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Professional Development of Secondary Science
and Mathematics Teachers: A Model

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Abstract

Since 1990, teachers of Science and Mathematics in the North West Region of New South Wales have been taking part in a professional development model, that arose out of concerns from the teachers themselves. These concerns revolved around a perceived need for change in the present inservice programmes. The model that was developed by the UNE project team centred around the methodology of problem solving and ownership of outcomes associated with an issue or problem. Each participating school identified its own area of concern and addressed it over a 12-month period, using their own strategic plan. This paper provides details of the model and some of the perceptions of the programme by the delivery team from UNE and the participants.

Background

At the end of 1989, a group of secondary-teacher representatives from the North-West Region of NSW met with representatives from the Department of Science, Technology and Mathematics Education at the University of New England, Armidale. The aim of the meeting was to develop a framework for an inservice programme which would improve on what already existed by better catering for secondary teachers professional development within a rural environment. One reason for the meeting was prompted by a sense of the limited nature of the long-term success of numerous inservice initiatives in the Region by the university staff. This was despite an extremely positive reception towards previous offerings.

In order to address this issue of developing a programme for more effective inservice that would bring about real change in classroom practice, the meeting began to reflect on present and past experiences.

At the outset it was noted that typical programmes usually consisted of one or a combination of the following:

- (a) a lecture, providing teachers with recent research findings on some topic;
- (b) a workshop, in which teachers work in groups developing materials or discussing some issue;
- (c) a seminar, in which UNE staff act as a resource used to provide further information or clarification as desired.

Some schools had commented that where funds had been available and University staff had worked with school staff on a number of occasions over a reasonable time period that our observation of little noticeable change was not true. Of course, this observation is confirmed in the literature, namely, that for real change to take place it needs to be set in a context of gradual growth of an extended period (see for example Taylor (1986) and Price and Gawronski (1981)). This important element then became a central theme for the proposed model.

Six other major issues arose out of the discussion and they are summarised briefly below.

1. Finances: There is not sufficient funds available to meet the perceived needs of the teaching staff. Despite the fact that country

teachers see many changes taking place, isolation from centres of decision making resulted in a feeling that they have been largely forgotten. This sense of isolation is compounded by financial constraints on travel in getting to and from inservice courses and the cost to bring in outside school support.

2. Focus: Most inservice, even if valuable, is usually initiated from above and usually reflects perceived needs rather than actual needs of staff. As a result, teachers often find the focus to be vague or misguided and many of the ideas or materials presented to be unavailable or not applicable to their circumstances.

3. Distance: This has already been addressed in point 1, as regards to cost. However, in addition, it often involves staff being away from home for extended periods. This form of commitment conflicts with family and other community activities. As a result some staff are not able to participate in the limited available professional support activities.

4. Type of programme: The limitations of funds and distance combine to encourage one-day or half-day courses. This places clear restrictions on the amount of material that can be covered by visiting 'experts' or and allowable development acquired by the participants. Hence teachers, although appreciative, see the courses as often : rushed and lecture-based. They complain that there is not enough time to understand the issues or participate in the sessions except as a passive observer, i.e., no time for growth to take place.

5. Short term: It is unusual for such courses to have follow-up or effective monitoring of the outcomes over time. There is usually some end of session evaluation of the course based on what the participants experience but it is unclear what relationship, if any, such evaluation provides for the more important long-term goals.

6. Different needs: Teachers are not a homogenous group. Even years of experience is not a satisfactory way to categorise staff in order to identify specific needs.

It is clearly difficult to meet individual teachers needs in the sort of environment described above. Despite these problems school mathematics staffs continued to request professional development

support and to be positive towards and appreciative of what was offered and to those people who took the time to work with them. However, it was clear that there needed to be an alternative model, which could survive within the limits set by funding levels and met the "tyranny of distance". This model would also need to be seen to be relevant to the staff involved, run over an extended period of time, and include ongoing follow-up and monitoring.

