PROFESSIONAL DEVELOPMENT AND THE SECONDARY MATHEMATICS TEACHER: A CASE STUDY

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INTRODUCTION

This paper reports a case study of the development, implementation and outcomes of the "Active and Reflective Teaching In Secondary Mathematics" (ARTISM) professional development program. This development arose through the collaboration of teachers on three school sites, the school system (Catholic Education Office), and a tertiary institution (Australian Catholic University). An evaluation has been undertaken to document the development process, the presentation of the program, and participants' responses, including the long-term take-up of the program's key features in the participants' classroom practices. Details are presented of development and delivery and the preliminary findings of the evaluation.

The ARTISM professional development program is predicated on the belief that change will arise from the classroom experiences of teachers who have undertaken to field-test some of the new techniques. Adopting this perspective, the teacher's commitment to field-test some of the techniques becomes an essential condition of a teacher's participation in an in-service activity. This model of professional development assumes that the value of the new approach will emerge most clearly and with greatest personal impact when applied in the teacher's own classroom, and that this will fuel a change in teacher's beliefs, generating on-going commitment to further professional development. The professional development cycle so established (Clarke, 1988, p. 188, see Figure 1) will hopefully become an upward spiral.

Two points must be made:

1. As Figure 1 makes clear, each stage is mediated by factors peculiar to the particular teacher's situation. As a result, the nature of each teacher's professional development will be a unique product of their personal history and their present situation.

2. It is possible to join the cycle at any point: a chance question or an improvised activity may demonstrate the inadequacy of previous methods and lead to a reassessment of beliefs about good teaching; or participation in a professional development program may raise the unexpected possibility of attractive new methods. It is also possible to leave the cycle at any point should the mediating factors provide insurmountable obstacles. For instance, a new approach may be successful in achieving goals which are not valued by the school community, and the professional development subside for lack of support, recognition or encouragement.

