Identifying and Analysing Processes in NSW Public Schooling Producing Outstanding Educational Outcomes in Mathematics

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This paper reports on a project that identified and explored the factors leading to outstanding mathematics outcomes in junior secondary public education in NSW for students across the ability spectrum. Once a sample of mathematics faculties was identified by drawing upon the extensive quantitative and qualitative data-bases within the NSW Department of Education and Training (DET), seven intensive case studies were conducted to identify faculty-level factors. Seven common themes are reported and these are the strong sense of team, staff qualifications and experience, teaching style, time on task, assessment practices, expectations of students, and teachers caring for students.

An Exceptional Schooling Outcomes Project (ÆSOP) was designed to investigate the principles, processes, and practices in a sample of sites in NSW Years 7-10 Department of Education and Training (DET) schools producing outstanding educational outcomes. The research focus was on teams of teachers (i.e., mathematics faculties). The nature of "outstanding educational outcomes" was determined using the *Adelaide Declaration on National Goals for Schooling in the Twenty-first Century*, approved by all State, Territory and Commonwealth Ministers of Education in 1999. They stated that schooling should:

- Develop fully the talents and capacities of all students;
- Enable high standards of knowledge, skills and understanding through a comprehensive and balanced curriculum; and
- Be "socially just" (MCEETYA, 1999).

There is growing evidence in the research literature of the importance of a research focus on faculties in secondary schools. Although there is an extensive body of research highlighting the important roles played by the school Principal at one end of the spectrum, and the individual classroom teacher at the other, in advancing the quality of students' educational outcomes as they proceed through school, there is comparatively little research on the significance of the roles played by subject faculties as groupings of teachers working towards a common agenda. Yet, as Goodson and Marsh (1996, p. 54) stated "the subject department provides the most common organisational vehicle for school subject knowledge, certainly in secondary schools, but unlike 'the curriculum' it has not been widely researched or much noted in our studies of schools." Bennett (1999, p. 289) supported this perspective suggesting that the latest school effectiveness and school improvement research recognised the different levels of school structure and practice, and the "resurgence of interest in sub-units of schools" – in particular, subject faculties and their organisation and leadership (Busher & Harris, 1999; Sammons, Thomas, & Mortimore, 1997).

Other evidence from school improvement research has also emphasised the growing importance of focusing efforts at changing practices at various levels within an organisation. For example, the largest study of differential school effectiveness in the

United Kingdom identified the differences between faculties as a means of explaining school performance (Busher & Harris, 1999; Sammons et al., 1997). As Hannay and Ross (1999, p. 346) concluded, "we need far more research on the micro-processes involved in secondary schools."

In a report on the *Investigation of Effective Mathematics Teaching and Learning in Australian Secondary Schools* (ACER, 2004) one of the main findings of the study was that the effectiveness of mathematics teaching in a school is related to the strength of professional community in the school's mathematics department. Ayres, Sawyer, and Dinham (2004) came to a similar conclusion in their study that focused on characteristics of effective teachers at the Higher School Certificate (HSC) level. The researchers found that the subject faculty was one of seven factors deemed to contribute towards HSC teaching success and warranting further investigation.

This paper reports on seven mathematics faculties in which the past 4 years of student cohorts had either scored consistently highly on value-added measures or demonstrated consistent improvement on the same scores. Importantly, sites had to demonstrate their ability to "value add" for students in low, middle and high achievement bands. Sites were selected to cover as wide a socio-economic and geographical cross-section of schools as possible. In particular, the more influential themes emerging from the analysis of processes and procedures of secondary mathematics faculties visited are discussed.

Research Design and Methods

Overall, the ÆSOP study involved a series of approximately 50 intensive case studies in a variety of "sites" across NSW. These sites were generally faculty-based although some other teacher groupings were explored in some schools (e.g., learning support teachers). Paramount to the project was a valid and justifiable method for selecting schools given that students had to be achieving outstanding educational outcomes.

Selection of Sites in Schools

The process for selecting schools for inclusion in the project was complex, involving a matrix of data. The basic source was value-added data collected for all students attending DET schools in NSW. The data were prepared by the DET School Accountability and Assessment Directorate by profiling student learning outcomes as measured in standardised tests commencing with the Year 5 Basic Skills Test, the Year 7 ELLA and SNAP tests, and the English/literacy, mathematics, science, Australian history, geography, civics and citizenship tests in the School Certificate. The criteria for selection of a site in a school were as follows:

- Cohorts of students consistently, i.e., over the past four years, scoring high on value-added data, across the low, middle and high achievement bands, or
- Cohorts of students consistently, i.e., over the past four years, improving their value added scores across the low, middle and high achievement bands.