As a result of the discussion, several themes emerged which must be taken into account if professional development benefits are to be maximised for as many staff as possible. These include:

1. There must be teacher involvement in all aspects of the professional development.
2. The programmes must be long-term and allow teachers to acquire skills, knowledge and/or attitudinal changes at their own rate.
3. The programme must have long term goals that are achievable and associated with this must be the ongoing monitoring of the programme.
4. Support by outside mentors is important
 - (a) to act as a catalyst for action, and
 - (b) to provide input where appropriate as decided by the participant staff.
5. Funding must be organised so as to maintain the benefits of the program, i.e., costed over a full school-year period.

The meeting decided that the model below did address many of the identified problems associated with current inservice programmes. The model used with Mathematics was named Improving Teaching Approaches to Mathematics (ITAM) and for Science was named Help In Teaching Science

(HITS).

Common features of both programmes included:

- A commitment to the program by a 'key' group from each school and how they are supported by a number of the remaining members of the mathematics or science staff.
- For growth to take place, time was the regulator of change and different teachers acquired the necessary skills for change at varying rates.
- The programme was sequentially structured with achievable goals and constant monitoring of progress throughout.
- Outside support was essential to provide input at intervals throughout the programme and to act as a catalyst for action.
- A report needed to be written to formalise the steps taken to achieve change, so that staff could formally reflect on both what had been achieved over the year and the process of change of which they had been apart.

Description of the Model

Aim

The aim of the model was to lead teachers through a self-help process. This was to be achieved by enhancing teachers knowledge of the processes and procedures of teaching mathematics and science as well as

notions associated with change.

Specifically the objectives of ITAM and HITS were to assist teachers in mathematics and science faculties:

- To identify issues of importance that require action in the teaching of mathematics and science in their school.
- To develop and carry out solution (or improvement)strategies related to the identified issues.
- To evaluate the effectiveness of change resulting from the actions taken.
- To build up school-based expertise in tackling issues of concern.
- To locate resources, human and material, to address the issues identified.
- To provide the inservice support needed.

In order to achieve this at least two individuals from a staff (referred to as the 'key' group) were needed to act as the initiators of action at the school level. Their role was to work collaboratively with their staff:

- To identify area(s) of concern that could be improved within individual faculties.
- To develop strategies that might help improve the situation identified.
- To carry out a well delineated action plan and to encourage the fulfilment of the theoretical strategies needed for change. This includes isolating needed resources (material and human) to address the problem or issue identified.
- To evaluate the effectiveness of the changes resulting from the action taken.

Programme Plan

The following flow chart briefly summarises the seven broad stages of the model and how they fitted into the school year.

February

- Invitation sent to schools.
- Schools selected by geographic location.
- 'Key' group identified within each faculty.

April

- Two-day residential workshop with key groups from all schools.
- Discussion centres on:
 - 1aspects to assist problem identification;
 - 2processes in implementing change;
 - 3an action plan for the period to the next meeting.

May

- Collegial meeting of entire faculties within each participating school.
- Discussion centres on:
 - 1reporting on progress in identifying the staff's main area of concern;
 - 2sharing ideas among different schools;
 - 3clarifying pathways developed to address area of concern.

May to September

- Action plans within the schools are commenced and methods refined to isolate the real problem area.

September

- Second two-day residential workshop for 'key' group.

- Discussion centres on:

- 1 successes and/or failures of the change process thus far;

- 2 ideas to try and overcome any obstacles with the action pathway;

- 3 available evaluation techniques.

September to November

- The change process continues. Continual assessment of the effect of change on the identified area of concern.

- Preparation of report begins.

November

- Second collegial meeting of entire faculties of participating schools.

- Discussion focuses on:

- 1 reflection on and sharing of experiences;

- 2 future plans for change considered for the following year.

- Report submitted.

Each step of the programme plan was deemed necessary to the success of the developmental inservice model. Progress through the steps was dependent on intervention in the form of consultative support and progress monitoring by the UNE team.

Discussion of Programme Plan

After initial acceptance of schools into the programme, the participating faculties were asked to identify a 'key' group. This group, usually two people, was seen as the main impetus for isolating area(s) of concern or issues to be pursued, and the main agent of change in the school. They had a leadership and directive role of their faculty members in their move towards addressing the concern or issue. The key group need not necessarily include the head teacher, but, if not, he/she must support the faculty's commitment to the programme and the initiatives of the 'key' group.

