Student and teacher perceptions of preparation in mathematics in middle school and its impact on students’ self-efficacy and performance in an upper secondary school in Western Australia

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Abstract

Middle school initiatives (including heterogeneous classes and an integrated, flexible curriculum together with promotion of student input) have been implemented in schools in Western Australia in response to a perceived need to align schools more closely with a more student-centred approach to learning, in the expectation of meeting more students’ needs and thereby reducing student dissatisfaction and increasing the possibility of students pursuing life long learning. Specific goals underlying the initiative include the development of independent learning and student responsibility for learning through a series of strategies such as self-paced learning, student involvement in negotiating their own learning, and a strong emphasis on respecting and valuing student input into the implementation of curricula. However, owing to the way that the curricula for Middle and Upper secondary school mathematics are currently structured, problems might arise for students in the transition from “a relaxed to a highly discipline-based organization of content” (as described by Venville, Wallace, Rennie, Malone (1998). Students accustomed to the current approaches implemented in Middle schools (Years 8 to 10) may be disadvantaged in the transition to Upper secondary school courses (Years 11 and 12) compared with those students who have been exposed to a more discipline-based organization of content throughout early adolescence and prior to entry into courses leading to tertiary entrance (T.E.E. courses). The aim of this project was to investigate the possible effects of Middle school initiatives in a group of students from three Middle schools in Western Australia in one subject area – mathematics – on the perceptions of self-efficacy and preparation in mathematics once the students encounter Year 11 Upper school courses.

A survey containing Likert-type rating scales pertinent to four areas of interest – Self-efficacy in mathematics; Self-Directed Regulation; Views on current teaching;
and Views on prior teaching were administered to students transferring from three “feeder” Middle schools to Year 11 (Upper secondary school) classes in one Senior College in Western Australia for each of 4 consecutive years. Students were also asked for their comments regarding preparation for the challenges of their chosen courses in mathematics. In addition, their levels of performance in a range of mathematical skills were assessed using a teacher-developed test. The perceptions of their Middle and Senior School teachers were also sought. As the survey was administered to all students as a routine part of action research within the mathematics faculty at the Senior College, only the results of those students who subsequently agreed to be participants in the study are reported in this dissertation. Results indicated that a mismatch existed in approaches and skills between Middle School and Senior College Mathematics. The reliance on students making suitable choices for themselves, the absence of specialist teachers of mathematics in middle schools, mixed ability classes in which specialist teachers of mathematics find it difficult to operate successfully and a curriculum that was so flexible that teachers omitted key elements required for later studies were the main factors that resulted in a significant number of students making the transition from middle to senior school with insufficient preparation. Implications for the teaching of mathematics in these three Middle schools and the Upper school are discussed.
Chapter 1

Introduction

There can be many reasons for change in education and, once a ‘climate’ for change is established; some of these changes may be expedited - perhaps without sufficient evidence by which they may be evaluated. Sometimes the perception of an urgent need for innovation based on a set of perceived problems can overwhelm any other considerations. One of these considerations may be the access to suitable preparation for senior mathematics for students who are attending schools which use a middle school approach to education – a recent initiative being implemented by the state education system in Western Australia.

The far-reaching influences of constructivist, student-centred philosophies have been applied to many educational contexts in different ways over the past century but came, especially, to underpin a climate of educational change late in the twentieth century which led to new initiatives in the education of West Australian students. This was linked to and supported by the popular perception demonstrated by contributors to the 2000 Yearbook of the National Council of Teachers of Mathematics, U.S.A. (Learning Mathematics for a New Century) that mathematics education, in particular, could not move into the 21st century without appropriate reform. Reasons for this included, firstly, that technology had much to offer in the learning of mathematics, and to ignore the opportunities it can provide could severely hinder the progress of students. Secondly, that mathematics should show greater relevance to students’ everyday lives with more real applications, and, thirdly, that mathematics needed to be more accessible to all students, rather than being geared primarily to those students with relatively high levels of academic ability. The philosophies inherent in the approach to early secondary schooling known as Middle
schooling has been perceived by supporters of reforms to help in achieving the goals described above as a result of the approach’s emphasis on an integrated, flexible curriculum, less testing, and mixed ability classes. At the forefront of the goals underlying these ‘innovations’ was the desire for equity amongst students (that is, equal opportunity to engage in the same learning). Although the advantages of such an approach are numerous and have been embraced enthusiastically by many educators, others were apprehensive about the impact the new approaches might have on students, particularly those of relatively high ability. Specifically it was possible that, in spite of the advantages of Middle schooling for some students, more capable students might be disadvantaged - once they entered upper secondary schools - compared with similar students from ‘other’ schools that did not have a Middle school approach.

Significance of the study

The research being undertaken herein sought to examine the possible impact of middle school approaches to teaching and learning in the subject area of mathematics in one small sector of the Western Australian state school system. The schools in the sector of focus consisted of a Senior (Secondary) College for Year 11 and 12 (which first opened in the year prior to Year 1 of this study) and three Middle schools (Schools A, B, and C) which act as “feeder” schools for the secondary college and are responsible for the education of students in Years 8, 9 and 10. Another group of students from ‘Other’ schools throughout the state, other states or from other countries make up a smaller yet significant proportion of the students arriving at the Senior College each year. One of the features of the three middle schools (A, B and C) involved the reduced influence of specialist teachers of mathematics either due to the position adopted within middle schooling discussed later on p. 35 or a lack of availability of these specialist teachers to schools A, B and C compared with ‘Other’
schools. The researcher was a teacher at the College for the first three years of the study and his job included the conduct of a research program involving teachers and students across the Middle schools and Senior College in order to promote the teaching of mathematics.

**Context of the study**

When the College was established in 2001, most teachers of mathematics from one of the feeder schools, here designated as School B, transferred to the College. Unfortunately this meant that School B and, to a lesser extent, School A were left without the wealth of experience in teaching mathematics that previously existed and, instead, a significant amount of the mathematics teaching in those two feeder schools was delivered by teachers whose specialisation was in other subjects. However, this seems to be a common occurrence when Middle schools are established - the literature on middle schools indicates that there is a tendency for less specialised teachers to be employed (Schemo, 2000; Kissane, 2002). In the developing stages of new Middle schools, the absence of specialist, experienced teachers may be viewed as providing a greater opportunity to achieve the broader goals of middle schooling with less emphasis on the specific needs for particular subject matter. If, for example, teachers whose specialisation was science taught mathematics, then this may be regarded as a major step towards implementing an integrated curriculum, which, in turn, may be regarded as a greater priority than the specific mathematical development of students.

The thrust towards developing Middle schools was aided, in addition, by the development and implementation of the West Australian Department of Education’s *Curriculum Framework* which called for “more flexibility” (*Curriculum Framework* 1998, p.14 and p.17) in how particular concepts are taught. The mathematics learning
area statements also refer to “common high standards and flexible curricula” (Curriculum Framework, p178). Within this flexible curriculum the focus is on the outcome rather than the means by which the outcome is achieved. The more flexible approaches to learning which may be viewed as stemming from constructivist, student-centred concepts may be seen as being in opposition to more traditional methods of delivery in mathematics where a particular syllabus of content material is taught.

Constructivism has been a major influence in education over the last 100 years and may be seen to constitute the most influential theoretical principles on which the notion of Middle Schooling is based. In this thesis, consideration of this potential conflict between Middle Schooling and Senior School requirements is considered, together with the impact of outcomes-based education. The interpretation of the flexible curriculum advocated within the Curriculum Framework has provided further challenges or tensions for classroom teachers and highlighted other possible problems in its implementation. Yet another factor to be taken into consideration in this study is the impact that technology has had and continues to have on modern mathematics curricula, although this impact is not the focus of this study and thus is not addressed in the gathering and analysis of data.

The thesis argued here is that when the constructivist-based, student-centred characteristics of middle schooling and outcomes-based education meet the practical considerations within the classroom, tensions may be created, some of which need to be carefully considered if students of all levels of ability are to be adequately catered for.
All of the above influences have the potential to cause difficulties in the preparation of students for Senior College, and perhaps most especially in mathematics which relies to a great extent on the establishment of sound first principles as a basis for the successful transition to higher level mathematics. This study considers student and teacher perceptions of students’ preparation for studies in upper secondary level mathematics, and the possible disadvantages to students from schools using a Middle School approach.

**Structure of the dissertation**

In Chapter 2 an overview of the major ideas and bodies of knowledge relevant to the thesis is presented. Chapter 3 describes the aims of the study, the research design, sample, participants, instruments, procedures and data analyses. Results from the surveys, tests of performance and qualitative data from both students and teachers are presented in Chapters 4 and 5. In Chapter 6, these findings are integrated in light of the study aims and the existing research literature. Chapter 6 also summarises the study and discusses the limitations of the research and implications for the teaching of mathematics in secondary schools.
Chapter 2

Review of the Literature

The three factors identified as impacting on changes in the teaching of mathematics in recent years are addressed here in turn, namely, constructivism (especially its formulation in student-centred learning), outcomes-based education and the rise of technology (and its influence on the learning of mathematics). These are followed by a description and critical evaluation of the characteristics of Middle Schooling, particularly as practiced in three of the four Lower secondary school categories which participated in this study. Specifically, as these schools have demonstrated a commitment to mixed ability groupings, a consideration of the literature associated with this subject is included. Lastly, self-efficacy and its relationship with the perceptions of preparation for studies in mathematics, and the relationship to the idea of student-directed learning are discussed.

Constructivism and student-centred learning

Often we hear adults using phrases such as “It doesn’t make sense to me”, “I couldn’t get to grips with it” or “I can’t relate to that”. When this occurs, it is probably due to the fact that whatever is being encountered does not have a connection with the learner’s previous knowledge or experience. To tie in new learning with something with which the learner is familiar can be explained in terms of constructivist theory and is, in fact, one of the fundamental strategies used in a constructivist approach to teaching. When a student possesses some background knowledge and is encouraged or guided to actively relate new concepts to existing knowledge, there is a greater possibility that a better understanding will occur. This
is described by Simon, Tzur, Heinz and Kinzel (2004, p. 306), who cite von Glaserfeld’s (1995) interpretation of Piaget’s work asserting that, without an appropriate “conception”, the student is disadvantaged compared with students who have access to background knowledge.

Similarly Baroody, A. J. and Ginsburg H. P. (1994, p.16) refer to gaps “between formal instruction and a child’s existing knowledge” which “can make school-taught skills and concepts seem foreign and difficult to children” also leaving them at a disadvantage. Another major principle of radical constructivism (Von Glaserfield 1990, p.22) is the assumption that acquisition of knowledge requires active participation on the part of the recipient.

While the origins of constructivism can be traced back to philosophers such as Plato of ancient Greece, to delve too far into epistemology (the branch of philosophy which deals with knowledge) would involve not only a distraction that would not be relevant to this research but also is a task that has proven to be an enormous challenge for many researchers. Although constructivism is regarded as important as a theory of learning, it is necessary to understand that many researchers, including Matthews, von Glaserfeld and Noddings, feel compelled to emphasise its limitations. Matthews states (2000 p.164) “Although there are countless thousands of constructivist articles, it is rare to find ones with fully worked out epistemology, learning theory, or ethical and political positions. This makes appraisal difficult.” Matthews also quotes constructivist Antonio Bettencourt as saying, “constructivism, like idealism, maintains that we are cognitively isolated from the nature of reality” and there is an “in principle barrier between evidence and theory” leaving only “ideology, personal and group self-interest, or just ‘feel-goodness’ to determine theory choice and educational policy.”(Matthews, 2000 p.168, 169). This is
particularly important when ‘radical’ constructivism is associated with programs in education and where the influences of post modernism and humanism combine under the flag of constructivism. von Glaserfeld abandons a “theory of knowledge” position for a “theory of knowing” (or theory of learning) orientation while Noddings (1990, p.7) also recognises that constructivism operates from a weak position regarding knowledge preferring to consider it from a post-epistemological perspective.

Descartes, who attempted to construct his knowledge from the premise “I think, therefore I am” observed that we cannot always rely on knowledge received through our senses. Building on the little that he actually ‘knew’ to start with (the fact that he existed as a thinking being) Descartes then used deductive reasoning to examine further ‘truths’. This was a method common to Rationalist philosophers. It is no coincidence that steps taken in solving problems in mathematics closely relate to the philosophy of the rationalists who held mathematics in high esteem.

The constructivist approach became extremely popular late in the 20th century and has far-reaching influences in education today. Matthews (2000, p.165) quotes Fosnot (1996) “Most recent reforms advocated by national professional groups are based on constructivism. For example, the National Council of Teachers of Mathematics…and the National Science Teachers Association”. Also “The mathematics components of the National Profiles in Australia and National Curriculum in England are influenced by constructivist thought.” (Matthews, 99th Yearbook: p.165)

Lerman (1993) agrees that constructivism is most influential, also stating that, although it has been condemned at times it has survived “attacks and political manoeuvrings”.

8
The influence of constructivism on education at the local level is evident in the requirements of a middle school that advertised for a Mathematics/Science Specialist, during the period of this research, including the statement “Applicants should have an understanding of, and be passionate about, social constructivist education”. (The *West Australian* 18th December 2004).