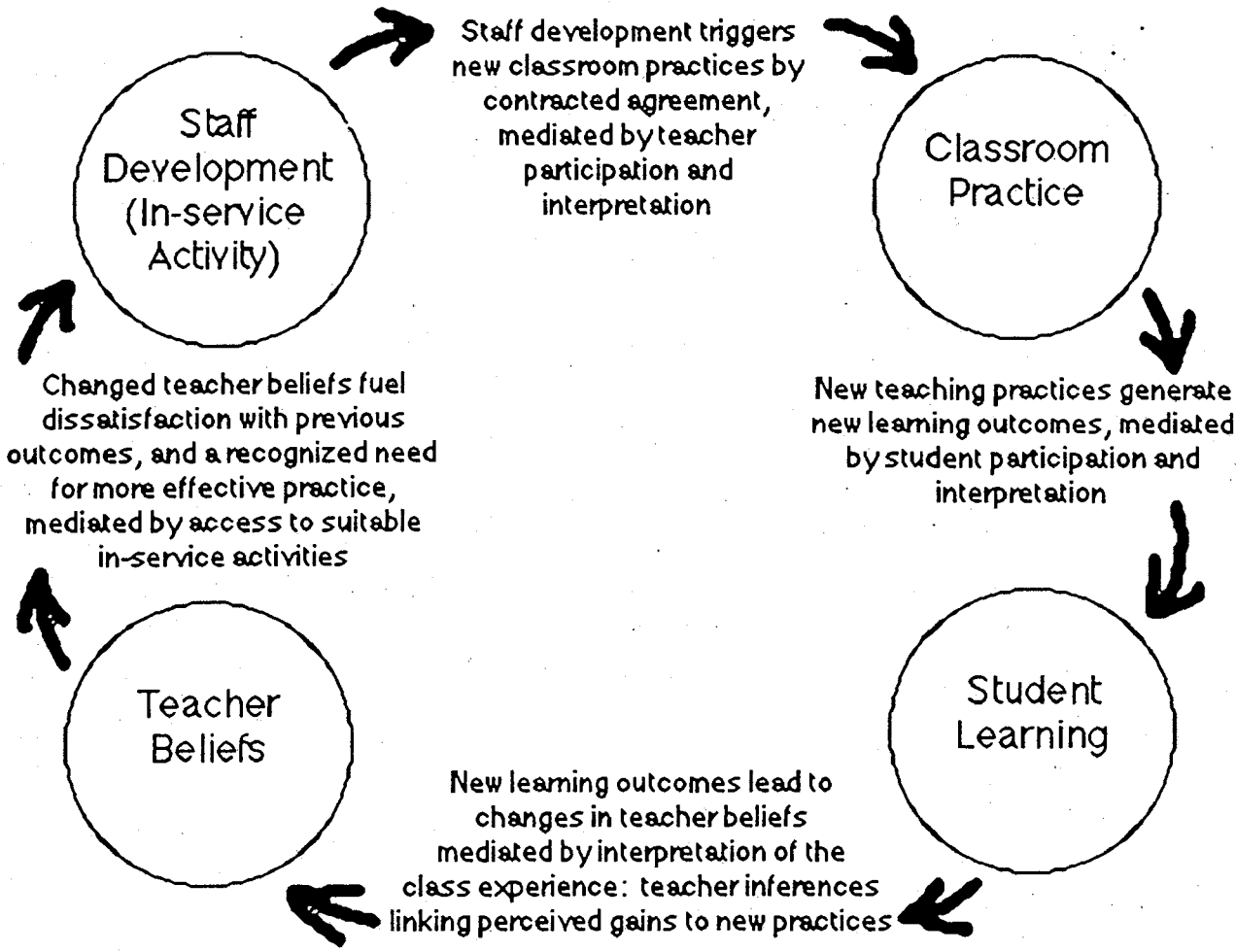

Figure 1: A Cycle of Professional Development (from Clarke, 1988)

This view of professional development employs the same elements as the linear model developed by Guskey (1985), and embodies a picture of the teacher as learner, constructing personal professional practice from in-service activities and classroom experiences in a way which reflects the teacher's personal history and present situation.

THE PROGRAM

Basis for the program

ARTISM was intended to make the participating teachers aware of the current developments in the learning and teaching of mathematics while acknowledging the factors inhibiting implementation, making realistic demands of teachers, while providing appropriate support. This professional development program was predicated on the belief that change will arise from the classroom experiences of teachers who have undertaken to field-test some of the new techniques. The application of the key content of the sessions in the teachers' own classrooms is an essential element of the course.

Program structure

An initial questioning of the mathematics co-ordinators of the three schools indicated a clear preference for a program structure providing models of teaching and learning as well as certain content issues that are regarded important in secondary mathematics.

This led to the following program structure:

Unit 1: Mathematical Problem Solving and Modelling

Unit 2: Communication and Classroom Structures

Unit 3: Technology in the Mathematics Classroom

Unit 4: Assessment Alternatives and Module Planning

Unit 5: Reflection on Action and Further Planning

Units 1 and 2 were offered at the commencement of the school year on two separate evenings, one week apart. A four week classroom exploration period was provided between units 2 and 3 to enable the teachers to undertake significant exploration of the course themes and techniques.

As ongoing follow-up and reflection on the implementation of the intended change are crucial for successful and effective professional development (Zigarmi, Betz, & Jensen, 1977, p.551), the fifth session about reflection and the school visits of consultants and presenters at the three school sites between the sessions on a regular basis were included as an integral part of the course. These school visits, which occurred during the four week break between the second and the third session and between unit four and five, served three principal functions: to support teachers in their trialling of the strategies offered in the course; to provide a measure of accountability, increasing the teachers' sense of obligation to make use of the course materials; and, to collect evaluation data through informal discussion with teachers regarding their classroom successes and concerns.