At the first two-day residential conference, the 'key' group from each participating school was sensitised to two major issues:

- 1 Strategies for problem identification.

- 2 The process of change.

The first of these issues gave each school ownership of their own area of concern. This aspect was critical to the success of the second issue mentioned above.

The collegial meetings were held for the benefit of all members of the mathematics or science staff from each participating school. The focus of each after-school meeting was on open discussion and the sharing of ideas. These gatherings ultimately led to refinement of problem identification techniques, design of action plans toward solutions within the context of each individual school, and clarification of human and material resources needed to implement the action plans.

The second two-day workshop for the 'key' groups provided a forum for discussion of the success thus far of the individual faculty's

implementation of the change process. Evaluation strategies were discussed to gauge the strengths and weaknesses of each school's problem-solving techniques. This last aspect was crucial, so that the skills gained over the 12-month period of participation in the programme, could be continued and enhanced to tackle different issues

the following year.

The reason for the second collegial meeting was to reflect on the process of change that had taken place at the school level over the year and to share these experiences with the other participating schools.

For success, the programme required continual monitoring and administration over the year. This process of ongoing intervention, assistance and encouragement from the UNE project team, meant that the momentum was sustained.

Perceptions of the Programme

At the conclusion of the last collegial meeting, a discussion was initiated about the programs effectiveness. The outcomes were discussed and also included in the written reports which were compiled and submitted to the project team.

Two themes became obvious.

Theme A: The process of problem identification and solution.

Theme B: The process of teacher growth.

The two themes form the foundations of the model. With the addition of ownership of their own professional needs, the model gave the structure to improve many areas of concern in the mathematics and science teaching areas.

Each 'key' group was provided with a range of skills that helped in the isolation of an area of concern, relevant to their situation. The issue under investigation was from one of three targeted areas, namely, student-centred, faculty-centred or curriculum-centred.

Each area is not discrete and some schools concentrated on an issue which affected a combination of the above areas. Therefore, some problems identified were specific in nature and others were more global.

Examples of Issues

The examples provided below illustrate the diversity of concerns or issues, the participating schools attempted to address.

Staff A: This mathematics staff had recently had a major influx of new members to what had been previously a very stable staff in terms of turnovers. As a result there were two distinct groups. Those that had been in the school for a large number of years and those who had just arrived.

In an attempt to find common ground it was decided to make a three pronged attack by working simultaneously with the staff, students and parents. The idea being to see whether there might be any consistent trends across the three groups. The staff's views were canvassed over a number of faculty meetings, a sample of students across years were interviewed and parents were asked to complete a survey.

Staff B: The staff had been together for a number of years. They approached the problem identification by having a meeting after school in an informal setting. Each member of the staff was asked to prepare a short presentation about the issue that was of most concern to him/her. After considerable discussion a consensus was reached on a department-centred approach associated with resources.

Staff C & D: These two staffs were in a similar position to Staff B. They had been together for sometime and they chose to have their respective staffs talk through issues/problems of concern and come to a consensus. In the case of Staff D the consensus arose out their ranking a number of staff identified problems. The important difference between Staff B and Staff C and D was that the issue in the latter case was student-centred. As a result, and after the discussion at the collegial meetings, it became clear that both Staffs needed to return to their schools to clarify further whether these areas were problems in the eyes of their students. Here was two cases where the key groups had embarked upon a department-centred approach but in order

to more clearly understand the problem a student-centred approach had to be undertaken.

This feature, i.e., modifying the approach as the problem/issue became clearer was also a feature of other staffs.

Staff E The science staff included four members with more than 15 years experience each, two casuals, one first year out and a job share situation. The school was in the initial stages of establishing itself as a Technology high school.

During an informal gathering of the science staff outside of school hours and the school environment, a consensus was reached on what issue would form the basis for their attention. The issue the science staff wished to address was to take stock of the major curriculum change that had taken place in the Science Key Learning Area over the last three years, i.e., the formation of mixed ability classes, the integration of problem-solving processes, a change of emphasis from knowledge-based programmes to process-based programmes, and the development of small group strategies. The HITS programme provided the vehicle to pursue the next logical step in the developmental process, i.e., investigating Junior Science Curriculum from the student's viewpoint.