In 1990, Davis, Maher and Noddings referred to reports that indicated that the United States were not succeeding in mathematics and that the steps suggested to overcome this problem resulted in the formation of two ‘camps’ and an ensuing ‘math war’ which was fought on two fronts (Davis et al, 1990, p.1). One school of thought argued for more mathematics, more schooling, accountability through testing, more homework and an emphasis on gaining knowledge through a common curriculum. The alternative was perceived as fitting mathematics into the lives of students, requiring less testing and providing children with time to make connections with their previous experience.

To proponents of more explicit mathematics the alternative appeared a softer, less rigorous option, with a more flexible curriculum which, in itself, they considered precluded testing and made evaluation of progress (of students and the program itself) more unreliable. Within this less rigorous, less threatening approach to education, Matthews (2000, p. 162) quoting Watts (1994) relates a whole range of humanistic qualities including “caring for one’s ideas, personal theory, self image, human development, professional theory, professional esteem, people”. Matthews (p.166) elaborates on “the high hopes held for constructivism” stating that there is much confidence that constructivism will provide all concerned (”teachers, students and researchers”) with a more enlightened alternative to the traditional methods used to deliver mathematics leading us “out of the wilderness into the educational
Promised Land”. He quotes Jeremy Kilpatrick’s plenary address to the Eleventh International Conference for Psychology of Mathematics Education 1987 in which Kilpatrick states that there is a “committed band of true believers whose credo demands absolute faith and unquestioning commitment, whose tolerance for debate is minimal, and who view compromise as sin; an apocalyptic vision that governs all of life, answers all questions, and puts an end to doubt”

McCarty and Schwandt (2000, p.86) assert that constructivism (both radical and social) foster political correctness, possessing flexibility for the learner to determine the pace and other factors associated with learning, including a sense of community. Specifically, constructivism is opposed to “authoritarian forms of pedagogy”. As constructivism relates well to the teaching of mathematics, teachers of mathematics may be using or have encouraged students to use, approaches similar to those that may be espoused from a constructivist viewpoint, in many cases without realising it or even being aware of the existence of constructivism. Phillips (2000, p.5) gives two reasons why constructivists have devoted significant attention to mathematics education. If the learning of mathematics and science can be explained in terms of constructivism, then constructivism “can succeed anywhere”. Also “much of the cutting-edge research in learning theory” has incorporated the psychology of mathematics and science education.

von Glaserfeld (1991) writes that students in ‘traditional’ mathematics classrooms were not given the opportunity to develop mathematical ideas for themselves but would be expected to “pick it up” by witnessing teachers’ examples and practicing similar examples for themselves. There is a belief (at least a suggestion) that, if the right conditions are provided allowing mathematics to fit into their lives, students might be expected to construct their knowledge in a similar way to Descartes. The
possibility that all students might be capable of this kind of achievement may shock some but reflects the confidence that exists amongst supporters of reforms in the teaching of mathematics.

Phillips (2000, p.12) observes that “..some of his (Von Glaserfeld’s) views are shocking (to use his own description)”, emphasising a need to quote accurately what is said because he (Phillips) has observed “from personal experience that if one paraphrases a “shocking” position (rather than quoting from it quite precisely and in detail), one’s audience is tempted to say that “no-one could ever say such a thing”

Martin (2004, p.17) writes “much of the current research that emanates from DEST (Department of Education, Science and Training) and other government departments does not resonate with teachers.” He advocates “placing a greater emphasis on the valuative views of practitioners and less on the qualitative measures imposed by the economically driven bureaucrats and outside critics”

Consequently there is another reason why a quotation that ‘resonates’ should be allowed to remain in its original form. Shocking or otherwise, if it is impressive enough to attract one’s attention, to ‘resonate’ with practitioners, then it must possess enough power to pass on in its original form. Consequently there are a number of quotations, some quite extensive, that ‘resonate’ enough to retain in their entirety within this dissertation. The “valuative views of teachers” from interviews and student comments should also be quoted where necessary to ensure that these views are precise and not taken out of context.

Phillips (2000) adds “There is a related interpretive issue. Sometimes a writer is inconsistent, or seems to be saying in one place something that, taken literally, contradicts what he or she has said somewhere else. Judgement is required to
determine if this is a genuine contradiction or confusion, or whether there is some reading that would dissolve the apparent problem.” Also “Radical constructivists insist that each of us is ‘in contact’ only with our individual ‘experience’, we do not have ‘contact’ with an ‘external world’, which is simply a construction of ours. This position seems to isolate each of us in a universe of our own construction, a shocking view indeed, and one that has appeared in the earlier history of Western philosophy and which has been subject to strong criticism.”

In the U.K., according to Askew (2000, p274) who quotes Willan (1998) when he states that the National Curriculum in the United Kingdom “had a deeply egalitarian rhetoric: a curriculum regardless of location, status or background and two key principles were embodied in the spirit of the National Curriculum:

- That the needs of individual pupils had to be provided for;
- That the actual teaching approaches that would meet these needs should be determined by teachers.

The specific needs of the National Numeracy strategy transformed this approach

- Away from the needs of the individual towards collective targets;
- Towards increasing specification of teaching approaches.

Lerman (1994, p.41) echoes this egalitarian rhetoric identifying a desire for individualised learning and avoiding competition. However, writing in the Journal of Mathematics Education, Boaler (July 2002, p.239, 240) acknowledges the concerns of some researchers, specifically Lubienski (2000) and Delpit (1988) about reforms and their capacity to “promote equity”. The consequences of reforms “may reflect a certain naïveté in our assumptions that open learning would be accessible to all”.
The shift away from individual to collective targets has encouraged what some would regard as excessive accountability with Ofsted (Office of Standards in Education) inspections and education tables.

The British Broadcasting Corporation (B.B.C.) also offers some disturbing information concerning schools with poor results. The following links (from the B.B.C. web site) illustrate the emphasis on accountability, results and other associated issues.

The B.B.C. web site links.

Thursday, 23 January, 2003, 06:41 GMT

School named worst in England
14 Feb 03 | Education  27 Nov 02 | Scotland
A-level league tables postponed again  Call to scrap school league tables
05 Dec 02 | Education  11 Oct 00 | Education
Sandwell schools' results are worst  Share-a-teacher idea in staffing crisis

Williams, (1995, p.143) is critical of the eagerness of the government in the U.K. to take control of education declaring that “since 1979, the politics of educational denigration has flourished.” This control of education has, in the view of some including Williams, created a competitive situation leading to educational denigration. League tables are published, schools that perform consistently poorly in exams or Ofsted reports risk closure. Teachers and schools are labelled publicly because the Ofsted report can be accessed readily on the internet.

Bishop (1991, p.203) notes a characteristic of mathematics that is absent from the subjectivity of constructivist approaches and how society values the objectivity that mathematics possesses. Perhaps life would be more controllable, more comfortable, safe and healthier if the certainty of mathematics could be applied to medical science, law and other walks of life. (If we could say “I am as sure as 2 plus 2 equals 4 that this medication will cure you or that the defendant is guilty”). Philosophers,
including Descartes and Kant, even tried to set metaphysics on the sure path of mathematics. Bishop believes that the emphasis on rules and laws across disciplines, seeking to achieve the objectivity of mathematics, indicates that “we are valuing the quality of control.”

However there are concerns from critics including Popper, Matthews, McCarty and Schwandt, extending to justice and ethics that the construction of different sets of values by individuals invites all kinds of dangers and, according to McCarty and Schwandt (2000, p.78)…”individualistic constructivism is officially opposed to universalistic moral stands.”

Matthews (2000, p.182-184) criticises the elaborate, verbose, frequently ambiguous recent terminology used by educators in elucidating the values and practices of radical constructivist/ post modern approaches, stating that this “is using theoretical terms to complicate simple matters” adding that there are enough challenges for teachers without the added intrusion of the extra “illusory challenges” provided by such language. Matthews compares ‘constructivist’ (although this probably involves the post modern/ radical constructivist influence) and ‘plain’ language using examples such as the following.

*Since co-participation involves the negotiation of a shared language, the focus is on sustaining a dynamic system in which discursive resources are evolving in a direction that is constrained by the values of the majority culture while demonstrating respect for the habitus of participants from minority culture, all the time guarding against the debilitation of symbolic violence.*

This may just as well be written as: *Teach in a way that is sensitive to cultural values.*

(The example was taken from Tobin, *Constructivism and Education p.212*)
Outcomes/ Standards based education

In the *Western Australian Curriculum Framework* (1998), the overarching learning outcomes, just like visions and mission statements before them, emphasise important values. Integrity, respect for oneself, for others, for the environment, and being true to one’s potential are amongst important concepts that teachers should model and emphasise to students. These common values, with *universalistic moral stands*, certainly stand in contrast to the radical *individualistic constructivism* as portrayed above by McCarty and Schwandt.

It is important to emphasise that an outcome does not express the *contents* of the curriculum but “*focuses our attention on the actual student learning we would be prepared to accept as evidence of (their and our) success*” (MacDonald, 1993, p. 485), specifying “*what we expect from them*” (Willis, 1997, p.9). Willis (1996, p.14) elaborates, stating that the same outcomes can be achieved by different curricula, and says “*To suggest, however, that Level 6 in Algebra describes the Year 10 curriculum in Algebra is to completely misunderstand the Student Outcome Statements and could lead to a lowering of expectations.*” (Willis 1997, p.11)

The following table 2.1 illustrates how an outcome at level 5 mathematics “*The student reads, writes, says and understands the meaning, order and relative magnitude of whole number and decimal numbers and negative integers*” may mistakenly form part of an ‘impoverished’ course of study if the curriculum framework is treated as a content curriculum. Perhaps this is why the review of the literature on *Outcomes Based Education* (EDWA 1995, p.21) calls for “*common understanding and consensus*” to be established in order to ensure that teachers “*interpret them in the same way*”. Misunderstandings such as these certainly have had the potential to cause deficiencies in student preparation.
Explanation of the table which follows:-

Under the various ‘curricula’ in the table (U.S.A., U.K and Western Australia’s previous Unit Curriculum) negative numbers should be introduced early in middle school, possibly late in primary school. This type of curriculum allowed for consistency in the delivery of mathematics but was viewed as not encouraging a flexible interpretation. It also encouraged the promotion of rigorous standards. Once students have a background in negative numbers, they are empowered to consider a wider range of solutions in problem solving, are able to consider graphs of functions in all four quadrants and are given the opportunity to apply these negative numbers in a wide variety of situations. The Curriculum Framework places negative numbers at level 5, which resulted in students entering tertiary bound courses in Year 11 without sufficient skills in dealing with negative numbers. Science teachers have also commented that students faced difficulties when being introduced to work that required an understanding of these concepts (e.g. negative ions).

The writers of these outcomes could certainly criticise teachers for what appears to be a very common misunderstanding of the intentions of this type of flexible curriculum and direct them to the relevant literature. For example, Chutima Thamraksa (2003, p. 60) states that criticism of student centred approaches in Thailand “reflects the failure, not of the approach per se, but the teacher’s misinterpretation, misuse and abuse of the concept”. Posturing to place the blame on teachers for this misunderstanding would appear to be rife. Perhaps an alternative would involve ensuring a “common understanding and consensus” (as recommended) prior to implementation which could have retained a rigour and avoided a “lowering of expectations.”
Nevertheless the fact that students have entered tertiary bound courses without these skills leaves them at a disadvantage. This might have been overcome with the use of more explicit, unambiguous requirements, “overcoming illusory challenges”, in the Curriculum Framework. There are varying consequences when students discover that the belief that they possessed a suitable background was misplaced. These consequences depend heavily on the self-efficacy, considered later, of the student involved and the extent to which the student was unprepared with regard to other background skills in mathematics.
Table 2.1. Negative numbers outcome- a comparison across curricula.

<table>
<thead>
<tr>
<th>Principles and standards for School Mathematics (N.C.T.M)</th>
<th>National curriculum (England)</th>
<th>Unit Curriculum</th>
<th>CURRICULUM FRAMEWORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>In grades 3–5 all students should (NCTM) explore numbers less than 0 by extending the number line and through familiar applications.</td>
<td>counting back in steps of any size from any integer, extending to negative integers when counting back (P.21) (Key Stage 2)</td>
<td>N.2.4. Develop an understanding of negative integers.</td>
<td></td>
</tr>
<tr>
<td>In grades 6–8 all students should develop meaning for integers and represent and compare quantities with them.</td>
<td>Use previous understanding of integers .use negative numbers on number line. Positive and negative square roots (Key Stage 3)</td>
<td>N 3.2. Develop an understanding of operations with negative integers.</td>
<td></td>
</tr>
<tr>
<td>Once introduced, negative numbers can be used in all contexts involving integers— real numbers, word problems, number generalisations. Etc. (across all strands)</td>
<td>Add, subtract, multiply and divide integers and then any number (this includes negative integers) (Key Stage 4)</td>
<td>Once introduced, negative numbers can be used in all contexts involving integers— real numbers, word problems, number generalisations etc. (across all strands)</td>
<td>The student reads, writes, says and understands the meaning, order and relative magnitude of whole and decimal numbers and negative integers.</td>
</tr>
</tbody>
</table>
Willis (1992, p.30) also says, “The OCM (Office of Multicultural Interests) symposium even suggested that people would be disappointed if mathematics wasn’t difficult”, and quotes Howson and Kahane (1986, p.13) as saying, “More perversely, however, there is a widespread popular feeling in some countries that school mathematics should be difficult, a feeling perhaps associated with a vague belief that it has a role in character training ...It is a belief that must be countered by every means possible.” Foster (1991, p.13) points out that “historically” the failure of a proportion of students has been anticipated and, without this failure, “academic rigour” is considered to be missing. On the other hand, Bolotin (1993, p14) criticises the preoccupation with equity in reforms stating that too much attention to equity will mean that the “standard... will match the lowest common denominator in the nation” reflecting the concern with ‘dumbing down’ frequently referred to in research on reforms in the U.S.A. Spady (1988, p.14) emphasises that all students should “reach very high standards” where outcomes are “reasonably within their grasp”. Also “schools cannot be expected to overcome the external circumstances that adversely effect (sic) some learners.” (p.21). Some students will achieve outcomes earlier than others and (p.31) “students too must take responsibility for their own learning”.

