professional Development Content:* The initial Focus Teacher professional development program focus on the domain of Number exclusively with greater input on leadership and within-class support, a clinical interview for Space and Measurement be developed, and professional development be differentiated generally to a far greater extent, allowing for participant expertise and previous experience.
- *Clear role descriptions:* The roles of NROs and Focus Teachers be more clearly stated.
- *Enhanced communication:* Greater liaison between NROs, principals, and curriculum advisers, and regular written and electronic communication of new resources and SINE developments be implemented.
- *Ongoing evaluation of the SINE program:* Clear goals be defined for SINE for the next three years, and an evaluation design be developed to assess their achievement.

Conclusion

In the past, evaluations of sector-initiated programs for teacher professional development tended to be limited to measuring teacher satisfaction with what had been offered. Some attention may have been given to assessing long-term impact on schools. Improvement in student learning was expected to follow. Today, sector-driven programs are expected to account for the major investment of resources that they use. Teacher satisfaction and school change are important, but there is now a necessary requirement for these programs to demonstrate improved outcomes for children's learning. New models for evaluation are needed. This evaluation of the SINE Prep to Year 4 program provided such a model, yielding rich and important data on student understanding, as well as measures of changed practices in schools and classrooms, and constructive recommendations for enhancing the program and levels of implementation in the future.

References

- Bobis, J., Clarke, B. A., Clarke, D. M., Gould, P., Thomas, G., Wright, R., Young-Loveridge, J., & Gould, P. (2005). Supporting teachers in the development of young children's mathematical thinking: Three large scale cases. *Mathematics Education Research Journal*, 16(3), 27-57.
- Catholic Education Commission of Victoria (2004). *Success in Numeracy Education: Preparatory to Year 4 (Text and CD Rom)*. East Melbourne: Author.
- Clarke, D. M. (1994). Ten key principles from research for the professional development of mathematics teachers. In D. B. Aichele & A. F. Croxford (Eds.), *Professional development for teachers of mathematics* (pp. 37-48). Reston, VA: National Council of Teachers of Mathematics.
- Clarke, D. M., Cheeseman, J., Gervasoni, A., Gronn, D., Horne, M., McDonough, A., Montgomery, P., Roche, A., Sullivan, P., Clarke, B. & Rowley, G. (2000). *Early Numeracy Research Project Final Report, February 2002*. Fitzroy, Victoria: Australian Catholic University.
- Clements, D. H., Swaminathan, S., Hannibal, M. A. Z., & Sarama, J. (1999). Young children's conceptions of space. *Journal for Research in Mathematics Education*, 30(2), 192-212.
- Clements, M. A., & Ellerton, N. (1995). Assessing the effectiveness of pencil-and-paper tests for school mathematics. In S. Flavel, I. Isaacs, D. Lee, R. Hurley, T. Roberts, A. Richards, R. Laird & V. M. Ram (Eds.), *Galtha* (pp. 184-188). Darwin: MERGA.
- Doyle, W. (1990). Themes in teacher education research. In W. R. Houston (Eds.), *Handbook of research on teacher education* (pp. 3-41). New York: Macmillan.
- Fuson, K. (1992). Research on whole number addition and subtraction. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 243-275). New York: Macmillan.
- Gervasoni, A. (2000). Using growth point profiles to identify Year 1 students who are at risk of not learning school mathematics successfully. In J. Bana & A. Chapman (Eds.), *Mathematics education beyond 2000* (pp. 275-282). Fremantle, Western Australia: MERGA.
- Johnson, N., & Scull, J. (1998). The power of learning teams. In Department of Education (Ed.), *Sharing the Journey: Proceedings of the Early Years of Schooling Conference* (pp. 16-22). Melbourne: Editor.
- McIntosh, A. (1994). *A new look at arithmetic and computation*. Adelaide: Australian Association of Mathematics Teachers.
- Mulligan, J., & Mitchelmore, M. (1995). Children's intuitive models of multiplication and division. In S. Flavel, I. Isaacs, D. Lee, R. Hurley, T. Roberts, A. Richards, R. Laird, & V. M. Ram (Eds.), *GALTHA* (pp. 427-433). Darwin: MERGA.
- Pearn, C., & Merrifield, M. (1998, October). *Mathematics intervention*. Paper presented to the Early Numeracy Networks, Department of Education, Melbourne, Victoria.
- Steffe, L.P., Von Glasersfeld, E., Richards, J., & Cobb, P. (1983). *Children's counting types: Philosophy, theory, and application*. New York: Praeger.
- Wright, R. (1998). An overview of a research-based framework for assessing and teaching early number learning. In C. Kanes, M. Goos, & E. Warren (Eds.), *Teaching mathematics in new times* (pp. 701-708). Brisbane: MERGA.
- Young-Loveridge, J. (1999). The acquisition of numeracy. *SET Research Information for Teachers*, 12(1), 1-8.