The way that the science members decided to isolate the issue, was to survey all junior classes, by asking three students from each class to fill out a comprehensive questionnaire.

Staff F The science faculty was large, diverse and experienced. The head teacher allocated certain times each week for faculty meetings in which the staff discussed the identification of an issue deserving of time and effort.

After considerable discussion the issues nominated by the staff were ranked according to priority. The final issue isolated was "To identify and list skills other than knowledge and understanding needed

by students at the end of Year 10 for the successful completion of senior science.”

To try to identify these skills, the staff decided to:

1. Have faculty members draw up a list of skills.
2. Survey students in Year 11.

The staff in the science faculty were relatively young, and had been functioning as a cohesive group for approximately three years. They, as did Staff F, set aside certain times each week, following the initial HITS two-day conference, to discuss an issue that they felt needed attention.

The science faculty generally taught with a process skill orientation, but felt the reporting system used was more knowledge-based and a norm-referenced form of assessment. The issue they therefore chose, was to change the reporting format. To obtain sufficient data to build up a number of options, the ‘key’ group collected report forms from across the state. The strategy used was to fax all state secondary schools in N.S.W., asking for a copy of their report format. The response percentage was about 50%. They collated all the data and constructed a format which reflected their philosophy on reporting assessment.

The issues that the faculties addressed were very diverse. Each school used different strategies to isolate these issues. One common feature amongst all the faculties and individuals in the ‘key’ group was the concept of ‘change’ and ‘growth’.

Teacher Growth

The term ‘teacher growth’ implies an improvement in the ability to deal with problems, with an increased acquisition of problem-solving skills. This development was achieved in three ways within the programme:

- 1 Through the problem solving activity carried out at the individual school level.
- 2 Through the interaction of staffs from different schools at the collegial meetings and the two two-day conferences.
- 3 Through interaction with the UNE team.

A comment made by one of the key group members sums up the feeling of

most participants, i.e., she suggested that the long time frame was critical to the program as it provided,.....

“Time to evolve ... (as time was required for) ... overcoming my resistance to the ideas I had about implementing change. I now see change as growth rather than something to be feared”.

The two prime-movers for change and subsequent teacher growth (problem solving and sharing of ideas) are dependent on co-operation and collaboration within the ‘key’ group and amongst the mathematics or science faculties which they represent. The most important factor which allowed this growth was the commitment to the programme. This was necessary and all schools realised that they were making a 12 months commitment for the programme to be productive and successful.

Outcomes

In evaluating the programme, teacher’s comments indicated that having contact with university staff and current research, as well as sharing

ideas with teachers from other schools greatly assisted them. As one member of a 'key' group said, ...

"It provided a structure whereby future problems or concerns can be worked through ... and it did not follow traditional inservice programmes, and that was great!"

The schools mentioned in this report achieved differing results at the end of the programme, as the following examples show.

Staff A The result of the investigation was that 'communication' was seen as their major issue. This was identified in three areas, namely, staff-staff, staff-students, staff-parents. To address this issue a series of new initiatives were trialled. In brief they were: (i) a faculty period set aside each week of which half the time would be allocated to professional development matters, (ii) a semester meeting with students by Year to discuss general issues of concern. Also included in the meetings were reflections by students in the older years. (iii) a semester newsletter was established to go home to parents to inform them of general department policies and areas of student success.

Staff B The staff identified the sharing of resources and teaching ideas within the faculty as the issue they wanted to explore. An earlier answer to their problem was the purchase of a filing cabinet. The limiting nature of this solution soon became apparent and other initiatives developed including: visits to other members classes; professional development discussions at faculty meetings; and, evaluation of and reporting on purchased resources.

Staff C & D Both staffs identified curriculum issues to be a problem. One school (C) was concerned about the attitudes and performance of the middle ability group in Years 9 and 10, while the other identified the mixed ability classes in year 7 as a concern. Although they had identified the broad issue, they both chose to go back and interview relevant students to see if they could find out why it was a concern. The result of this intervention meant that the problem was able to be considered in terms of a series of tightly focussed issues. As a result staff (C) experimented with different classroom groupings, more practical/outside lessons and invited talks by senior students who had undertaken the course previously. Staff D implemented a series of writing groups who were charged with producing core material with extension work for the more able. In addition they focussed on questions that would enable students, at various levels, to be involved. Thus offering alternative pathways for the staff in dealing with the large range of abilities.