Hence, within outcome-based education in Western Australia, there is some resemblance with the less rigorous school of thought, which was considered at the beginning of this literature review with regard to the United States. In theory, the slower delivery associated with this approach may allow students with difficulties greater opportunity to succeed. Although this may be the case it is also possible, as others have claimed, that this could happen at the expense of the rigour under which more able students have thrived.
‘Rigour’ is open to interpretation and would be traditionally associated with “a highly discipline-based organization of content” (as described by Venville et al) but, with regard to the study of mathematics, portions of the dictionary definition (accurate, careful, conscientious, meticulous and detailed) would indicate some of the characteristics of a rigorous course of study.

The following passage, was published on http://www.mathsnet.net/articles/trouble.html as a response to an article published in the Guardian newspaper in the United Kingdom (Crace J, October 2002). The original Guardian article discussed a number of problems facing maths education including the image of mathematics amongst students, resulting in diminishing standards and the difficulty in attracting students to higher courses in mathematics with the consequences being a decline in the supply of teachers of mathematics. The article recognises that the consequences for industry and education “are extremely worrying” and the article also declares that, to be an effective teacher of mathematics, you “don’t just need scientific excellence, you need to be a good performer and crowd controller”. The passage may also relate to the “belief that must be countered by every means possible” (Willis, 1997).

At the same time it provides some of the concerns about a vanishing rigour along with some of the process skills that a rigorous approach to mathematics can provide.

“Whatever maths is, it has barely changed in over a thousand years. Therefore, if it is difficult, unpopular, boring now, was it not always the same? Maybe not. Maybe other things have changed. Maybe there has been a general dumbing down. Maybe great changes have occurred in other subjects that keep our students happily occupied, and while they are busy, short attention spans engaged, they do not care what the point is. School
students are notoriously uninterested in the future, be it their careers, college courses, even-amazingly enough-their own exam prospects. They are fully taken up with the now. They want gratification now. A large element of school mathematics involves the acquisition of difficult skills; how to work with algebra, the four rules of fractions, etc, etc. But what are these skills for? Maths is important at school because it is the one discipline where a whole range of important issues comes together in almost every lesson.

Can you listen to instructions?

Can you carry out a sequence of steps?

Can you think quickly?

Can you be precise in your thinking and working?

Can you sustain a thinking and working session beyond a few minutes?

Can you move from the particular case to the general case?

Can you think in the abstract?

Can you stick at it when the going gets tough?

Can you seek advice?

Your progress will falter if you are weak at any one of these...I would argue that we need a society proficient in these skills. We need to get across to our students firstly that these skills are being taught and secondly that they are good for them, and we need to do this quickly before they all mentally jump ship, get their crayons out and return to colouring in.

One problem I will admit about school mathematics. It is about the above skills and, unfortunately, it is not about much else. It is unrelentingly focused.”

Another factor connected with equity, the barriers that students themselves construct to prevent them from gaining access to equity, which has been omitted in the
Outcome-Based Education: A review of the literature (1997) is considered in detail by Mason (1999 p. 164-167) who identifies major problems or “tensions” for teachers of mathematics in (challenging) classroom situations, as follows:

1. If only pupils wanted to learn....
2. If only they would pay attention..
3. If only the class were smaller...

In his view, “most tensions are endemic and inescapable”. He includes quotes from pupils and teachers to support this view:

1. The pupils asked me if this was ‘on the exam’. I said ‘well no, not exactly...’ and they switched off completely.
2. I want to get them enjoying mathematics. They just want to get through the day.
3. Don’t make me think about it; just tell me how to do it!
4. I’ve read the card. Miss, but is it an add or a multiply?

He also emphasises that, while “success is associated only with jumping hurdles, like tests and examinations”, other opportunities such as “seeing a generality, or capturing it in words and symbols, or explaining it to someone else” may be overlooked and not appreciated by students.

Mason also asks

“What then do I do with a capable but unproductive pupil? Some pushing may help get through a barrier, but it may produce dependency on me to keep pushing. If a teacher leaves it up to the pupils to work on their own initiative, will they miss out on essential skills while coming to grips with being responsible for their own learning?
Military disciplinarians believe that by imposing very strong discipline you break through barriers and train people to be highly self-disciplined.

....there is no answer to this tension, no way to relieve it”.

It is no mean feat, yet it seems central and essential to an effective teaching situation to come to terms with these tensions along with other external pressures. While the majority of teachers may come to terms with tensions in the normal course of events, when new initiatives are introduced such tensions may take a different, less familiar form and create an environment with which many teachers would not be comfortable especially if there is the added intrusion of the extra “illusory challenges”, such as the use of unfamiliar and seemingly unnecessarily convoluted terminology. For this reason many teachers would prefer a more cautious, gradual change.

Noddings cites Cobb, Wood & Yackel (1990, p.16) who understand some of the difficulties faced by teachers writing that “Many mathematics educators recognize the power of “constructivist methods” in one-to-one situations, but they also see that schoolteachers cannot work continuously in such situations”. Also “Classroom situations force us to think about instructional economies”. During their research Cobb et al “took for granted the goal of attempting to transform the teachers into constructivists who thought just like we did. It was only when working with teachers that we became aware of the gross hypocrisy implicit in this goal.” They believe that it would be more appropriate to refer to “forms of teaching compatible with constructivism” rather than “constructivist teaching.”

However Tobin and Inwold (1993, p.16.) insist that, in order for teachers to change their practices, they will need to believe that reforms are necessary and commit
themselves to being active in the reform process. This is clearly a major step in the
difficult task of convincing the community (including parents) that these reforms are
necessary.

The following passage from Wheeler (2001, p.11) also emphasises problems faced in schools:

It may be a civil rights issue to give every student the opportunity to receive a
high-quality education; it is also each students’ inalienable right to take it or
reject it, to take some of it and reject the rest, to take some of it sometimes
and to reject the rest of it the rest of the time, and so on. The teachers
responsibility ends with providing the opportunities to learn, develop,
change, to all his students- a difficult enough aim, in all conscience. He need
not congratulate himself or blame himself for what his students make of what
he offers. (We know the customary variant of this procedure, of course).

Davies, Hides and Gray (2001, p. 1025) make the observation about students in
higher education, which could probably extend to students in later years of secondary
school: “students are increasingly seeing themselves as customers and behaving
accordingly”. The possible consequences for students in compulsory education, who
perceive that they have these choices, may be to opt out of more challenging learning
situations instead of persevering with them. This leads to additional ‘tensions’.

Relational understanding (relevance and reality)

It is hoped and anticipated that further contributions of mathematics to society and
specifically in mathematics education will be more likely as the benefits of more
reliable technology are taken up in the study of mathematics. De Pillis (2000. p. 74)
in Technology in Education: Minefield or Cornucopia?) lists the drawbacks and benefits of technology within schools. Included in drawbacks are: time investment (the need to be familiar with software and other factors, meanwhile technology acts as barrier to learning); ease of use (not all classrooms are equally well equipped, practical issues of setting up equipment properly gets in the way); and, calculation skills lost (a serious concern to many instructors as we may forget to do some of the simplest tasks ourselves). There is also the potential obsolescence of new technology, possibility of making a commitment to the wrong platform and the need to have a back-up plan if technology fails.

The benefits he mentions include: visualization (e.g. 3-D rotations, cross sections of geometrical shapes etc.); modelling and demonstration (Simulations of physical experiments can be carried out computationally and systems can be seen to evolve in real time); and, discovery (Technological tools can allow students to discover scientific and mathematical concepts on their own by removing the need to carry out time-consuming hand calculations).

The “calculation skills lost” stated by De Pilis as one of the “drawbacks” for technology could in the future be replaced by gains in understanding. This appears to be the major, substantial shift in emphasis associated with the contribution that technology is expected to make to the study of mathematics. While acquisition of extensive skills in mathematics, perhaps without any connection with reality or connection between topics during late primary and lower secondary, has previously been mainly accessible to the more capable and most dedicated students, there is optimism that technology will provide more students with an understanding and appreciation of the power of mathematics. The following quote, though referring to college level mathematics, also presents possibilities for students in their final years of secondary education. According to Teles (2000, p.151) recently program directors
at the National Science Foundation were asked to identify the most significant achievements in science, technology, engineering, and mathematics (STEM) research and education in the twentieth century. They came up with the following achievements:

*First achievement: shift from teacher-centred to learner-centred for undergraduate education. Second is recognition that balance must be achieved between learning of ‘facts’ and learning of processes. Third achievement is the exploitation of various technologies (smart laboratory instruments, computers, calculators, modelling and visualization tools, the Internet) to allow students to explore theories and concepts without getting bogged down in tedious calculations or manipulations; or learn outside the confines of a particular time and classroom laboratory setting. This relates both to learning anytime and anywhere and to engaging students in the observation or simulation of processes normally too large, too small, too fast, too slow, or too dangerous for direct interaction.*

There seems to be considerable concern that students have, in the past, fulfilled requirements at the highest level of mathematics but have not understood this mathematics or the principles it embodies at a deeper level. Reform programs in mathematics tend to place a lot of importance on one of the types of understanding (relational understanding). However Skemp (1976, p.24) recognises that relating new learning experiences to established knowledge can certainly take longer and can be more complex than the idea being taught. It may be that relating something to the real world involves additional information that may not be readily available until taught later in science or some other subject. As a result, Skemp (1976, p.24) gives 4 possible reasons for rejecting a relational approach to teaching maths.
1) A relational understanding may take longer to achieve.

2) A relational approach may be too hard since relationships can be more abstract than the aspects being delivered.

3) Pupils may need to learn to perform the skill or technique, say in science or technology lessons, before they can work on the deeper meanings of it.

4) A teacher might work in an environment where instrumental approaches are the norm and attempts to work relationally are unsupported.

While reformist mathematics may advance the idea of relating mathematics to the child’s experience, Wheeler (2000, p.53) is concerned about two points in particular. What is meant by the word ‘real’? Too often this seems to be taken to mean exclusively the physical, tangible world or (as it is often called) the world of ‘everyday life’. I find this an objectionable qualification. To exclude from reality, including the students’ reality, the life of the human intellect and the life of the imagination seems to me a potentially more oppressive dehumanisation of education than any of which traditional education has been guilty”.

“Most ‘real’ problems are intractable; the amenable ones often connect only with trivial mathematics; and the problems we know how to solve are generally adults’ problems, not students’ problems...”

However technology, involving simulations, may yet provide an opportunity for mathematics at a higher level to be connected to more ‘real’ applications.

The following table includes ‘Interdisciplinary lively application projects’ used at the United States Military Academy at West Point and show the potential for development of more relevant real simulations. While teachers of mathematics will need to have access to real simulations with less militaristic associations, some of the topics in this list have extremely wide applications
<table>
<thead>
<tr>
<th>Discrete Dynamical Systems and Intro to Calculus</th>
<th>Calculus I- Single Variable Calculus and Differential Equations.</th>
<th>Calculus II- Multivariable Calculus</th>
<th>Probability and Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID Heat Transfer</td>
<td>Flying Strategies</td>
<td>Missile Trajectory</td>
<td>Great Lakes Pollution</td>
</tr>
<tr>
<td>Pollution along a river.</td>
<td>Terrain Analysis</td>
<td>Laser Guided Munitions</td>
<td>Vehicle Accident Analysis</td>
</tr>
<tr>
<td>Chemical Chain Reaction</td>
<td>Aerobic Capacity</td>
<td>The Health Management Organization(HMO)</td>
<td>Remotely Piloted Vehicle</td>
</tr>
<tr>
<td>SMOG in LA basin</td>
<td>Vibration of an Airplane Wing</td>
<td>The Oil Refinery</td>
<td>Model of Dow Jones Industrial Average</td>
</tr>
<tr>
<td>Car Financing</td>
<td>Air Traffic Control</td>
<td>Chemistry ABC’s</td>
<td>Hudson River Pollution Data</td>
</tr>
<tr>
<td>Making water in space</td>
<td>Clinic Profit Management</td>
<td>Rocket Control</td>
<td></td>
</tr>
<tr>
<td>Water Treatment</td>
<td>Wheel Suspension Design</td>
<td>The Satellite Problem</td>
<td></td>
</tr>
<tr>
<td>Analysis of Military Retirement Pay</td>
<td>Bass Population</td>
<td>Trajectories in 3-space &amp; Least Squares Analysis of Motion Lab data</td>
<td></td>
</tr>
<tr>
<td>Viral Infection</td>
<td>Bungee Cord/ Parachute Jumping</td>
<td>Telemetry Data Interpretation</td>
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<td>Real Estate Taxation</td>
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<td>Road Construction</td>
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<td>Airport Construction</td>
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<td>Forrest Fire Fighting</td>
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<td>Water Reservoir Management</td>
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<td></td>
<td>Cut/fill and Bridge Abutment/ Span Computations</td>
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<td>Railway Headwall design</td>
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<td></td>
<td>Earthquake Tower Problem</td>
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</tbody>
</table>
Change which has the potential to increase ‘tensions’ within schools

Although the value and application of mathematics is constantly being reviewed and demonstrated, there are some schools where this success in mathematics is given a lower priority as

“there is a current emphasis in middle schooling practices that sees a teacher taking classes for several subjects. In some quarters this is seen as a mechanism, albeit probably unintended, to reduce the likelihood that students will be taught mathematics by a teacher for whom such activity is their professional specialisation.”