Participants' commitments

* Maintain a journal/portfolio

* Complete readings for each week

* Undertake classroom tasks specified for each week

* Develop or rewrite a unit of work

* Complete additional feedback sheets, or provide information as required

Desired outcomes of ARTISM

* An expanded repertoire of teaching strategies, practice and success with new ideas

* Improved student learning

* Willingness of teachers to experiment

* Changes in school classroom practice

* Changes in the school mathematics program

* Resources (and where to get them)

* Teacher affective outcomes

EVALUATION

Evaluation Design

The development of the ARTISM professional development program was characterised by the collaboration of teachers on three school sites, the school system (Catholic Education Office of Victoria, and a tertiary institution (Australian Catholic University). The evaluation of the program was required to address the needs of all three collaborating groups, while simultaneously assessing program outcomes within a structure informed by earlier research into teacher professional development. The evaluation guidelines set out by Guskey and Sparks (1991) have informed the evaluation of the ARTISM course specifically.

The evaluation was conceived and undertaken at the same time as the development of the professional development program. From the outset, the development team, the educational system, and the participating schools were represented in the establishment of the program's goals and the criteria by which the success of the program might be assessed. The program design and the evaluation were integrated to maximize the opportunity for the preliminary findings from the evaluation to inform the implementation of the program. The identification of objectives encompassed system goals, school goals, departmental goals, and the goals of the individual participants. It was seen as essential that each of these goals be documented at the commencement of the program. An obligation to access multiple sources of data was seen as an imperative for research into educational contexts, where control of environment and treatment is limited and where the reality of participation, motivation and consequent action resides with the individual (for instance, Clarke, 1984) In such research situations it is the responsibility of the researcher to document the individual realities of the participating subjects from as many perspectives as possible, since the authority regarding "what really happened" does not reside with any individual data source, but rather the assessment of both experiences and outcomes is most appropriately expressed with independent reference to each of the participating groups: program developers and presenters, the facilitating educational system, and the participating teachers and their respective school communities.

Participants' perceptions will be sought regarding their current practices, their perceived needs, their current concerns, their opinions of the value of program components, perceived program omissions, the practicality of suggested practices, and the classroom outcomes attributable to their participation in the progam.

Data collection categories for the evaluation of the ARTISM program can be characterised as related to:

- **Context**: the existing administrative and environmental constraints affecting participants, and pre-existing beliefs, practices and expectations;

- **Participation**: the nature of teacher participation in the program, consistency in attendance, completion of work requirements, and teacher perceptions of program components;

- **Implementation**: the details of the implementation of the program, the identification of what constitutes the "treatment" or "innovation" to which participants are being asked to respond, fidelity to the program design, and changes to the program arising during implementation;

- **Satisfaction**: the satisfaction of the participants with the program, enjoyment, interest, practicality, and the extent to which the program met their needs and offered something of value;

- **Change in teaching practice**: the changes in the practices of the participating teachers attributable to program participation, changes in teacher beliefs, and consequent organizational changes in participating schools;

- **Student outcomes**: the student outcomes which can be associated with teachers' participation in the program, through changes to the classroom environment or to teachers' work practices.

Results

The results which follow are organized around the above data collection categories. A more extensive discussion of the results of this study can be found in Clarke, Carlin and Peter (1992).

Participants

Thirty-three teachers from three Catholic boys' secondary schools enrolled for the program.

CONTEXT

In completing the questionnaire "My Classroom Structure", teachers were asked to "Think of a junior secondary mathematics class which you have taught over the last 3 - 4 weeks. Circle the words in the table below which best describe that class." The distribution of teacher responses is given below in Table 1.

Table 1: Number of teachers (Percentage in brackets) responding in each category.