Staff E As a consequence of participating in the HITS programme, the staff had begun to restructure all their Junior Science programmes, revolving around integration of the sciences. There was also a stronger emphasis on skill orientation.

Staff F As a result of the large student survey (Year 11), the science faculty had instigated a "special lesson structure" for Year 10

students to choose a lesson/cycle which was specifically designed to

improve the skills which were identified as needing attention, e.g., drawing accurate scientific diagrams, performing simple mathematical operations and use of a calculator.

Staff GThis faculty achieved the goal they set themselves. They completely changed the reporting format. A new form was developed which was linked to their new assessment guidelines. This was put into practice in term four.

Conclusion

Were the ITAM and HITS programme a success? It would be expected that those closely involved with such a programme would be positive and hence the easy answer is "yes". Nevertheless, there are other factors which appear to support this observation. Changes have occurred. Staff involved, cited numerous examples of how their thinking and attitudes had evolved. More importantly, there were clear, identifiable changes that happened at the student-teacher interface.

The major criterion for success of change in teachers or schooling must be: Does a professional development course result in a positive change at the classroom level? The written reports provided by the staff of the participating schools indicated that the programme provided the framework for numerous examples of this fundamental change: new report cards which clarify teaching objectives and link teaching procedures more closely to assessment criteria; initiation of improved programming more in line with the process-orientated Junior Science syllabus; the application of different strategies to strengthen identified weaknesses in such areas as classroom dynamics, e.g., student-student and student-teacher interaction.

When these points are taken into consideration, both programmes would be considered a success. Further, it shows that when teachers are given the opportunity in the form of resources, the time to allow change to occur, and the support of other professionals, much can be achieved.

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There were also differences. School Orange belonged to a large country town and was, in country area terms, a large school of 900 students. There was seven other high schools in the town and they were all of a reasonable size. School Green belonged to a much smaller town. The school had approximately 400 students and there were only three high schools in all, in the town: one was a Catholic School which only

catered for year 7 to year 10 students.

There was one other major difference between the two schools and it was because of this feature that these schools were selected to develop the model. [Although it is fair to say that there were many interesting features worth analysing and discussing in each school in the programme]. This difference arose in the focus of the problem/issue that the staffs had selected. As will be seen in the next section, School Orange had a student centred focus while School Green chose a staff centred focus.

School Green

At the first two-day conference the key groups spoke about the new principal to the school and the efforts he was making to lift the school's image in the eyes of the community, staff and students. They also noted that some of the staff of their school had not attended any after school inservice. They were not clear on what issues or concerns would be identified by their peers.

After the two-day conference the "key groups" reported to the mathematics staff at the next faculty period meeting about what had occurred, the structure of ITAM and the general direction it was to take. The decision was taken at this meeting for all staff to think about what they saw as issues or problems within the Department. They also decided to meet, after school, in two weeks time to discuss their views. At the meeting, the head Teacher (who was not a member of the key group) supplied refreshments. Each staff member indicated a problem area and spoke about it. This then became a focus and all staff were encouraged to share their views and ideas. The problems presented could be summarised into four areas:

- 1.Lack of preparation time - This led to a discussion on lack of sharing of resources, e.g., tests, worksheets, O.H.T. within the department.
- 2.Teachers working outside subject area. Two teachers were not mathematics teachers.
- 3.Little use of "Hands on" material in years 7 and 8.
- 4.Testing of component B in years 11 and 12. Was their system satisfactory.

During their discussion it became evident that by focussing on problem 1 (above) they could also be addressing aspects of the other problems. However, to achieve this problem 1 would need to be redefined.

The agreed problem was then given as:

STAFF WORKING AS INDIVIDUALS AND NOT AS AN ORGANISED TEAM

The staff agreed on the following strategy

- 1.SELECTION OF YEAR CO-ORDINATORS TO

- a) Collect and file tests
- b) Organise resources
- c) Consider revision of programs and update resources

2. OBTAIN FILING SYSTEM/CABINETS

3. IMPROVE COMMUNICATION

time at faculty meetings regarding individual years to discuss resources and treatment for topics.