Kissane B. Editorial AMT August 2002, p.38

While Kissane uses the phrase “albeit probably unintended”, Humes (2000, p.39) makes an observation that frequently prevails in a reform-oriented environment where “compliance and conformity are rewarded while resistance is penalised” and quotes Anderson (1998, p.42)

“teachers increasingly complain that participation (in reforms) is often bogus and, far from increasing job satisfaction, adds to their workload and reduces the amount of time they can devote to what they see as their primary task, namely interactions with students”.

West (1999, p.189) refers to Ball’s (1987)

“description of the school as an ‘arena of struggle’-a place where differing ideological perspectives and differing ambitions and expectations are inevitable”. Also “This situation of inter-group competition is not altogether new, there have always been inter-group rivalries, but the scope for influencing outcomes has increased dramatically with the transfer of decision-making powers into the school.”
Robinson (1989, p.272) writes and Johnson (1969, p.142) makes the observation that change is occurring all of the time in schools. This may be a gentle, gradual transformation, an evolution, “almost imperceptible, like the melting of an iceberg” (Robinson, 1989, p.276). A change, originating externally, “usually creates more problems than it solves” while providing the appropriate atmosphere for change increases the probability that positive change will occur. Robinson promotes this “empowerment paradigm (as opposed to the management paradigm)” asserting that the conditions for this are optimal when teachers are offered “meaningful choices”. Encouraging a flexible curriculum may be regarded as providing choice but whether this choice is meaningful would depend on the experience of the teacher and the environment into which the curriculum was being introduced.

Julian Weissglass (1994, p.78) also supports a gradual, cautious approach because, although “policy makers and reformers may wish it were different”, the classroom teacher has strong feelings about and control over what is going on in the classroom. Weissglass advises that reformists should not overlook these realities.

Researchers, such as O’Faircheallaigh, Wanna, & Weller. (1999, p.16), and Julius, Baldridge, and Pfeffer (1999, p.127) use such emotive terms as “change merchants” (O’Faircheallaigh et al) or “change agents” (Julius et al) to describe those who offer dubious solutions during times of change adding that “Success is difficult to judge in most professional organizations because the tasks are too ambiguous to be assessed.” The writers also make the point that “social validation” is frequently used as a de facto measure of success in the absence of “hard evaluation criteria”. 
Fullan (1993, p.161) also gives guidelines for change emphasizing that all must take an interest in change and warning that it should not be left up to the ‘experts’. Also Fullan (1999, p.166) advocates “operating on the edge of chaos” (Accept some uncertainty. Don’t micromanage change through rules and structures).

However, Evers & Lakomski. (1996, p.72) offer a word of caution, within transformational leadership, claims made “should not outrun the evidence provided to support them.” A major step in getting teachers of mathematics to believe that reforms are necessary is to provide this evidence, understand the “tensions” and the different forms that they take when changes are made, and respect their reluctance to accept that chaos is an option.

Technology is frequently perceived as a valuable tool that may even reduce the reliance on traditional mathematics. Steen (1988, p. 612) points out that

Applications, computers, and mathematics form a tightly coupled system yielding results never before possible and ideas never before imagined..... Too often technology is embraced as an unquestioned boon. Its limitations and disadvantages for mathematics instruction, as well as its potential for transforming the curriculum, have yet to be seriously questioned and analysed.

Of course, the technology in question has certainly improved since Steen made this statement in 1988, and Steen acknowledges this in her later work.
Dimmock (2000, p.252) also emphasises the role of computer technology. The “intrusiveness” of this technology is having a huge impact as “traditional notions of teaching and learning are re-configured”. Lerman (1994, p. 41) also expresses that the presence of computers in schools “contributed to the rapid popularity of constructivism in the mathematics education community” believing that this “offered each child the possibility to be a mathematician.” The benefits of computers (listed earlier) indicate the possibilities (visualization, simulations and discovery are a few) to help students understand mathematics, providing them with the opportunity to work independently at a pace that suits them in a learning environment that is favourable to the construction of skills and understanding.

Where students do not acquire skills in mathematics it is often claimed that they (students) will be able to overcome this ‘shortfall’ by the possession of ‘process’ skills. The extensive statement included in Appendix G is a rare, genuine attempt by an author to list process skills for undergraduate mathematics. However Berger (2000, p.61) recognises early in the passage that others have avoided making these skills ‘explicit’ and is obviously not confident that this list is exhaustive emphasising this in his opening paragraph.
Change and the possible new content or approaches to courses in mathematics

Some researchers including D’Ambrosio (1997, p.244) would like to propose some new considerations calling upon teachers of mathematics to work for “the survival of the human species and full dignity for all” believing that the universal aspect of mathematics places it in a position to do this.

Researchers frequently emphasise the power of mathematics to develop reasoning and to lay the foundations for future discoveries. For example, writing in the Bulletin, Bagnall refers to American maths professor Dudley Underwood (2002) writing in the journal of the Mathematics Association of America, who puts it succinctly: "One of the tasks of schools is to do their best to teach students to think, and of all subjects none is better suited. In no other subject is it so clear that reasoning can get results that are right, verifiably right. Mathematics increases the ability to reason, and shows its power, all at the same time."

Guoco (1996, p.375) emphasises that “The mathematics developed in this century will be the basis for the technological and scientific innovations developed in the next one. The thought processes, the ways of looking at things, and the habits of mind used by mathematicians, computer scientists, and scientists will be mirrored in systems that will influence almost every aspect of our daily lives.”

As we have seen there is considerable debate in the ‘Math-wars’ continuing in the United States and spreading to the world stage, concerning what mathematics we should be teaching in the 21st century. While the teaching of mathematics has seen some shift of focus throughout the 20th century, oscillating between its’ pure form (previously labelled Pure Mathematics) and the form in which it contributes to science, economics and engineering (Applied Mathematics), the rapidly increasing efficiency of technology (mainly computers and graphic calculators) means that the
content and approach in the teaching of mathematics needs to be frequently reviewed.

Within this context some contemporary writers have introduced the term ‘Humanistic Mathematics’ perhaps seeking to rename the afore-mentioned ‘Pure Mathematics’

Davis (1990, p.10) (Essays in Humanistic Mathematics) writes,

“To teach mathematics as a humanity means nothing less than to teach that it possesses the awesome power to influence and change our lives, and to teach that we who use and foster it, must subject it to constant study and scrutiny”

Tymoczko (1992, p.11) also discusses the humane attributes of mathematics proclaiming that “Pure mathematics is ultimately humanistic mathematics, one of the humanities, because it is an intellectual discipline with a human perspective and a history that matters.”

While there is often a need to relate all that we teach to some real application, Wales (1993 p. 33) provides a suggestion: The perennial student’s question, “When will we ever use this? is a misguided question, one to which we should not succumb. That is not to say that we should refuse to answer it; but we should deny that the question is determinative of what is important in a person’s study of mathematics. Mathematics is one side of a myriad of important analogies; if we are to understand that side, then we must understand, we must teach and learn mathematics itself. It also means that we should resist, and teach our students to resist, any tendency to neglect those aspects of other sorts of reality that do not fit into those analogies with mathematical
reality that we call applications... We will be richer for knowing what of
mathematical reality does not fit the physical circumstances, and what of physical
reality does not fit the mathematical circumstances, of whatever mathematical
application with which we are dealing.”

Also it is important to remember the frequent, continual contributions made, almost coincidentally as a ‘by-product’ of the traditional study of mathematics.

Middle Schooling in Western Australia

Middle schooling occurs after primary education and prior to the start of the two years in senior school when students are preparing for university, TAFE or work. While ages or school years for middle schools may vary from state to state and even from school to school, many have perceived the period of pre-adolescence to and adolescence from Year 7 to Year 9 to be the years designated for middle schooling. However there would be many implications of changing Year 7 from a primary to a secondary setting, as would need to occur in most Western Australian schools, while a Year 7-10 range could be viewed as close to traditional lower school (United Kingdom) or junior high (United States). In general, with regard to how middle schooling should be organised, theories differ and there have been many interpretations in the research. The age range of students is just one issue that falls into this category.

With middle schooling in the United States having a substantial history, this is one of the most influential sources of ideas in Australia. According to the document for
the Ministerial Committee on *Middle Schooling: Planning for Middle schooling in Western Australia* (1999), middle schooling is regarded as an educational process which involves “the development and behaviour of contemporary adolescents” including their “social, emotional, physical and intellectual needs” and also aims to connect with the provision of “greater choice and diversity” for older students.

There is an underlying belief that, “if the organisation and culture of primary and secondary school are changed for the better so too might the behaviour of students” which tends to embrace Matthew’s view on the hopes of constructivism delivering “us out of the wilderness into the educational Promised Land” (p. 9 this study).

The major question is whether “all or only some of our students” have problems that require different approaches. This report provides examples of problems such as risk behaviour including absenteeism, incidences of violence, alcohol consumption, use of drugs, mental health, alienation and adolescent suicidal behaviour. Literature on middle schooling also places a lot of emphasis on the topics of ‘multiple intelligences’ and ‘identity formation’.

However the committee involved in presenting the report states that it is “not competent to arbitrate disputes among psychologists about the nature of intelligence or its development”, which must surely echo the thoughts of teachers who are suddenly thrust into decisions involving these and other matters which have the potential to create confusion, chaos and tension. Also” while some school-aged adolescents may in fact feel alienated from schooling, most do not” Zubrick, Silburn, Gurrin, Teoh, Shepherd, Carlton and Lawrence (1997).

Carrington (Curriculum Perspectives Vol 24, No 1. p.30) offers a different perspective concerning adolescents in education. There is a distinction between the
targets of the middle school focus in the United States and the targets in Australia. In the US the focus has been on ‘at risk’ groups while all adolescents in Australia are placed “at risk of disengagement and underachievement.” Carrington (2004)

The Curriculum Framework, which “makes explicit the learning outcomes which all Western Australian students should achieve”, (1998) has provided further considerations for the transition from primary to middle school. The consideration given to negative numbers earlier illustrates how these could be introduced as early as primary school but, due to documentation that was open to misinterpretation by teachers, a significant number of students went as far as Senior School without sufficient knowledge of or skills to deal with situations involving negative numbers. The possibility of this type of misconception and the subsequent effects on student preparation would be one of the further considerations for any transition, including that from primary to middle school.

Major concerns, emphasised in the report, for middle schools in the U.S. were that they tend “to isolate themselves” from colleagues in other schools or that practices have been adopted because of “prevalence in the literature” instead of addressing the needs of the school community. Williamson (1998, p.30) proclaims that the “perfect middle school model does not exist” and that the presence of a caring, supportive environment should also extend to high achieving students. This implies that, within U.S. Middle Schools, the needs of capable students have frequently been neglected. There is also a concern (Venville, Wallace, Rennie, Malone (1998) cites Bean (1991)) that traditional subjects have not been accessible to all students and comprise “territorial spaces carved out by academic scholars for their own purposes.”
Schemo (2000) quotes Lee Stiff (President of the National Council of Teachers of Mathematics) stating that it suits the needs of middle schools to employ teachers with general education degrees “since that gives administrators flexibility in assigning teachers to a variety of classrooms” and also has the advantage of reducing the effect of these “territorial spaces”. Also Schemo quotes Carol Stoel (Director of Schools Around the World) who calls for “greater emphasis on serious work at middle school level” observing that, while teachers in middle school are “committed, content matter” requires support within a middle school curriculum that “often looks disjointed, non sequential and trivial because important concepts and skills” have been left out.

Hence some of the major problems that exist in middle schooling in the U.S. come from a failure to attend to the needs of high achieving students due to a reaction of these schools to traditional approaches. This has seen a tendency to place less emphasis on a structured learning environment. The perceived advantages of employing teachers who can fill a wide range of needs within middle schools and an aversion to traditional approaches have resulted in what Stoel regards as a lack of serious work. While this and other available literature warns of these concerns within the United States, it may be expected that Australian middle schools should avoid these same problems.

However, as each middle school is different and a significant amount of the literature (including Williamson) tends to discourage the continuation of a model from one school to another or from one year to another, it would not be surprising if the problems that have frequently occurred in the “substantial history” of middle schooling in the U.S. are duplicated on many occasions within Australian schools.
Mixed-ability classes

The Schools Council Working Group (UK, 1977) defines different methods of grouping students. In the US, the words *tracking* or *laning* are also used, whereas the term *streaming* tends to be used within schools in Western Australia to describe any grouping using ability levels. Definitions of these and other terms are shown in Table 2.3. The advantages and disadvantages of mixed ability groupings are also identified in Table 2.4.