With the emphasis on the three bands of students, selective schools in NSW were automatically excluded as potential sites due to the lack of low and often middle achieving students.

Selection also included qualitative data as part of a triangulation process. Nominations of sites were sought from DET staff at the central, district, and school levels, as well as key education groups, such as the NSW Teachers' Federation, the NSW Federation of Parents

and Citizens, the NSW Secondary Principals' Council, the Professional Teachers' Associations and the NSW Student Representative Council. In all cases, nominations had to be substantiated by evidence. Consideration was also given to HSC data in the relevant subject area in terms of the numbers of students pursuing the subject and overall student results. Finally, District Superintendents and school Principals were contacted by phone to discuss the appropriateness of the selection of sites particular to their district and school, respectively. Once the initial selection of the *sample* sites was verified as potentially outstanding, agreement was reached with Principals of schools for the research visits to 35 schools in 23 districts throughout the state. Site visits were made to seven schools for mathematics representing a cross-section of socio-economic and geographical locations (Table 1).

Table 1
Profile of Sites Visited for ÆSOP Mathematics

School	Location	Student Population	% Indigenous Students	% NESB Students	Other Characteristics
1	Western NSW	900-1000	2	4	High proportion of students with disabilities Middle socio-economic status
2	Northern Coast NSW	900	< 1	< 1	Few students with disabilities Middle socio-economic status
3	Northern Sydney	1300-1500	< 1	< 1	Few students with disabilities High socio-economic status
4	Western Sydney	1000-1200	< 1	85	Middle socio-economic status
5	South Western Sydney (Female only)	1000-1100	< 1	92	Low to middle socio-economic status
6	South Western Sydney (male only)	900	< 1	50	Low to middle socio-economic status
7	South Sydney	1100	< 1	85	Middle socio-economic status

Study Design

ÆSOP was guided by four research questions:

- What are the variables and processes leading to outstanding educational outcomes in terms of the goals specified in *The Adelaide Declaration* – personal identify, academic success, and social attainment?
- Is it possible to identify the relationship(s), if any, between the different types of goals specified in *The Adelaide Declaration* as achieved through subject departments and/or other formal groups and special programmes and initiatives?

- What organisational and institutional factors – NSW DET, district, school, leadership, community, faculty, other groups and individuals – contribute to and/or constrain this success?
- To what degree and through what means, if any, can the outstanding educational outcomes identified be shared with others within and beyond the schools investigated?

With sites selected intensive case studies were undertaken in each of the schools. This involved a Project Team consisting of a university researcher in a related discipline (i.e., mathematics education), a university researcher with expertise in case study methodology, the local Chief Education Officer (School Improvement), and a Head Teacher from a nearby school. Each team spent up to 5 days investigating the policies, programs, and practices that lead to the outstanding schooling outcomes being achieved in sites.

In the school the team collected a range of data. This included semi-structured interviews with Principals, Deputy Principal(s), Head Teachers, subject teachers, school advisors, students (Year 7-11), and parents. Lesson observations using a specified protocol were conducted with teachers who agreed to the involvement of the research team. Finally, a document analysis was undertaken of school reports, results, subject programmes, school and faculty policy documents, and any other documents deemed appropriate (e.g., media coverage). All interviews were taped with approval of interviewees.

Once the protocols and procedures for ensuring consistency across Project Teams were developed, four site visits were conducted to pilot the techniques for the main study. This resulted in an interim report with changes made to the conceptual framework guiding the study, alterations to the protocols, and variation to the overall design. The main study was conducted over the next 2 years of the project.

Data Analysis

At the completion of each site visit the research team prepared a report using the data available. The work of the writing teams was assisted by two key activities – consultations/workshops and detailed, qualitative analysis of each relevant site report. Frequent combined meetings of the writing teams were held so that experiences during visits could be shared with preliminary findings discussed and compared. Further analysis of each site report was assisted through the use of NUD*IST software. This facilitated analysis through a tree-node system as a hierarchical index of topics, themes, concepts, and ideas emerged (Richards, 2002).

Results and Discussion

Analysis of the mathematics data identified seven major elements in relation to the school, faculty, characteristics of teachers, pedagogical practices, and parents and students. The findings discussed in this section represent a number of the major themes that emerged as being particularly influential from these elements.