4. INVESTIGATE OTHER SCHOOLS

- a) What do they have to offer, eg., mathematics in Practice for Year 12

- b) Programs
- c) Resources
- d) Graded classes
- e) Exam papers

It was this problem that was presented to the other schools at the first collegial meeting.

Despite the broad nature of the problem it became clear in the presentation and discussion at the collegial meeting that the principal focus was on the accumulation of resources in the form of tests and

worksheets and the purchase of folders and filing cabinet. When the focus of the discussion turned towards the limiting nature of the solution (i.e., the filing cabinet) and that this would not address their real concerns the staff were this not willing to accepted or acknowledged this point involved. As a result their action up to the next conference focused on the need for "shelves and folders" and for staff to "look after" a different year-group.

At the second two-day conference the key groups reported that the filling had commenced. However, they also reported that attempts had been made to supplement the filing so it could be made more useful. An example of this was when time was allocated at each faculty meeting to discuss strategies associated with different materials. A further addition was that the staff had been able to meet with some teachers from another school outside (ITAM) and had used this time to talk about mathematics programmes and to swap examination papers.

The time line for the remainder of the year involved a deepening analysis of the teaching process and the consideration of resources from outside sources. That is, the need to look more widely to supplement the ideas of the staff had become clearer. One aspect of this was the full day visit of one of the team to the school to teach and analyse lessons.

Their progress at the end of the year can be summarised in part by this extract from their report:

"We have had immediate gains from our faculty meetings, meetings with the schools and the school visit. All have been thought provoking and stimulating.

We have had much more discussion on teaching ideas than we have had for many years.

The filing system is progressing and we should benefit from it next year. We are more aware of resources available both within our school and others that could be purchased"

Reflection on the School's progress.

Three features stand out about the effects of the programme on school Green.

First, the commitment of the staff to the programme. All staff stayed with the programme for the year. They all attended the collegial meetings and this occurred despite the fact that two of the staff had never been to an after school meeting before. It was also interesting how much value the staff reported from ? with and discussing different issues with other staff.

Second, the earlier strong focus on folders, filing cabinets and worksheets was interesting. These features were seen to be the answer to the problems they identified. While the focus never ceased over the entire year it did assume a less critical role.

Third, associated with the above, was the growth widened in the staff as the benefits of the programme began to evolve. There was a subtle yet noticeable, overtone, change in what the staff viewed as important. In single terms it went from seeing physical resources as the answer to the redirection that the answers lay in how they used and interpreted these resources.

Conclusion

We are all keen to continue the process. We wish to build on our filing

system which is made up mostly of work from the second half of the year.

We feel that ITAM provides us with the stimulus and time checks that we need to keep us at our plan. We also see ITAM as an excellent forum for the exchange of ideas with other schools in our Region. It has been a stimulating and valuable experience. The attendance and participation of the key group at the first two day conference was enthusiastic. Their description of their school and mathematics faculty indicated.....

Their major issue of concern seemed to be the introduction of mixed ability classes in Year 7 that had been forced upon them by the school executive.

On return to to their schools a report was given to the faculty at a meeting one and a half weeks after the conference and a procedure for identifying the issue to be the focus of the project was decided upon. A "Department Centred" approach was chosen by general consensus. Each member of the faculty was asked to submit five problems to be placed on a common list. However, no discussion or final choice was made at this stage. The list was placed on the notice board for one week. During this week considerable discussion and reflection took place. After the week a second faculty meeting was held at which a short list was created. This was done by.....

Staff were then asked to rank the items on the short list from one to eight according to the importance they placed on the issue. On collation of the staff survey results three potential problems emerged as being perceived as worthy of investigation. These were:

- The interest and motivation of pupils in the Year 9 and 10 Intermediate Mathematics course.
- The linking of algebra with the rest of the curriculum.
- The integration of problem solving with the rest of the curriculum.

On further reflection it was decided that the issues of algebra and problem solving were possible subsets of the more general issue of the Year 9 and 10 Intermediate mathematics course.