Table 2.3. Types of teaching group. (Schools Working Council)

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streaming</td>
<td>The division of pupils into classes on the basis of general ability and/or attainment, the classes then remaining the same for all subjects.</td>
</tr>
<tr>
<td>Setting</td>
<td>A whole or part of a year group is timetabled as a block; pupils are then divided on the basis of attainment within each subject.</td>
</tr>
<tr>
<td>Banding</td>
<td>A year group is divided into a number of broad streams on the basis of attainment. Wide-ability classes or else classes within which there is assumed to be a similar range of ability can then be formed within each band.</td>
</tr>
<tr>
<td>Mixed-ability grouping</td>
<td>Classes are formed covering the full range, roughly matching that found in the population of the school. Such classes may have the least able pupils removed for some or all of the time. (Since any group of pupils will constitute a ‘mixed-ability group’ a better term might be ‘all-ability group’).</td>
</tr>
</tbody>
</table>
Table 2.4. A list of advantages and disadvantages of mixed ability grouping presented by the Schools Working Council.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social benefits</td>
<td>The difficulty of providing for the less able and very able, in terms of finding suitable work.</td>
</tr>
<tr>
<td>Curriculum development: they had to re-think aims and objectives and introduce new ideas into the classroom.</td>
<td>The difficulty of providing and organising a variety of materials in the classroom.</td>
</tr>
<tr>
<td>Team-work: it had forced them to work together. The resultant team-work and a consistent approach had made it easier to integrate new members of staff.</td>
<td>Problems associated with continuity: how to introduce a topic for the second time.</td>
</tr>
<tr>
<td>Teachers were more aware of individual differences between pupils and the need to cater for these differences.</td>
<td>The problem of finding an efficient allocation of the teacher’s time in the classroom.</td>
</tr>
<tr>
<td>A good working atmosphere was created in the classroom, there were fewer behaviour problems and closer contact was established between teacher and pupil.</td>
<td>The resulting heavy demands made on the teacher both inside and outside the classroom.</td>
</tr>
<tr>
<td>It raised the levels of expectation of both teachers and pupils; pupils lost the sense of defeat or failure sometimes experienced in mathematics and gained a sense of enjoyment.</td>
<td>The exclusion of the teacher from effective interaction with pupils in some schemes.</td>
</tr>
<tr>
<td>There was more variety for the teacher within the class.</td>
<td></td>
</tr>
</tbody>
</table>

Despite the considerable research on mixed ability teaching and streaming in the U.K. during the 70’s, it remains as “one of the most controversial issues in education” Boaler (1997, p.575-595). The Times Education Supplement (2005) discusses Slavin’s analysis (1990) that found there was “no differences in achievement between students taught in mixed ability and setted classes.” Also (Hoffer 1992; Kerckhoff, 1986) refer to Linchevski’s (1995) finding regarding “statistically insignificant increases for students in high sets at the expense of large, statistically significant losses, for students in low sets”. Much of the current
literature coming from this source refers to policies aimed at stealing “the headlines in the right wing press.” The statement, referred to by Clare Dean (1996), and made by Tony Blair that “Equality must not become the enemy of quality.” falls into this category. Richard Pring, professor of educational studies at Oxford University adds “It seems as though there is funny game going on and it is far from where the action is- in schools. The idea that there is monolithic support for mixed-ability teaching is a myth.” Earlier this research briefly discussed change originating externally which creates “more problems than it solves” which also resembles the “funny game” that is going on “far from where the action is.”

Reva Klein (*Times Education Supplement*, March 1995) refers to schools in the Nottingham L.E.A., which were “doing particularly badly with the higher achieving children, those who get on with things quietly and appear to be doing well but not fulfilling their potential.” However the notion of fulfilling one’s potential is a term that is used widely but provides a quantity that is difficult to measure unless we are to be exposed to another collection of subjective issues.

Of course there are emotive statements constantly recurring in this debate about this “most controversial issue”. The statement by Boaler, who refers to Jackson’s study (1964) which includes “the tendency of teachers to under-estimate the potential of working class children, and the likelihood that that low-stream groups would be given less experienced and less qualified teachers” certainly involves a major consideration but may be regarded as only part of the problem for teachers and may distract from other factors. Problems of this sort have been encountered and discussed earlier in this research.

The term ‘working class children’ provides a convenient way of introducing a host of associated factors all of which do not necessarily apply at this time to the group
being considered. Within the scope of this research, absenteeism (truancy) and what is referred to, in recent U.K. publications, as low level disruptions (talking over teachers, ignoring instructions – incidents that erode teachers’ authority and limit student preparation for further studies) tend to occur in less academic groups. These less academic groups should not be considered as being synonymous with working class students.

Within the Nottingham project, there are strategies being developed that may be applied to the teaching of mathematics in the schools being researched and will provide strategies for the future. First the statement that “sets are not made of stone” reflects some of the structures within mathematics faculties that have been adopted to overcome concerns about streaming/setting. Also the organisation of the timetable so that students are placed in sets during the morning for Mathematics and English then regrouped into mixed ability classes after lunch for other subjects for a given purpose. Hence “mixing of methodologies is very much part of the scheme” which provides the environment for “professional judgement” to group students successfully.

**Self-efficacy**

Suitable preparation for senior school provides students with more confidence to make the transition. This confidence is related to self-efficacy which is defined by Bandura (1977, p.71) as the perceptions that individuals have of their potential to perform at levels that “exercise influence over events that affect their lives” with regard to their “cognitive, motivational, affective and selection processes.”

“People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. They set themselves
challenging goals and maintain strong commitment to them”. If they fail to accomplish what they set out to achieve, these people increase their effort or set out to acquire the skills or knowledge to improve. “Such an efficacious outlook produces personal accomplishments, reduces stress and lowers vulnerability to depression.”

On the other hand those who have doubts about, or lack confidence in, their ability to face challenging situations feel threatened because they do not believe they have the strengths to overcome problems that they may be faced with. Bandura observes that “They fall easy victim to stress and depression.”

If students choose to undertake tasks or courses that do not suit them they can encounter “needless failures”, “unnecessary anxiety and self-doubts” and “subsequent debilitating efficacy beliefs.”

Pintrich and Schunk represent the reactions for different levels of self efficacy and outcome expectations in the following table.

Table 2.5. Self efficacy and Outcome expectations (beliefs about the consequences of actions.)

<table>
<thead>
<tr>
<th>High self-efficacy</th>
<th>Low outcome expectation</th>
<th>High outcome expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Social activism</td>
<td>Assured, opportune action</td>
</tr>
<tr>
<td></td>
<td>Protest</td>
<td>High cognitive engagement</td>
</tr>
<tr>
<td></td>
<td>Grievance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milieu change</td>
<td></td>
</tr>
<tr>
<td>Low self-efficacy</td>
<td>Resignation</td>
<td>Self-devaluation</td>
</tr>
<tr>
<td></td>
<td>Apathy</td>
<td>Depression</td>
</tr>
<tr>
<td></td>
<td>Withdrawal</td>
<td></td>
</tr>
</tbody>
</table>
In addition, a series of experimental studies conducted by Schunk (1982, 1983a, 1983b, 1983c, 1983d, 1984, 1987, 1996) showed that efficacy was a significant predictor of learning and achievement, even after prior achievement and cognitive skills were taken into consideration.

Pintrich and Schunk (p.85) state that “the research on expectancy and value beliefs provides a number of implications for teachers” and (p.86) offer “suggestions as a guide for teacher practice”. The following section provides these suggestions along with an explanation of how these suggestions are relevant to the preparation and transition of students from middle school to tertiary-bound courses in senior school.

1. Help students maintain relatively accurate but high expectations and perceptions of competence and help students avoid the illusion of incompetence.

There is an obvious need to balance the “high expectations” and the need to “avoid the illusion of incompetence”. With an emphasis on pastoral care and the “feel-goodness” of radical constructivism/post modernism identified by Matthews, one can understand the tendency of well-intentioned teachers (middle-school or otherwise) to avoid demanding tasks which provide a challenge (or rigour) that may discourage students. Willis’ quote of Howson and Kahane (1986, p.13) that one must counter the belief that “school mathematics should be difficult” may be justification enough to err on the side of caution when providing mathematical challenges.

However…….
2. Students’ perceptions of competence develop, not just from accurate feedback from the teacher, but through actual success on challenging tasks. Keep tasks and assignments at a relatively challenging but reasonable level of difficulty.

Students may readily accept a lesser challenge, perhaps seeking to lighten their workload and yet complain later, following transition to a more rigorous environment, that their background in mathematics is insufficient. The emphasis on self-paced programmes may temporarily provide a way out for teachers but again, if these programmes lack sufficient organisation and do not challenge students, these same students will perceive them as being inadequate preparation. The term ‘Academic Rigour’ has been used previously and this would appear to be an important consideration here.

3. Foster the belief that competence or ability is a changeable, controllable aspect of development.

Students arriving in senior school may not possess the appropriate background for courses that they have selected. However, with the help of resources and strategies, genuine students who persevere frequently attain at a level that may not have believed possible earlier.
4. *Decrease the amount of relative ability information that is publicly available to students.*

Most teachers have long been sensitive to the way that feedback is given to students. The use of nom de plumes or a code, known only to the teacher and individual student, is a strategy employed by some. Individual feedback provided privately to students is another alternative. Authorities have also implemented strategies to avoid labelling students according to their ability. While it would be naïve to expect that these strategies will provide a total solution to the problem, at least the possibility of the teacher as a source of the information can be eliminated. Discouraging students from comparing their own performances will be extremely difficult, if not impossible.

5. *Students’ perceptions of competence are domain specific and are not equivalent to global self-esteem. It is more productive for academic learning to help students develop their self-perceptions of competence rather than their global self-esteem.*

The authors elaborate “Although global self-esteem can be important for general mental health, in the academic domains, it is more important for students’ learning that they have accurate feedback about their performance and begin to develop accurate and positive perceptions of their competence. General self-esteem improvement may not be that helpful, particularly when students can see they can’t do a certain type of math or science problem. In this case, older children will quickly surmise the insincerity of the praise and discount it in terms of their perception of ability to perform the specific task.”
This passage emphasises the need for teachers to value, model and preserve honesty.

6. **Teachers should offer rationales for schoolwork that include discussion of the importance and utility value of the work.**

Relational understanding, discussed previously, helps to establish applications of mathematics in the real world. However it is not always possible, given that “classroom situations force us to think about instructional economies” (Cobb et al) and Wheeler also has raised concerns about the availability of ‘real problems’ which may be helpful for students. However the authors add that the utility can be emphasised by discussing career options that may require mathematics (or other subjects).

7. **Model value and interest in the content of the lesson or unit.**

Students’ motivation will obviously be affected by their perception of the interest and value placed on the subject by the teacher.

8. **Activate personal interest through opportunities for choice and control.**

Pintrich and Schunk emphasis (again) that “Although it can be very difficult, impractical, and probably unnecessary to develop a wholly child-centred curriculum based on students’ individual interests, teachers can provide opportunities for students to exercise some choice and control over their learning.”
Summary

The turn of the century, with technology ‘maturing’ and a realisation that some established methods in education have not been succeeding with a significant proportion of children, has led to a number of new initiatives. Some of these ‘reforms’ have been identified as unwise by researchers including Humes, Anderson, James and Connolly (2000) who question the wisdom of such changes without an effective means of evaluating them. However this has not prevented their implementation.

Some of these changes appear, on the surface, to offer hope for students who may have struggled, and perhaps failed, in previous circumstances. However, there are also concerns about such changes that may improve learning for these students at the expense of the learning of more able students.

With teachers of mathematics seeming to be divided into two distinct camps, it appears to some educators that mathematics, which had previously been given a significant role in selection of students for higher level courses, is no longer taking as dominant a role. While teachers of mathematics experiment with the enormous challenge provided by technology, there are some who believe that the same technology will suddenly make mathematics easily accessible to all (p. 25 this review). If this is the case and technology can provide the anticipated interaction in the future, this technology may even solve some of the problems resulting from the present shortage of specialist teachers.

Researchers into mathematics education debate the need for a ‘humanistic’ element, real applications and the continued alliance of STEM (the relationship between science, technology, engineering and mathematics.).
The tensions that exist within schools are increased as ideas, some from outside, call for changes that have the potential to distract teachers from their “primary task, namely interactions with students”. (Anderson, p.36 this study).

Of course there is nothing new about schools providing a caring environment and building on the confidence of students. A less demanding, non-threatening approach may promote a more compassionate environment. However, students may then not be prepared for a situation in senior school or beyond which involves a focus on high-stakes, external assessment for Tertiary Entrance or a competitive, challenging working environment. Even so the student’s wellbeing is not ignored during these years at senior school as strategies are implemented to address the many concerns that exist during this time. Students should ideally make the transition from Middle to Upper secondary school with a genuine idea of their potential, an opportunity to compete and compare their progress with students of similar ability from other schools.

An approach to a mathematics curriculum that is more flexible and allows students to connect new ideas with their previous experience may not be one that sufficiently prepares students for further studies in mathematics. It is possible that, as a result of recent changes, schools have slowed the delivery of mathematics so that all students can have an opportunity to build their knowledge, but have so slowed the pace for more able students, that they are subsequently disadvantaged in Upper school level mathematics. While most successful students in Upper school examinations have had examination practice for almost five years prior to this examination, this may be something students from Middle Schools will not have experienced. How do students from the new Middle Schools with their emphasis on
flexible, self-paced, negotiated work, and much reduced assessment feel about their
experience in middle schools? Could the desire for a more equitable learning
environment for lower achieving students actually result in a situation whereby
students in some schools are actually further disadvantaged, as well as
disadvantaging more able students?