Strong Sense of Team

> We are working in a friendly environment, staff are helpful. Good teamwork. Keen to help each other. We have similar views … like correct Mathematics … We use different methods. Our department has a staff room that is good for working together. I am very happy to teach here. (Teacher)

This quote encapsulates many of the comments made by mathematics teachers about their faculties as teachers invariably likened the experience to working as a "family". Interestingly, this included agreements and disagreements, good times and bad, and friendships of varying intensities. Through it all, however, there was a unifying sense of purpose and collegiality. It was common to hear teachers speak about how much they gained from sharing with their colleagues and how much they appreciated their own opinions being valued. The ability of mathematics teachers to function collaboratively was evident from the policy changes (e.g., registers and programmes), continued changes in assessment practices, and improved classroom approaches aimed at enhancing student understanding.

At the individual level, teachers were cognisant of issues their mathematics colleagues faced and were supportive of one another's challenges and achievements. Teachers had established good working relationships with their peers and used their initiative to determine ways to help colleagues maintain a high-quality learning environment for their students. The focus of this support was evident in various ways such as ensuring colleagues' classes were not disadvantaged by covering absences and ensuring equity in the provision of resources.

Each team of mathematics teachers exhibited a clear sense of pride in the culture of success they helped create and this was disseminated to newly appointed teachers. New teachers who came to the school spoke of encountering an established faculty culture with an expectation for conformity to meet relatively high standards of performance. The enculturation of new staff was implicit and/or explicit ensuring that members of these faculties were able to advocate and share a common vision that encouraged a consistent staff approach.

Importantly, leadership qualities were admired and respected by the mathematics staff. Although leadership was usually the province of the Head Teacher this was not always the case with a distributed leadership (Spillane, Halverson, & Diamond, 2001) style evident in some instances. In general, the leaders of these exceptional faculties exhibited common characteristics including a commitment to keeping abreast of the latest developments in teaching mathematics, a strong subject and syllabus knowledge that would enable them to support other faculty members, and sound classroom practice. These leaders appeared pivotal in establishing and/or maintaining the culture of the faculty.

Qualified Staff with a Breadth and Depth of Experience

Subject knowledge and experience in teaching mathematics were two important features of the staff in the faculties visited. First, the University training of the staff was at a high level with the majority of teachers holding third-year majors or an equivalent in mathematics in their degrees. Second, teachers in these faculties had many years of successful teaching experience, often in several schools. Subsequently, they brought a wealth of different experiences to their current positions.

These faculties could be described as communities of scholars with deep knowledge of the subject and a special pride in teaching mathematics clearly evident. Their work was well recognised by people outside the faculty who were aware that the Mathematics teachers always exhibited a high degree of professionalism. As one Year Adviser remarked:

> Staff members here are confident about mathematics. We sit here and talk Mathematics and exchange ideas. When we put in a request for what classes we want next year there are a number of us who automatically put up our hands for the lower classes … I think that is unusual.

Solid Teaching

All teachers interviewed referred to their style as "traditional" meaning it involved a "standard" approach to classroom instruction. Although there were variations to the meaning of a standard approach there was a great deal of commonality in approaches across schools. In particular, there was a clear and consistent structure to lessons.

In practice, this common structure related to similarities in the way teachers started lessons, how lessons proceeded, and how lessons ended. This structure gave a sense of security to students in their learning. Nevertheless, within this structure, there was still variety in these lessons. For students, lessons were not dull, repetitive, or boring.

At some stage in the lessons observed students were given practice exercises. Students who finished the work were given additional activities, usually from another source. Teachers made every effort to ensure that students were given an opportunity to learn, or to practise skills, in each lesson. A feature of the lessons observed was that teachers were aware of the need for appropriate revision before proceeding, careful explanation of new concepts, appropriate practice and follow-up.

Common to many lessons observed was an underlying rigour appropriate to the ability of the students. Teachers were conscious of helping and encouraging all students to achieve. Numerous conversations with teachers revealed the importance of "bringing students up to a level rather than pitching the work down". Every effort was made to ensure that students achieved syllabus outcomes.

Faculty members established supportive classroom environments for their students using an array of teaching aids or interesting approaches to topics. They accepted the need for some change and appeared willing to try new ideas, but did so in an environment of scrutiny. They were skeptical of educational fads and felt that they had been "burnt" many times before through change for change's sake. They spoke about being prepared to put in place whatever was needed to ensure that their students were placed in the best position to benefit from changes.