Year level of class	7	8	9	10
No. teachers (percentage)(n=18)	1(6)	4(22)	6(33)	7(39)
Most common teaching group	Whole class	small group	individual pupil	
No. teachers (percentage)(n=22)	15(68)	3(14)	4(18)	
Most common working group	Whole class	small group	individual pupil	
No. teachers (percentage)(n=24)	7(29)	7(29)	10(42)	
Most common emphasis	Problem solving	Applications	Skills	
No. teachers (percentage)(n=21)	2(10)	6(29)	13(62)	
Most common materials (circle one or more)	Text	W'sheets	Aids	Cal'tors	C'puters	Others
No. teachers (percentage)(n=24)	10(42)	13(54)	5(21)	10(42)	1(4)	1(4)

Some classroom "scenarios" were provided. These scenarios were clustered into groups, which had certain characteristics in common. Teachers indicated which scenario most resembled their classroom, and then which other scenario in another group they would consider using. The results for each of the groups of scenarios are recorded in Tables 2 and 3.

Table 2: Number (and percent) of teachers recording each scenario group as representative of their current practice (n=24).

Group	Scenarios	Characteristics	No.	%
A	1 and 2	whole class, skills and bookwork	13	54
B	3, 4, 5 and 6	variations on small group work	2	8
C	7 and 8	problem-based instruction	1	4
D	9 and 10	skills then applications	5	21
E	11	vocational mathematics, few new maths skills	0	0
F	12	individualized maths programs	3	13
G	13	vertical modular grouping and multi-age structures	0	0

Table 3: Number (and percent) of teachers recording each scenario group as one (different from their current practice) which they would consider using (n = 24).

Group	Scenarios	Characteristics	No.	%
A	1 and 2	whole class, skills and bookwork	1	4
B	3, 4, 5 and 6	variations on small group work	6	25
C	7 and 8	problem-based instruction	7	29
D	9 and 10	skills then applications	2	8
E	11	vocational mathematics, few new maths skills	0	0
F	12	individualized maths programs	4	17
G	13	vertical modular grouping and multi-age structures	0	0
None		none of the above	3	13
Any		any of the above	1	4

Pre-existing concerns with the School Context

Teachers nominated a range of concerns regarding their present school mathematics programs. The most commonly cited concerns were grouped into categories sharing common features. These categories were: Staff; Resources; Content; The school mathematics program; Senior mathematics; and, Classroom practicalities.

Perceived strengths of the school program

The most commonly cited strengths were grouped similarly into categories sharing common features. These categories were: The school mathematics program; Staff; Co-ordination; Teaching environment/Resources; Professional support; and Students' motivation.

Expectations of the ARTISM Program

The expectations of the three mathematics co-ordinators could be related to specific issues or educational constructs:

- increase teaching "expertise";
- engender teacher "enthusiasm", "ability" and "confidence";
- to equip teachers to "evaluate effectively";
- to increase the focus of mathematics programs on "real world experiences";
- a clearer picture of what is "problem solving and modelling";
- increase the repertoire of classroom management techniques;

The curriculum co-ordinator at one school expressed the desire that the program: "affirm the things that staff are doing well" and "establish a network of mathematics teachers across the three schools".

The teachers indicated a highly diverse list of desired outcomes for the ARTISM program, which included: Classroom Practice, Problem Solving and Modelling, Assessment, Curriculum Planning, Professional Support, Classroom Environment and Learning.

At this stage in the development and evaluation of the ARTISM program the data collated is primarily descriptive and specific to the existing context. Data relating to the teachers' participation in the formal program is reported in the following sections. Teachers' application of the strategies advocated in the program is the subject of on-going study.

This report presents preliminary data of a case study into the development and evaluation of a collaborative professional program which is still in progress at the time of writing. In summary, four critical stages can be identified:

Stage 1 - the initial input of the first four sessions;

Stage 2 -
a. applications of new practices in the classroom;
b. group preparation of mathematics teaching modules to be taught at some stage during terms two or three;

Stage 3 - the collective review and reflection on the first four sessions and the classroom application of new ideas;

Stage 4 -
a. continued application of new practices in the classroom;
b. teaching of the designed unit of work (teaching module) and reflection on the outcomes.