A number of teachers feel threatened by constant changes and wish to teach within a
more stable and defined environment (p.23 this study). However, many teachers
may accept change more readily if an approach were maintained in which claims did
not “outrun the evidence provided to support them.” Evers and Lakomski (1996.
p.72).
It is one of the main characteristics of any responsible educator to establish ‘best
practice’ or at least an effective model. This study may be seen as contributing
toward an evaluation of one new approach to the teaching of mathematics, namely,
the adequacy of preparation of students (as perceived by them and their teachers) in
Middle school environments for Upper Secondary mathematics. Some of the
questions this study seeks to address are: How do students from Middle schools cope
with the transition compared with those from a traditional Lower secondary school?
Are they confident that they can cope in mathematics? Do they feel that they have
the appropriate background for their course? In their view, have they had access to
appropriate expertise in the subject in middle school? Do they feel that they have
access to that expertise in Upper school?
In the next chapter, the research aims are set out, together with description of the
research design and methodology used to address the aims.
Chapter 3

Methodology

Research aims

The aim of this research was to investigate whether the preparation in mathematics of University bound students has been affected by reforms or strategies in middle schools, such as mixed ability grouping, a flexible or integrated curriculum and utilisation of generalist teachers instead of mathematics specialists.

The summary of the literature review concluded with a number of questions requiring investigation and relevant to the aim of this research. Specific questions included how students coped with the transition, whether they felt confidence in their mathematics background, whether they perceived that appropriate expertise was available to them prior to transition and whether it would be available to them following transition.

The Case and a naturalistic, constructivist inquiry

Students making the transition from middle school to upper school are entitled to make this transition with the confidence that they are at least reasonably prepared for the course ahead. The research in this particular study is underpinned by the belief that this fundamental right is non-negotiable.

Mathematics has been a focus of constructivist research because of its sequential form. While some may choose to ponder over the need for greater understanding within the subject, without background skills on which to construct and relate others
students will not cope, will lose confidence and may ultimately be ‘at risk’ of not achieving their goals. Although this has been a ‘fact of life’ in the past because many students overestimate their own prospects, it would seem that many of the skills previously developed and maintained in a ‘rigorous’ curriculum may be neglected within a flexible curriculum. It is an admirable aim to promote a positive environment in which students feel good about themselves and their futures, but it also would appear morally and educationally wrong to perpetuate a situation in which students’ perceptions do not approximate to their true potential.

**Research Design-Mixed Methods**

A case study approach was taken in which both quantitative and qualitative methodologies were used to examine the possible relationships amongst student competences, self-efficacy, views on current and prior teaching, and teacher views on issues involved in student transition from Middle to a Senior College. The case was comprised of one Upper secondary state school (Senior College), its three major “feeder” Middle schools and a group of students from schools ‘Other’ than the three middle schools with a mathematics as the centre of attention. There were four major groups of stakeholders in the case –

1. the students entering Year 11 (first year of upper school) from the feeder schools;
2. a group of students entering Year 11 from schools ‘Other’ than the local middle schools. (Many of these ‘Other’ schools do not have a Middle school structure.)
3. teachers of mathematics in the feeder schools and
4. teachers of mathematics at the Senior College.

Students entering the Senior College in each of four years (2002-2005) completed the Mathematical Skills Test (see description under section on Instruments and Appendix D) and the Survey (see Appendix C) which included scales on Self-
efficacy and Views on Teaching. These data have been used routinely in the course of the School’s normal evaluation processes to assist in advising students about decisions concerning their courses of study in mathematics. However, for the purposes of the research study reported in this dissertation, only the results from those students who agreed to be participants in the study are reported. Thus the study included samples of students from the whole Year 11 population over a period of four years. This design is represented in Figure 3.1. The major independent variable is the variation in the delivery of mathematics which characterise the four feeder schools. This variation includes the use of mixed ability grouping, an integrated curriculum, an outcomes-based curriculum, and the general absence of specialist teachers of mathematics.

Table 3.1 Research design over the period 2002-2005

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Schools</th>
<th>Teachers</th>
<th>Upper secondary school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A (Middle)</td>
<td>B (Middle)</td>
<td>C (Middle)</td>
</tr>
<tr>
<td>Mathematical Skills Test</td>
<td>Term 1 2002-2005</td>
<td>Term 1 2002-2005</td>
<td>Term 1 2002-2005</td>
</tr>
<tr>
<td>Student survey: Self-efficacy Self-directed learning. Views on teaching</td>
<td>2002</td>
<td>Term 2 N=4</td>
<td>Term 2 N=17</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>N=10</td>
<td>N=13</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>N=11</td>
<td>N=18</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>N=4</td>
<td>N=5</td>
</tr>
</tbody>
</table>

Note: 28 additional students in 2005 consented but previous schools not identified. 6 teachers of mathematics at the Senior College provided comments regarding transition.
Also there will be consideration of ‘Dialogues’ from the National Council of Teachers of Mathematics (U.S.) involving considerations of similar reforms. These Dialogues “provide a forum through which members can be well informed about compelling, complex, timely issues that transcend grade levels in mathematics education.” As middle schooling and its’ substantial history in the U.S.A. has been cited in the report by the Ministerial Committee on Middle Schooling; Planning for Middle schooling in Western Australia (1999) the views of teachers on factors contributing to the preparation of students in mathematics can be considered as relevant to this research.

Combining qualitative and quantitative research approaches is accepted as a powerful way of investigating research questions. In general, quantitative data provides a broad perspective while qualitative data can provide detail and depth. A kind of triangulation is provided that, performed correctly, increases the validity and reliability of the findings Patten (1990). An example of the successful application of this combination is the Kalamazoo model, which is included in Appendix A to demonstrate the joint use of quantitative and qualitative data.

**Instruments**

Within the Senior College, soon after student’s transition, strategies were used as components of action research to gauge the preparedness for, and confidence to confront, the rigorous courses in Year 11 and 12 which would culminate in Tertiary Entrance Examinations during November of the year following transition. These strategies also contributed to the investigation of the research questions.
In order to assess the preparation with regard to confidence and available expertise students were asked to complete a survey at the end of the first term in Year 11. This survey, included in Appendix C, is explained later in this Chapter, analysed using quantitative measures in Chapter 4 and analysed again using qualitative measures in Chapter 5. Hence a mixed mode of study was used throughout this research.

In addition to, and preceding student comments in Chapter 5, is qualitative data obtained from a variety of sources. First, ‘Dialogues’ from Teachers of Mathematics in the U.S.A. are included, providing what can be regarded both as a world view and part of the “substantial history” of middle schooling in the U.S. (Lit. p.35). The ‘Dialogues’ provide valuative views of U.S. teachers on Mixed-ability classes (Lit. p.39 to 42), High Stakes Testing which is relevant to Academic Rigour (Lit. p. 19), highly discipline-based organization of content (Lit. p.20) and greater emphasis on serious work at middle school level (Lit. p.38), and Justifying Mathematics to Students which has been considered throughout the Literature Review. They also reflect opinions of participants involved in this research, establishing that similar concerns have occurred elsewhere.

Then the views of Upper Secondary Teachers during the second and third years of the research have been included. These connect strongly with the tensions (Lit. p.22) that exist, Self Efficacy considerations (Lit. p.44), teacher Dialogues, along with the views of participants in interviews from middle schools and the comments in the survey from students. Consequently there is a continued association, triangulation between the sources of qualitative data as well with quantitative data reinforcing the validity and reliability of the data.
Following this, interviews were conducted with Middle School Teachers. Although prompts were available, and are included in Chapter 5, these teachers were extremely willing to discuss their perceptions of the preparation of students in mathematics without prompts. Their views have been included under the following headings and connections with relevant pages of the Literature Review are given below.

(a) *Mathematics in an integrated or cross curricula environment.*

Relational understanding (relevance and reality) (Lit. p.24)

(b) *The Flexible Curriculum (Curriculum Framework)* and (c) *The aims of Outcome Based Education.*

Outcomes/ Standards based education (Lit. p.15)

(c) *Middle schooling approaches*

Middle Schooling in Western Australia (Lit. p.35)

(d) *Self paced learning.*

Constructivism and student-centred learning (Lit. p.6 to 14), Outcomes/ Standards Based education (Lit. p.15 to 19), ‘Tensions’ (Lit. p.22, 23) and Self-efficacy considerations (Lit. p.44 to 47).

(e) *Pastoral Care.*

Middle Schooling in Western Australia (Lit. 35)

(f) *Rigour*

Constructivism and student-centred learning (Lit. p.6 to 14), Outcomes/ Standards Based education (Lit. p.15 to 19),

(g) *Expectations of mathematics learning, maths time, maths teachers...*  
Change which has the potential to increase ‘tensions’ within schools (p. 29)  
Change and the possible new content or approaches to courses in mathematics.  
(p.33)

(h) *Self Efficacy, Independence and Tensions*

‘Tensions’ (Lit. p.22, 23 ) and Self-efficacy. (Lit. p. 44)
Survey of Year 11’s making the transition from Year 10 to Year 11
(Years 1, 2, 3 and 4 of the study) and corresponding analysis

Between mid and late Term 1 Year 11 students, after they had settled in to their courses but before they had forgotten the contribution of their previous teacher, were asked to complete a survey regarding various factors surrounding their transition from middle school to Year 11. This transition has always been a difficult one even when students remain in the same environment. Students often choose courses to which they are not suited. Some students, who do not possess the background or work ethic required for certain courses, suddenly get the idea that, within two years, they will be able to enter courses in medicine, law or start training to become fighter pilots. Also students appear to develop in various ways during the summer holidays and one of the most apparent developments involves a sudden sense of responsibility towards their own learning that, in many cases, was extremely questionable prior to the transition. However having good intentions are one thing and developing a mature, genuine, organised (rigorous) approach to their study is another. Many of the student comments provide an insight into the ‘good intentions’ that students at times lack the maturity to bring into effect during their year 11 studies.

In addition to these existing problems, a further complication (in some environments) involves transition from middle school, with accompanying philosophies, to senior school where students enter in February of one year and are subjected to high stakes external examinations in November of the following year. Initial investigations indicated that those who have taken up the challenge and selected tertiary bound
(T.E.E. courses) appear to be affected considerably more than students who have
chosen courses that were less academic (non T.E.E.)

The Mathematical Skills Test

In order to identify skills retained by students following transition a multiple choice
skills test was administered during the first week of school following transition from
Year 10 to Year 11. This skills test, presented and analysed in Appendix B, included
37 questions with 5 possible answers from which students were required to select
what they believed to be the correct answer. The test incorporated skills that were part
of traditional courses under previous structures, including the Achievement
Certificate and the Unit Curriculum, modified to include the use of graphic
calculators. The researcher and his colleagues had previously used similar skills tests
for more than ten years. Consideration of relationships, between this skills test and
performances either late in Year 10 or early in Year 11, were always conducted and
found to be significant. Consequently the researcher was confident that this test
would be a useful instrument in diagnosing the preparedness of students for tertiary
bound courses as far as background skills were concerned. Analysis of this
relationship is presented in Chapter 4 for skills tests administered during the years of
this research.

It is reasonable to expect students entering the academic Year 11 courses in
mathematics to demonstrate adequate skills on which they can build. Basic tenets of
constructivism (Literature Review p. 6) emphasise that, without sufficient skills on
which to build, further learning becomes more difficult. During the course of this
research it was noticeable that some topics received reduced attention prior to Year
11 compared with previous years. While the use of negative numbers has been
considered in detail as being a skill that should not be neglected, some topics such as conditions for congruence of triangles have been omitted with good reason. It may be argued that only students entering the most academic courses may require these skills and, in Appendix B (ii), the analysis helps to identify topics that could be omitted for many students entering the courses being considered in this research. Hence, some concepts have restricted applications and can be readily considered at the point of application in Senior School while others serve to empower students mathematically and should be introduced early and maintained throughout middle school.

Nevertheless, using the skills test, it is reasonable to expect all T.E.E. students at transition to be able to demonstrate that they possess at least a third of these skills and those entering more academic courses to achieve more than half.

It is important for the transition process within mathematics, specifically the transition from Year 10 to Year 11, to establish a number of factors. First of all, as discussed above, we need to identify (early) whether students, who have chosen courses which are likely to challenge them, carry with them skills on which to construct the new skills encountered within the chosen course. It would also be desirable to evaluate such qualities as the student’s work ethic and perseverance. However qualities such as these require time within a series of genuine challenges before they can be appraised.

On this basis, since the Senior College was established in 2001, the teacher-developed Mathematical Skills Test, comprising 37 questions, has been used to evaluate the skills performance of students entering courses in mathematics at the College early in Term 1 of every year. Of course a single assessment cannot be expected to predict the future performance of every student. However, in the
absence of other valid instruments which may assess performance levels based on the new Student Outcome Statements, the Mathematical Skills Test has been found to be extremely reliable as a predictor of future performance and useful in helping students make decisions about their mathematics courses. An investigation into this reliability and the results of the Mathematical Skills Test is reported in Chapter 4.