> We have battled away with all these new approaches in teaching, group work and so forth … and mathematics-wise we have found it very hard to really move away from set maths lessons … you know your structured maths lessons. … As soon as you get the unstructured happening the students are not comfortable. (Head Teacher Mathematics)

Time on Task

Time on-task was maximised by the teachers and students at the schools visited. Emphasis around "on-task" time and a commitment to a cooperative and supportive environment were high on the teachers' agendas. Classroom teachers made every effort to ensure that students were actively engaged in the learning process. When asked about discipline in Mathematics a Year 8 student said: "In Mathematics we are too busy to muck up."

The value of on-task time was also apparent in more subtle ways in the schools. An example from among many help exemplify intrinsic aspects of this feature. In one school visited, the staffroom was located at some distance from the demountable village teaching

rooms allocated to mathematics. Despite this geographic arrangement, the mathematics teachers were invariably punctual to lessons and got down to productive teaching and learning in minimum time. Further, when they had consecutive lessons it was noted that they took resources for all lessons with them so as to save time and not have students waiting while they returned to the staffroom.

In this and other cases there was a clear message being directed to students: their teachers valued mathematics, valued teaching mathematics, and valued the time provided to mathematics. Further, this implied that the time spent on Mathematics was important and teachers would do all they could to maximise this time. Students came to accept the importance of time. At the staff forum a teacher commented on this:

> When I came here my first problem was I'd walk in and would run out of work–what took 40 minutes at my former school took 20 minutes here so the implications of the students being good is that you have to change your style of teaching and I think that is characteristic of us here. We probably all come from different backgrounds and changed our style of teaching to suit the school … Kids come with a lot and we have to add to it. (Teacher)

Time-on-task was considered a vital factor in helping students achieve their best. This was communicated to students in many ways both explicitly and implicitly. Nothing seemed more powerful in getting the message across to students than the teachers' role-modelling this practice.

Assessment as a Catalyst for Teacher Cohesion

The faculties invariably had a well-developed testing regime. Some had formal half-yearly and yearly examinations that commenced with students in Year 7. Regardless of the type and formality of the testing, the faculties appeared to use the testing/assessment process for a variety of purposes. For students, the testing regime served to provide a catalyst to assist them in developing and consolidating their understanding. It also enhanced their skills, expectations, and preparation for examinations, revision techniques for examinations, and the establishment of regular patterns of study. Interestingly, students viewed this positively.

For teachers the testing process was different. It was to identify students' abilities, what they had understood, and how they were proceeding in comparison with their peers. However, tests were also used as a basis to discuss with colleagues the effectiveness of teaching various topics. They helped provide a focus on pacing lessons and illuminating different emphases that teachers had placed in their teaching. These tests were seen as helping identify and better understand the major issues, what were important subsidiary ideas, and the development of questions that would elicit greater student understanding.

Most faculties had elaborate and collaborative setting and marking plans for tests. Sometimes teachers not currently teaching a course were required to produce tests. In other faculties, teams of teachers teaching a particular course would collaborate, often with teachers within a team taking on different roles. Regardless, of the organisational structure, tests were carefully scrutinised. This would involve a focus on the wording, the breadth of content, the overall standard, and the marking scale. It was important in these faculties that there was consistency and that all tests were set to a high standard.

Quick feedback on student performance was also a feature. Papers were invariably returned very soon after the test. Feedback varied from school to school, but in general there was a focus on how the test had addressed syllabus outcomes and also what students needed to do to ensure a maximum score for each question. As classes were invariably

streamed, this enabled students to see where they were tracking in comparison with their peers. Usually, in the case of substantial tests, this ranking resulted in some students being allocated to a different class. The argument was that this reorganisation allowed students to work with peers at their level. This would encourage greater and more relevant on-task learning time as students within the same class would more likely be at similar learning points.

In practice there was some flexibility in this process and students were often moved or retained within a specific class out of consideration of social and/or personal factors. The overriding consideration was: "What was in the best educational interests for a particular student." In reaching decisions most Faculties involved parents and students.

Students appeared to respond positively to class movement based on test results, supporting teachers' view that this action had a motivating effect on students. They saw the outcomes as "fair" and in the case of those demoted, they spoke how they had the chance to return to their class if their results improved.

Clear Mission of High Expectations

> A lot has to do with the kids. The kids are on the whole studious, value an education, and they're concerned about their progress and that makes a big difference … The support you get from the families … If they are away for a day and miss something then they worry about what they have missed. Not like other kids who say "hooray I have missed something", they worry about it. (Head Teacher)

> The environment provided by the maths department teachers helps her (daughter) learn. (Parent)

These two quotes are illustrative of how teachers and parents attributed reasons for the exceptional mathematics performances in their school. A common theme associated with these observations was mutual respect among all parties. Teachers acknowledged that students and their parents were a central reason for the results obtained, whereas parents and students saw the teachers as being the key.