It was intended that the teaching module would provide a vehicle for the assimilation of the new practices met in the course.

PARTICIPATION AND IMPLEMENTATION

Together with a growing willingness to try new approaches, the emergence of a new collegiality among mathematics staff on all three school sites was seen as the major outcome of the ARTISM program by those responsible for the administration of mathematics within the three schools.

The level of teacher participation in the ARTISM program can be gauged by the continued attendance of the initial participants, by the classroom trialling by participants of the classroom exploration activities (documented through discussions during school visits), by participant engagement in the activities and discussion of the formal sessions, and by the participants' endorsement of the ideas and strategies discussed and modelled during the workshop sessions as expressed in teachers' journals and completed course review questionnaires. Participants' opinions regarding valued components of the course were sought in very practical terms: "I have tried the following activities ... " and "I have found the following useful ... ".

Most frequently cited course components were: problem solving approaches; 'Good Questions' (open-ended mathematics tasks); the 'Think, Pair, Share' strategy; and specific calculator activities. Other course components identified by participants as having been

used in the classroom (the endorsement of use), or as having been found to be useful (the endorsement of value) constituted an effective summary of the program content. It appeared that almost every aspect of the program received the explicit endorsement of at least some of the participants.

School visits made between course sessions provided an opportunity for conversation with teachers about their use of strategies such as those listed above. In addition, mathematics co-ordinators reported that such school visits provided a crucial accountability and a pretext for regular meetings of participating teachers. A record was maintained of these conversations, documenting key features of all such discussions, and illustrating these key features with specific teacher anecdotes. Classroom application of the new ideas and strategies were enthusiastically recounted. It was clear that many teachers felt that they were producing positive teaching and learning outcomes.

A consistent impression was gained of general interest and of specific enthusiasms. Participants engaged in enthusiastic and focussed discussion and analysis of teaching and learning. It became clear that participation did not mean total and unquestioning acceptance of the ideas and strategies being promoted in the sessions. The universal approach was adaptation rather than adoption of the new ideas.

PARTICIPANT SATISFACTION

Participants were asked to express their concerns regarding the ARTISM program. The responses were informative and occasionally contradictory. Only a small number of teachers expressed any concerns.

Frustration was expressed regarding attempts to implement the ideas presented in the program in the face of limited school facilities and lack of student motivation. Participants were asked to identify additional course components, or existing elements requiring greater emphasis or time allocation. Commonly cited as requiring greater attention were:
dealing with diverse student abilities; strategies for motivating students; planning techniques; classroom management techniques; additional examples of assessment alternatives; and, more specific classroom examples of content-specific teaching, applications of technology, and available resources.

CHANGES TO CLASSROOM PRACTICE

> It [the ARTISM program] made me think about what I am doing in my classroom and it is really challenging. The things that have been presented and taught during the sessions are valuable and really working. But we are quite stable and set in our ways and need more time to change, because it challenged the heart of our teaching.

From the outset, the major goal of the ARTISM program was to facilitate change in classroom practice. Participants were asked to indicate ways in which they felt that their classroom practice had changed.

Three key factors were most commonly cited:

greater instructional diversity,

greater diversity in assessment strategies,

and attempts to make mathematics instruction more student-centred.

These three factors represented major themes within the program. The prominence given to changing classroom practice with respect to these three factors is a strong endorsement of the approach taken by the program, and an indication of participants' attempts to put into practice the major themes of the ARTISM program.

PROFESSIONAL DEVELOPMENT: ONE TEACHER'S EXPERIENCE

The progression in professional development anticipated in Figure 1, can be seen in operation in the changing practice of one participant as recorded in weekly journal entries relating to the teaching of one class during the first four months of the ARTISM program. The content of each week's journal entry is summarised under the headings: Mathematical Content, Relation to ARTISM, Teaching Strategies, Assessment, and Teacher's Comments. The evaluation of these journal entries led to the following summative statements:

1. An increasing number of elements and strategies from the formal course were integrated progressively into the planning, implementation and evaluation of the lessons.