The Student Survey: Self-Efficacy Scale, Self-Directed Scale; Views on Teaching (Current and Prior)

While the skills test may provide some information to gauge the preparedness of students, there are many factors that require consideration. Students’ self efficacy (Lit p.44) was also regarded as being an important consideration. While teachers at the Senior College can contribute to the additional development of students’ skills, the short time spent in Senior School requires that Pintrich and Schunk’s suggestions for teacher practice (Lit p.44 to p.47) are addressed prior to transition.

In order to collect information relating to students’ perceptions of their level of self-efficacy in mathematics, their perceptions of self-directed learning, their appraisal of the adequacy of teaching in Middle school (Years 8 to 10) and currently in senior school (Year 11), students were asked to respond to a researcher-developed survey. The survey consisted (mainly) of statements with associated 6-point rating scales, and a space in which students could comment and elaborate on their responses to each of the statements. The full Survey with its four sub-scales is presented in Appendix C. The survey was completed first by Year 12 students (in Year 1 of the study) to check for ambiguous statements and other problems, and minor modifications were made on the basis of student responses at this time. In addition,
other teachers of mathematics at the College were asked for their views regarding the statements and whether there were additional statements that needed to be added to the survey to investigate the opinions of students about their preparation for transition to Upper secondary school. In this instrument all statements can be classified as favourable and clearly promote desirable outcomes. Students, who are suitably prepared for the transition from middle school to upper secondary schooling, would be expected to demonstrate a high level of ability to cope with mathematics studies using a self-efficacy scale. In particular, amongst other characteristics included in the survey, it would be expected that they:-

Be confident that they can succeed in these courses. (Q.2), perceive that they are competent to cope with their mathematics studies (Q.4) and perceive studies in mathematics to be relevant to them (Q.17; 2005 survey only).

**Self-Directed Learner Scale**

It would be expected that students take responsibility for their studies and for their success in those studies. Hence, they are expected to attribute success to themselves rather than to their teachers. Thus students should be able to apply themselves in a manner that promotes success (Q.5), be prepared to do what is necessary to succeed in their chosen courses. (Q.1) and understand that, no matter what other conditions have been met, acceptance of responsibility and development of independence is vital for their future prospects (Q.10)
Views on Teaching (Current and Prior)

Lastly, ideally, students should perceive that the teaching in Middle school and in the Upper secondary school was at a competent level. Thus they should view teaching in their present mathematics course as expert (Q.6) and able to help (Q.9), and perceive that their background in mathematics was appropriate (Q.3) and their previous teachers had contributed to this background. (Q.7).

In 2005, additional questions to assess further elements of self-efficacy were included in that scale. These were “I have always liked mathematics” (Q.11), “My interest in mathematics is increasing” (Q.12), “I do not believe that mathematics is important” (Q.13), “I am losing interest in mathematics” (Q.16), “I do not think that mathematics is relevant for my future” (Q.17), “I feel confident about my ability in mathematics” (Q.19) and “Mathematics has never been one of my favourite subjects” (Q.20)

For all four years of the study, questions 8. (I work in the library during my free time) 14. (My parents believe that mathematics is important) and 18. (My confidence in my mathematics ability increases when I have a mathematics teacher who teaches the subject well) were omitted from the analysis as they are not part of any of the four sub-scales and thus not relevant to the present study (see Cronbach’s alpha Appendix D for the analysis).
The Teacher views

1. The opinions of teachers of mathematics from the Upper secondary school were sought as to how their students had progressed during the first semester and how they have coped with the transition. Some indications regarding a perceived comparison with previous years were also sought.

2. The views of teachers from middle schools on issues relating to the transition of students from Year 10 to Year 11 from all schools involved in the case study were sought through individual interviews using a semi-structured interview that initially asked the participants to comment on the research question, with the optional use of more focussed probe questions.

Procedures

Early in the first term of Year 11, students were asked to complete the Mathematics Skills Test. They were informed that the results would assist staff to advise them on the best courses of mathematics to study and provide a baseline to monitor progress through their Year 11 studies.

At about the beginning of Term 2, once students settled into their courses and had some understanding of the expectations of these courses, they were asked to complete the Student Survey described earlier and included in Appendix C. In order to reduce the amount of time students would need to spend on responding to questions, and because research indicates that responses may be more reliable and valid if the number of questions is not great (Jaeger 1990, p.310), efficient administration of the survey was a prime consideration. The researcher was himself a
teacher at the Senior College so teachers administered the survey to minimise the possibility that students would respond according to how they considered the researcher might wish. Students were asked to circle the appropriate response that applied to them and to add comments where they felt the need to do so. They were also encouraged to ask a teacher to clarify anything that they were unsure about in responding to the Survey. As has already been discussed, apart from the few absentees on the day that the survey was administered, the entire target population of the case study completed the Survey. However, only those students who completed and returned a form consenting to allow their responses to be part of the study’s data (and who also confirmed that their responses were an accurate reflection of their opinions at the time) were included in the final case study.

In the original survey (for the first three years of this study) there are only ten statements and students were asked to respond using a six-point Likert scale of Strongly agree (6), Agree (5), Slightly agree (4), Slightly disagree (3), Disagree (2) and Strongly disagree (1). Two statements differed from the rest because a five-point Likert scale was considered to be more appropriate. For 2005 ten additional statements were added and these included only a four-point Likert scale.

There are a number of limitations associated with these scales. Firstly, they are clearly part of a school-based survey which is routinely used every year to identify the needs of students upon transition between differing environments. They were not, therefore, primarily developed as research instruments. Thus they are limited in the aspects which they could cover and the number of questions which they could contain. Nevertheless, they are regarded as useful for the purposes of this study as they address major concepts in Self-efficacy and Self-directed learning.
Ethical Issues

Again, as the survey was routinely administered to all students as part of school-based research, in the years 2002-2004 permission to use the data was sought from students after rather than before they had completed the Survey. To accomplish this, letters (including a copy of each student’s completed survey) were posted to all students who had participated during 2002, 2003 and 2004, seeking permission to use the data. If parents or students experienced any discomfort they could withhold their permission. The return rate for these three years was satisfactory, given the lapse of time since the survey was administered. In the cases where the permission forms were not returned, it was considered most likely that the reason for this would resemble that for any mailed survey or questionnaire rather than be due to a decision to withdraw because of a feeling of discomfort. The representativeness of the data from those who gave permission, compared with the entire population of students is examined in the first results chapter in the section addressing the validity and reliability of the data. In 2005, consent from students and their parents was gained before the Survey was administered to all students, and only data from the survey from students who consented to participate are reported in this study.

In the following two chapters, the results pertaining to different sets of data are presented, firstly for the student Skills and Survey (quantitative) data (Chapter 4) and, secondly, for the qualitative data, including teacher interviews and student comments (Chapter 5).
Data Analysis

The quantitative measures, which are conducted in Chapter 4, have used the skills test and survey ratings to establish relationships demonstrating the reliability through repeated relationships during the four years of the study. Specifically the reliability of items included in the survey were investigated using Cronbach’s Alpha included in Appendix D.

Anovas demonstrating the relationship between the combination of the year that the student had made the transition and the school from which the student came, and self efficacy and prior teaching contribute to the validity of the survey as a research instrument. Multiple regressions illustrating the effect of student’s perception of prior teaching, independence and skills in mathematics on self efficacy, and the effect of this self efficacy and skills on their mathematics mark during year 11 are also considered and also contribute to the validity of the survey.

As the validity and reliability of the survey are demonstrated quantitatively, qualitative considerations from the survey are also supported by this validity.

In Chapter 5 the qualitative aspects of the survey are considered. This was possible as, following the Kalamazoo model referred to earlier, space was left for the student to comment after each statement. Comments from students who gave permission for their data to be included has been considered and included at the end of Chapter 5.
Chapter 4

Results – Skills Test and Student Survey (Quantitative Data)

In this chapter, the quantitative data available from the Skills Test and from the Self-efficacy and View of teaching scales are first examined with respect to their validity and reliability, and then statistical analyses pertaining to each of them are presented. As there is the potential for a reduced emphasis on ‘rigour’ within areas such as testing, assessment and homework in middle schools there is a need to establish some measure of the skills that students entering T.E.E. courses have retained after making the transition from Year 10 to Year 11. Non-T.E.E. bound students and courses do not have the pressure of T.E.E. courses where students are required to prepare for an external examination in November of the year following transition into Upper School. For many of these (T.E.E) students, the first examination that they experience occurs at the end of the first semester in Year 11. Some middle schools have decided to avoid the regular testing that has existed in mathematics courses in the past and have accepted the demonstration of outcomes using other, less formal measures. Some of these measures, under the general heading of ‘professional judgement’, lack the credibility of formal tests because of the subjective aspect of observations. Also the practice of assessing specific outcomes by looking over the student’s shoulder in class and concluding that the outcome has been demonstrated is questionable for two major reasons:-

1. One cannot be sure in most situations that the work is that of an individual student and not a compilation of work from others close to the student

2. The student needs to demonstrate that (s)he has retained sufficient skills so that they may contribute to the mathematical development of the individual.
Of course, traditionally, tests have sought to ensure that both of these conditions have been met. Some teachers may justifiably argue that less formal measures can be blended with tests to obtain an overall picture of the student. However there are concerns about the credibility of achievement when regular, reliable checks are not part of the structure.

**The Skills Test**

The skills test consisting of 37 questions on topics from middle school mathematics has been used for about 20 years by the researcher and his colleagues with more able Year 10’s or with Year 11’s entering T.E.E. courses. Of course there have been modifications to this test due to calculator and course changes. At all times the linear relationship between the skills test, Year 10 and Senior School performance was tested and has been found to be significant.

This test was given to T.E.E. classes in 2002, 2003, 2004 and 2005. During 2003, 2004 and 2005 the test was also given to non-T.E.E. classes in order to identify students who may be capable enough in mathematics to attempt a T.E.E. subject. Some students have moved from the Mathematics in Practice (non T.E.E.) to Foundations of Mathematics (T.E.E.) on the strength of their performance in this skills test. In most cases this move has resulted in sound performances in Foundations (Year 11) and later in Discrete Mathematics (Year 12) depending on the perseverance of the student. Also, for many of these students, the mathematics course was their only T.E.E. course. This has the potential to empower these students mathematically (in a way that non-T.E.E. courses in mathematics have failed to do) to the extent that they have acquired skills that are appreciated in the work force and
for further training, especially in fields such as Information and Computer Technology.

Although the skills test has been a reliable predictor, it must be emphasised that the background skills must be complemented by attributes such as perseverance and work ethic which cannot be readily assessed upon transition.

Some middle school recommendations for courses in mathematics differ significantly from the potential demonstrated in the skills test. Once again, it is unwise to place such importance on one test. However, in some cases, the results from the skills test are significantly more reliable than the recommendation for mathematics from Middle Schools.

In some environments, it may be extremely difficult to provide students of mathematics with the same opportunity as those in schools where students enter Year 11 with a broader skills base, reliably checked through frequent credible tests and examinations. While tests and examinations attract criticism and some of the literature on Outcomes Based Education suggests that ‘professional judgement’ should be used, there are concerns whether certain forms of teacher judgement are effective. The test has been the most convenient and reliable means of confirming that the student has retained skills in mathematics. There are always students who, when asked whether they are focusing on their work, respond by showing the teacher that their work is complete, even correct. However, when checked to see if the skills have been retained, the student frequently fails to reach similar standards either because the skills have mysteriously vanished for reasons perhaps associated with inadequate active participation or belonged to somebody else in the first place for
reasons connected with ineffective participation in group learning. Consequently there are skills and work habits that need to be addressed prior to entry into T.E.E. courses.

Worldwide concerns exist about reforms and their benefit to the disadvantaged students. There is also ‘a certain naïveté’ in overlooking such opinions as these in the hope that middle school initiatives will provide a mathematical equity without the appropriate rigour provided by teachers who are able deliver these skills and ensure that they acquired.
The Monitoring Standards in Education instrument (in Algebra, Number and Measurement) was used with Year 10 students in late 2004 (Year 11 2005) in an attempt to predict students’ potential in T.E.E. courses. The table and graph alongside show a correlation between M.S.E. tests and actual Semester 1 performance in mathematics to be 0.499 (significant at the 0.01 level).

The Skills Test and Semester 1 mathematics performance had a correlation of 0.559 (also significant at the 0.01 level). Similar correlations, significant at the 0.01 level, between the Skills Test and Mathematics Performance occurred for 2002 (0.624, N=96), 2003 (0.650, N=108) and 2004 (0.623, N=152).
Figure 4.3

Correlations Semester 1 Mathematics Mark against Skills Test Year 1 of study.

<table>
<thead>
<tr>
<th>Correlations</th>
<th>SKILLS</th>
<th>YRMARK02</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKILLS</td>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>108</td>
</tr>
<tr>
<td>YRMARK02</td>
<td>Pearson Correlation</td>
<td>.586**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>108</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations Semester 1 Mathematics Mark against Skills Test Year 2 of study.

<table>
<thead>
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<th>YMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKILLS</td>
<td>Pearson Correlation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>126</td>
</tr>
<tr>
<td>YMARK</td>
<td>Pearson Correlation</td>
<td>.612**</td>
</tr>
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<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>126</td>
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</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations Semester 1 Mathematics Mark against Skills Test Year 3 of study.

<table>
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<th>MARK04</th>
</tr>
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<tbody>
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</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>152</td>
</tr>
<tr>
<td>MARK04</td>
<td>Pearson Correlation</td>
<td>.623**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>152</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
The correlation coefficients 0.586, 0.612, 0.623 and 0.559 from 2002 to 2005 (Year 1 to 4 of this research) demonstrate that the skills test is a reliable predictor for student performance following transition. The Monitoring Standards in Education test for 2005 returned a correlation coefficient of 0.499.