> Every time you deal with a parent here it is usually a very pleasant experience because they are interested in their kids. We might send letters home saying the standard sort of thing, "We are worried about your child in this area" or "They haven't been doing their homework" … Their response is usually positive. (Head Teacher)

Teachers spoke of students in their school being well motivated and that they came to school and to class willing to learn. The students appreciated the care and support provided by the mathematics teachers and they cooperated accordingly.

It was evident that a situation was established in these schools whereby teachers were assisted by students' commitment to learning and their desire to achieve. Students at all schools generally agreed that it was easy to get help from their mathematics teachers. One Year 8 student, when asked if she could go to the staffroom to ask for help, commented: "In class she asks if we have problems you only have to put your hand up."

Who has contributed most to success – the teacher, student or parent? The answer to this question is irrelevant. The key feature is that all three stakeholders are moving in the same direction. In these exceptional faculties there have developed over time a culture of success and achievement for students at all ability levels. Teachers, students and parents are all swept along with it. That each group takes pride in recognising the efforts of others is simply one manifestation on this shared commitment.

Caring for Students in their Learning

> In the maths area, I just think good pedagogy goes on up there. They have a fantastic concern for kids, all of them. In the school we have very few problems in the Maths area because they get on with kids and they work very well with them. I mean their programming and all that sort of stuff would be similar to what might occur in other Faculties. There is nothing innovative from what I have seen anyway, it is sequential as I would have seen other Maths Faculties. But I just think the personnel and the leadership and the way they get on with kids and their care for kids are very important factors as far as I am concerned. (Principal)

The Project Team was impressed by the strong student focus of the mathematics faculties visited. Policies and actions had a clear student focus. These policies, developed through ongoing discussion about student matters in the staffrooms were extensive. Clearly, teachers saw their role as helping students whenever they could.

Teachers reported genuine enjoyment in teaching their classes. They had developed a strong rapport and what appeared to be healthy relationships with students. There was a nice balance of formality and informality. At a personal level, the students saw their mathematics teachers as approachable and available to offer assistance.

It was obvious that teachers cared for their students' learning and encouraged students to approach them if they were having difficulties. Teachers were happy to make themselves available at breaks to assist students who came to the staff room. The staffrooms were welcoming places for students and many commented upon how they were encouraged when they went there for additional help. When they did ask for help, they found the teachers to be supportive, patient, and helpful.

At these schools it was common to see students from all years and at different ability levels at the mathematics staffroom seeking help. Seeing students across the full age range requesting help and being supported seemed to have a positive effect on all students. In particular, it was seen as beneficial to those with low self-esteem and belief in themselves. The practice of having staff readily available for help meant that students were aware that there was the backup in the faculty to support them and help them believe that they could be successful.

In considering the findings presented in this section it is important to interpret them in relation to the research questions and design. Essentially, only schools that demonstrated a sustained record (over 4 years) of outstanding achievement for students across all ability levels were targeted. Subsequently, there are particular findings of the study that are a direct consequence of the methodology employed. For example, there is no implication that the teaching practices observed were always "cutting edge", innovative, or exemplary and that the sites visited could not improve their practices. Answers to questions concerning what teaching practices display these qualities and how schools, who are achieving outstanding outcomes, improve further are interesting but they lie outside the scope of this particular study. Consequently, caution is required in generalising or extending the findings beyond what the research set out to achieve.

Conclusion

It is clear from these findings that these outstanding faculties have evolved over time and have developed a strong academic and educational culture in their schools. The mathematics teachers in these sites realised there was no opportunity for "resting on their laurels" with continued effort required to maintain these high standards.

An Exceptional Schoolings Outcomes Project (ÆSOP) has provided substantial evidence of excellent mathematics teaching in NSW public secondary schools in Years 7-10. The overriding challenge is how the insights generated by this study can improve the educational achievement of students across the public education system. It also highlights a number of potential important issues for schooling into the future around the need:

- To provide opportunities to help teachers develop the knowledge and skills necessary to exercise effective leadership in the role of Head Teacher;
- For early career teachers to work with and learn from experienced mid and later career teachers;
- To facilitate strong group interaction within faculties;
- For relevant professional development;
- For high subject-knowledge standards for new and current teachers;
- To create a culture in which teaching and learning, rather than behaviour management, dominates all classrooms; and
- To develop common goals among teachers, students, and families.

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