2. The school visits provided confirmation of progress through the sharing of experiences, and support for further progress.

3. Success with the new strategies encouraged this teacher to go further and try to explore more ideas from the ARTISM program, but the teacher always tried to adjust the ideas carefully to the content and special needs of the class.

4. The teacher was very concerned about appropriate assessment strategies and procedures. Other important issues which were mentioned several times include: control of work, supervision, student motivation.

5. The developmental progression documented in this case study demonstrated significant congruency with the ARTISM goals in terms of teacher affective outcomes (the teacher is gaining more confidence, enjoyment, enthusiasm, and professional satisfaction). Willingness to experiment increased as the teacher experienced success with the new ideas and improved student learning was observed. There was some evidence of a change in classroom practices.

The teacher also reported that other mathematics staff had begun to prepare more meaningful lessons, on the grounds, "We do not want to be left behind."

CONCLUSIONS AND IMPLICATIONS FOR FURTHER STUDY

The following comments can be made about the ARTISM program to the end of stage 3:

1. The course appeared to have met some important needs and expectations of both participants and school administrators. This observation was based on high levels of course attendance and enthusiastic participation, positive feedback from school administrators, and evidence from school visits by presenters and evaluators that a significant number of participants are trying new ideas and strategies. Teachers' written responses to course review questionnaires, and in their journals, also supported this conclusion. It also appeared from the accumulated body of written, oral and observation data that many of these teachers were producing positive teaching and learning outcomes.

2. The enthusiastic and focussed discussion and analysis of teaching and learning of mathematics which was observed during visits to schools appeared to support early impressions of the success of the program. It should be emphasized that enthusiastic participation does not mean total and unquestioning acceptance of the ideas and strategies being promoted in the sessions. There have been strong challenges to some of the practices being advocated. These discussions and reflections have the appearance of the beginnings of a "mini-college" of teaching within the three schools.

The kinds of long-term outcomes the program developers were aiming for included:

1. A continuing enthusiasm by teachers to continue their learnings and to try to reflect on new ideas and strategies in their teaching;

2. An increased capacity among teachers to write and teach better units of work based on their experiences in the ARTISM program;

3. An increased inclination among the teachers to meet together to review and reflect on their teaching practices in order to confirm and consolidate good practice, and to identify those aspects of their teaching or their schools' mathematics programs which require further development.

On the basis of the data collected so far, it appears likely that these goals will be achieved for many of the program participants.

ACKNOWLEDGEMENTS

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REFERENCES

Clarke, D.J. (1984). Secondary mathematics teaching: Towards a critical appraisal of current practice. *Vinculum* 21 (4), pp. 16-21.

Clarke, D.J. (1988). Realistic assessment. In D. Firth (Ed.), *Maths counts - who cares?*, Parkville: Mathematical Association of Victoria, pp. 187-192.

Clarke, D.J., Carlin, P., & Peter, A. (1992). *Professional development and the secondary mathematics teacher: A case study. Research Report 6.* Oakleigh: Mathematics Teaching and Learning Centre.

Clarke, D.M. (1991). The role of staff development programs in facilitating professional growth. Paper prepared to meet course requirements for the doctoral program in education, University of Wisconsin-Madison, USA.

Guskey, T.R. (1985). Staff development and teacher change. *Educational Leadership,* 42 (7), pp. 57- 60.

Guskey, T.R., & Sparks, D. (1991). What to consider when evaluating staff development. *Educational Leadership,* 49 (3), pp. 73-76.

Zigarmi, P., Betz, L., & Jensen, D. (1977). Teachers' preferences in and perceptions of in-service education. *Educational Leadership,* 34 (1), pp. 545-551.