The choice of this issue was received by the ITAM coordinators with some enthusiasm for a number of reasons. The issue had been noted by the state syllabus committee as one of significance quite independently of the activities at Orange High, thus it was felt that the problem identification training had produced a non trivial result. Secondly, the issue of mixed ability classes, flagged at the two day conference, had been replaced thus indicating that the staff had looked beyond the immediately obvious surface issues.

The whole mathematics staff attended the first cluster meeting at which the Key Group presented a report on the problem identification process. However, when they were questioned by the rest of the participants at the cluster meeting they had identified their problem only at the most global level. They were unable to be specific about the nature of "Interest and Motivation in Intermediate Mathematics". They were unable to identify any causes, or elements of the problem. Because of this lack of problem definition they were unable to plan any strategies for solving the problem.

In terms of Polya's problem solving stages The Orange High staff were focusing on stage 3, solving the problem, without spending sufficient time and energy on stages one and two; that is understanding the

problem and planning a solution.

As a consequence for this school the first cluster meeting was spent on developing a methodology for clarifying the nature of the problem. For this process three strategies were decided upon:

- Surveys of two groups of students- current Year 10 students in the Intermediate Mathematics course and current Year 11 students who had studied Intermediate mathematics the previous year.
- Follow up interviews of students by a faculty member not currently teaching the students surveyed.
A staff survey.

The student survey was designed to gather data on which topics the students enjoyed or disliked together with data on the students attitude to study and expectations. In addition Year 11 students were asked about how prepared they were for their current mathematics courses. The follow up interviews were conducted to provide some qualitative data to support the questionnaire results.

The results of the survey indicated that students wanted:

- A more practical Approach to mathematics.
- Mathematics related to real situations.
- More time on each topic.
- More explanations of WHY rather than just a focus on how to do the work.

The Year 11 students, in addition to type above, felt that the Year 9 and 10 work was too easy and there was not enough emphasis on task for the better students. While Mathematics and Society students felt they were adequately prepared by their junior school course the Two Unit Mathematics students felt that their preparation was deficient.

The staff survey focused on two issues. It asked in what ways the Intermediate course could be made more interesting and how could this be achieved. The second issue was how could the course be made flexible to better cater for the diverse student needs. The staff identified ten changes that they believed would improve the "Interest and Motivation" if students in the Intermediate Mathematics course. The ten changes were broadly based and focused on using community resources, changing teaching organisation, content changes, class restructuring, excursions and the incorporation of technology.

However, before these changes could be implemented the Government announced that Orange High School was to become a Technology High School. This announcement resulted in the whole school becoming involved in a major development project. The Mathematics staff felt that they had to be involved or they would be "left behind" by the rest of the school.

By this stage there was such commitment to the Year 9 and 10 project that they decided to proceed with their planned changes concurrently with participating in the whole school project of developing the necessary skills and infrastructure associated with becoming a Technology High School. Consequently at the second two day conference the Key Group devised an Action Plan that ran the two projects in parallel.

Of significant interest was the fact that the mathematics staff were well positioned to react to the Technology High School project and they used techniques and structures developed during ITAM to identify areas of concern. However on this occasion, instead of identifying a "global" issue they were able to identify twelve issues that could be categorise into three themes:

Course development.
Teacher development.
Resource management.

Arising from this process a number of specific changes were designed that could be implemented concurrently with the Year 9 and 10 Intermediate Mathematics project.
Perceptions of the Programme.

Each session in both the two-day conferences and the collegial meetings and the school visits seemed to offer much information on teacher thinking. This richness allowed for a number of insights into: how teachers go about finding and solving problems; how they grow in understanding the teaching process, and ; how they think about professional teaching issues. This section takes many of these observation and groups them into two themes which focus on (i) the process of problem identification and solution, and (ii) the process of teacher growth.

These themes will allow further explication of the model and give the reader a sense of what can happen if teachers are provided with the means to have ownership of their own professional needs.

Problem identification and solution

As stated members of the key groups were provided with the opportunity to explore a range of techniques that might help them in problem identification. These were based about three target areas which could be labelled: student centred, department centered; curriculum centered. While these areas are clearly not discrete they are useful descriptors. Having been acquainted with the richness and variety of procedures that is possible within each area the key groups and their respective staffs were expected to identify initially a problem.

The examples provided will illustrate the diversity in what the various schools attempted.

Staff E: This staff was very small, the key group made up the entire staff. They had decided on their issue very early and had begun to carry out their solution attempt. It was built around developing a mathematics programme which incorporated new syllabus guidelines and one that it was hoped would facilitate the better planning of their mathematics courses. After hearing reports from their schools they took the decision to ask samples of students about their mathematics. Armed with information about what their students preferred they were then able to use this to make important changes to what they had already written.

Staff B saw the sharing of resources among the Staff as a major issue. The initial attempt to address this resulted in the purchase of filing cabinets and folders. However, as the year progressed, the fact that these purchases had only partially addressed the problem became apparent. Ideas on paper and organisation of resources is a useful start but it does not guarantee a change in teaching practice or pupil achievement.

There is an important underlying issue in the previous paragraph, namely, teacher growth. The fact that the teachers at the school did not wish to consider in the early stages of the programme, that the physical resources that they needed would not solve their problem. Yet, overtime it became obvious. This feature was common to all staff in the programme and is described below.

Teacher Growth

There were numerous examples of teacher growth throughout the programme from all schools. It seemed to come about in two ways. First, through the problem solving activity carried on at the individual school level and second, through the interaction of staffs from different schools at the collegial meetings and the two-day conferences.

An example of the former type of growth came about in Staff B, mentioned earlier. The realisation that the cabinets and folders, which initially were "the answer" was at best a partial solution to a complex question. The staff grew to the extent that they saw the need for formal input from each other in areas where expertise was present and this involved into an analysis and a clarification of their own teaching approaches. Further, growth also became evident in their search for alternative procedures to supplement and extend their current teaching practice.

Staff F: An experienced staff who had all been teaching for more than 10 years. This staff also saw programming as an issue. However, they felt

that their individual experience and knowledge was all that was required. Over time, they came to see that without outside resources their expertise had a limited feel about it. Hence they developed procedures by which new materials would be assessed by staff members, shared, discussed and evaluated. Successful ideas were then incorporated into the programme.

A second aspect of the growth for the teachers in the programme came by way of the interaction of the key groups with each other at the 2-day conferences and of the mathematics staffs at the collegial meetings.

The detailed discussions undertaken at the two day conferences were very rewarding for the participants. The structure of the programme was such that there was always the time for the teachers to talk. It was interesting how much the teachers appreciated this opportunity. It was emphasised to the key groups how important it was to keep confidential many of the observations made about schools, teachers, parents and students. The professional integrity of the groups depended upon this. It was apparent that some school staff were under tensions brought about for a variety of reasons. Personal, argumental, school, peer, parent, student problems were all in evidence. Some teachers seemed to need to share their concerns as if to get it out in the open. Also of interest was both the sympathetic nature of the other participants and the valuable advice that they were able to provide.

There were other benefits in teachers talking with teachers and this was noticeable in the collegial meetings as well as the two day workshops. It was common for the staff of one school to pick up ideas, often outside of their problem area, from other staffs. This sharing of experiences which enabled a staff to take an idea "back to our school" struck a harmonious chord in both staffs.

This was also true of the problem identification and solving process. Staffs who had previously wished to avoid some strategy, e.g., they may have been unwilling (for whatever reason) to include students views in the deliberation seemed more eager to embrace the idea after learning about another school's experiences.

Finally, it is necessary to comment on the growth noticed in the persons who made up the key groups. These people were not necessarily the most outspoken and extroverted people of their staffs. However, in all cases they stuck to their initial commitments to see the programme

through. It seemed that the experiences gained in being expected to speak on several occasions over the 2-day workshops when coupled with their ownership of the process provided them with the necessary confidence to speak on behalf of their staffs. Their commitment to the task was very infectious and accounted for some of the additional benefits of the programme. Two examples will highlight this point. One

staff brought teachers to the collegial meetings whom had never attended an inservice course before. In another school, staff whom had resused to take part in the programme began to take part and make use of the materials developed as they saw the benefits of what was being achieved.

It should be clear from the above comments that there was the clear perception that the programme was achieving far more than the aim of addressing some issue of importance to a particular staff. Nevertheless it is appropriate to consider the programme from the eyes of the participants and more particularly the members of the key group.