**The Student Survey.**

The items constituting dependent variables for all four scales (Self Efficacy, Current Teaching, Prior Teaching and elements of Self Directed Regulation) are given on the next page along with the items from the survey that contribute to each of these scales.

An analysis of the reliability of these variables, using Cronbach’s alpha, was conducted and are presented in Appendix D.
Self-efficacy- Total score

This includes

- Competence
- Confidence
- Interest
- Relevance (importance)
- Coping Well.

Items used

2. (In general I am confident that I can succeed in the courses that I have chosen.)
4. (I am coping very well with my Mathematics.)
11. (I have always liked mathematics.)
12. (My interest in mathematics is increasing.)
19. (I feel confident in my ability in mathematics.)
and 13. (I do not believe mathematics is important.) Reversed
16. (I am losing interest in mathematics.) Reversed
17. (I do not think that mathematics is relevant for my future.) Reversed
20. (Mathematics has never been one of my favourite subjects.) Reversed

Student’s Perspective on Current Teaching.

Items

6. My current Mathematics teacher knows and teaches the subject extremely well.
9. My Mathematics teacher is doing everything possible to help me succeed.

Student’s Perspective on Prior Teaching.

Items

3. My background in mathematics was suitable for my chosen Year 11 course.
7. My Year Ten Mathematics teacher knew and taught the subject extremely well.

Elements of Self-Directed Regulation (Control over learning, independence)

Items omitted (Using Cronbach’s Alpha)

8. I work in the library during my free time.
14. My parents believe that mathematics is important
18. My confidence in my mathematics ability increases when I have a mathematics teacher who teaches the subject well.

The items 8, 14 and 18 were eliminated using Reliability Analysis (See Appendix D)

The same analysis justified the retention of the remaining seventeen items.
Reliability Analysis

Cronbach’s Alpha (see Appendix D)

This analysis was first run on all 20 responses. “Scale’ and ‘Scale if item deleted’ were selected in order to identify which of the 20 original items would need to be omitted to increase the overall reliability. (see Appendix D –Alpha 1)

Removing items 13, 16, 17 and 20 would have the greatest effect. However, this was because they were ‘negatively worded’.

“I do not believe mathematics is important.”

“I am losing interest in mathematics.”

“I do not think that mathematics is relevant for my future.”

“Mathematics has never been one of my favourite subjects.”

The values were reversed for these items and a new set of results were obtained. This made the selection of items for exclusion more obvious. Item 8 (I work in the library during my free time), item 14 and item 18 were removed as they did not discriminate.

An additional item (SUR 15 My success in mathematics depends on my mathematics teacher.) would be the next omission. Removal of this item would increase the Alpha to 0.8143 and the Standardized Item Alpha to 0.8392.

Proceeding with elimination and removing Item 10 (which was included to emphasise the importance of independence in maturing students) has little effect on the Alpha.

However a decision was made to retain the 17 Survey items included in the final reliability analysis (including SUR 15). Further consideration, including qualitative analysis with student comments, will consider SUR 10 and SUR 15 response to be not as significant as other responses and there will not be an emphasis on Sur 10 and
Sur 15. (Note: further exclusions beyond the removal of SUR 10 and SUR 15, using this method, do not improve the Alpha).

Nevertheless, recommendations for future research (school based or otherwise) may include an investigation of possible reasons for lack of discrimination for SUR 10 and SUR 15. It is possible that the inclusion in the survey of “I realise that, no matter how much my teacher helps me, it is my own determined and consistent effort that is important for me to achieve success” may have had an influence on student responses to “My success in mathematics depends on my mathematics teacher.”

Using the Self Efficacy, Students’ Perspective on Current Teaching, Students’ Perspective on Prior Teaching and Elements of Self Directed Regulation scales as discussed above, this data was further tested using

1. Graphs to investigate patterns of results within these scales across the four years of this research.
2. A one way between groups ANOVA with post-hoc comparisons in order to determine any differences for Years and Schools within the scales.
3. A two way between groups ANOVA. This will determine whether an interaction of a particular school and year is significant.
4. Multiple regression in order to determine the best prediction model for (dependent variables) Self Efficacy and Year 11 Semester 1 mathematics performance. Students’ perspective on prior teaching, current teaching, skills test performance and Elements of Self-Directed Regulation (Control over learning, independence) will be considered as independent (or explanatory) variables in both cases.
5. In order to further examine relationships amongst the variables, the correlations between self-efficacy items, skills, current teaching, prior teaching and self-directed items will be considered. These analyses have been included in Appendix E.

Analysis of individual items over four years

1. The graphs in Appendix F illustrate patterns, repeated over the four years of this study that, not only demonstrate the validity of the data from the survey, but provide ideas for further investigation.

![Figure 4.4](image)

Column graph example demonstrating preferred patterns in column graphs for survey questions.

The pattern shown in the graph above is preferred as students are placed on the left of this graph which tends to indicate that they perceive that they are working to capacity. (The graph is said to be skewed to the right.)

Most of the graphs have similar patterns but, apart from the items omitted using Cronbach’s Alpha, the graphs that display a pattern requiring further investigation are those for ‘My background in mathematics was suitable for my
chosen Year 11 course’ and ‘My Year Ten Mathematics teacher knew and taught the subject well’.

While all graphs are included in Appendix F, some with comments, the most relevant to this research are the contrasts in patterns for the following graphs.

![Graph 6](image1.png)

**Figure 4.5 Column graph comparison to determine differences.**

![Graph 7](image2.png)

**Figure 4.6 Column graph comparison to determine differences.**

The pattern, present in Figure 4.5 Graph 6, is one that teachers would prefer because most students agree that their current mathematics teacher knows and teaches the subject well. (Of course there are a small number that disagree and individual teachers may choose to consider this further.)

However there is an undesirable pattern that exists in the graph for My Year 10 mathematics teacher knew and taught the subject well (Figure 4.5, Graph 7). Also
there are additional features that present within this graph including the amount of students who strongly disagree during 2004 and particular attention will be paid to the student comments which may provide an insight into the reason for this rise.

2. A one way between groups ANOVA with post-hoc comparisons. This will determine any differences between Years and Schools within the scales.

The following table was obtained which indicates a significant difference in Prior teaching between schools A, B, C and O. Other scales were not significantly affected. The Post Hoc (Scheffe) test conducted and shown on the next page indicates that Students’ Perceptions of Prior Teaching at school 3 (C) was significantly different from schools 1 and 2 (A and B)

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
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<th>F</th>
<th>Sig.</th>
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<td></td>
<td>Within Groups</td>
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<td>2.707</td>
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<td></td>
<td>Total</td>
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<tr>
<td>PTTOT</td>
<td>Between Groups</td>
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<td>3</td>
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<td>SQTOT</td>
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<td>3</td>
<td>14.639</td>
<td>4.178</td>
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<td></td>
<td>Within Groups</td>
<td>564.129</td>
<td>161</td>
<td>3.504</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>608.045</td>
<td>164</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.6 ANOVA F statistics and p values for all scales examining differences between schools and years**

79
The mean difference is significant at the .05 level.*. The same test, conducted using ‘Year’ as a factor indicated no significant difference for any of these variables.
As a consequence of the significant mean differences, the ratings of students were further investigated and the table on the next page was obtained. This table presents the means and standard deviations for student ratings in the survey.

The most observable variations (confirmed by population data) existed during 2004 for schools B and C. Further research indicates that school C provided a modified Year 10 mathematics program to prepare students who had indicated an interest in pursuing T.E.E. courses in Year 11 (comments were made by students regarding this extra facility in the survey and are considered in Chapter 5). Also school B provided students with choices related to the completion of work sheets in a self-paced environment during 2003. Participants in interviews and student comments (considered later) indicate that this type of student choice may not be reliable and may result in students working below the standard of which they are capable. Within this table the differences, described above, present the most significant factors for research amongst qualitative data in Chapter 5.

In the first three years of the research Self-efficacy for students at ‘other’ schools was also rated higher. In the final year of the research, following adjustments within middle schools, student ratings from the three middle schools compared favourably with ‘other’ schools.
Table 4.8 Distribution of Means and Standard Deviations (Schools and Years)

<table>
<thead>
<tr>
<th>Year</th>
<th>School</th>
<th>Self Efficacy</th>
<th>Current Teaching</th>
<th>Prior teaching</th>
<th>Self Directed Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
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<tr>
<td></td>
<td></td>
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<td>0.7</td>
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</tbody>
</table>

Figure 4.8 Distribution of Means and Standard Deviations (Schools and Years)
3. (A Two Way between Groups ANOVA suggests that the interaction ‘Year and School’ provide significant differences but the effect is less significant than ‘School’ considered alone)

**Figure 4.9.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>57.749&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11</td>
<td>5.250</td>
<td>1.859</td>
<td>.049</td>
</tr>
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<td>Intercept</td>
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<td>1</td>
<td>4287.402</td>
<td>1518.400</td>
<td>.000</td>
</tr>
<tr>
<td>YEAR</td>
<td>24.153</td>
<td>3</td>
<td>8.051</td>
<td>2.851</td>
<td>.039</td>
</tr>
<tr>
<td>SCHOOL</td>
<td>47.240</td>
<td>3</td>
<td>15.747</td>
<td>5.577</td>
<td>.001</td>
</tr>
<tr>
<td>YEAR * SCHOOL</td>
<td>34.114</td>
<td>5</td>
<td>6.823</td>
<td>2.416</td>
<td>.039</td>
</tr>
<tr>
<td>Error</td>
<td>432.016</td>
<td>153</td>
<td>2.824</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>12994.280</td>
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<td></td>
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<tr>
<td>Corrected Total</td>
<td>489.765</td>
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</tr>
</tbody>
</table>

<sup>a</sup> R Squared = .118 (Adjusted R Squared = .054)

**Prior Teaching**

<table>
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<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
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<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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</thead>
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<tr>
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<td>4057.018</td>
<td>682.154</td>
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<tr>
<td>YEAR</td>
<td>22.707</td>
<td>3</td>
<td>7.569</td>
<td>1.273</td>
<td>.286</td>
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<tr>
<td>SCHOOL</td>
<td>118.778</td>
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<td>39.593</td>
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<td>.000</td>
</tr>
<tr>
<td>YEAR * SCHOOL</td>
<td>84.561</td>
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<td>16.912</td>
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<td>.017</td>
</tr>
<tr>
<td>Error</td>
<td>909.946</td>
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<td>5.947</td>
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<tr>
<td>Total</td>
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<tr>
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</tr>
</tbody>
</table>

<sup>a</sup> R Squared = .225 (Adjusted R Squared = .169)
Relationships amongst variables

Pearson (below) Correlation Coefficients were obtained for relevant items. There are many significant relationships. The most prominent are School and Year (0.368), Skills Test and Sem 1 result (0.683), Skills Test and Self efficacy (0.387), Skills Test and Prior Teaching (0.267), Self Efficacy and Sem 1 Result (0.443), Prior Teaching and Self Efficacy (0.393), Self Efficacy and Self Directed Learning (0.488), Current Teacher and Self Efficacy (0.416), Current Teaching and Self Directed Learning (0.441), Prior Teaching and School (0.235), Prior Teaching and Self Directed Learning (0.242).

Figure 4.10.

<table>
<thead>
<tr>
<th>Correlations</th>
<th>YEAR</th>
<th>SCHOOL</th>
<th>SKTEST</th>
<th>MATMARK</th>
<th>SETOT</th>
<th>CTTOT</th>
<th>PTTOT</th>
<th>SDTOT</th>
</tr>
</thead>
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<tr>
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<td>.368**</td>
<td>-.165</td>
<td>-.125</td>
<td>.029</td>
<td>-.131</td>
<td>.142*</td>
<td>-.087</td>
</tr>
<tr>
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<td>.000</td>
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<td>.169</td>
<td>.686</td>
<td>.069</td>
<td>.049</td>
<td>.227</td>
<td></td>
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<tr>
<td>N</td>
<td>193</td>
<td>165</td>
<td>122</td>
<td>122</td>
<td>193</td>
<td>193</td>
<td>193</td>
<td></td>
</tr>
<tr>
<td>SCHOOL Pearson Correlation</td>
<td>.368**</td>
<td>1</td>
<td>.170</td>
<td>-.012</td>
<td>-.129</td>
<td>-.039</td>
<td>.235*</td>
<td>-.054</td>
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<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.061</td>
<td>.894</td>
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<td>.620</td>
<td>.002</td>
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<td>SKTEST Pearson Correlation</td>
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<td>-.170</td>
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<td>.683**</td>
<td>.387**</td>
<td>.207*</td>
<td>.267**</td>
<td>.119</td>
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<tr>
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<td>.061</td>
<td>.000</td>
<td>.000</td>
<td>.022</td>
<td>.003</td>
<td>.192</td>
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<td>122</td>
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<td>122</td>
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<td>.443**</td>
<td>.247**</td>
<td>.142</td>
<td>.141</td>
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<td>Sig. (2-tailed)</td>
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<td>.000</td>
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<td>.387**</td>
<td>.443**</td>
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<td>.416**</td>
<td>.393**</td>
<td>.488**</td>
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<tr>
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<td>.126</td>
<td>.441*</td>
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<td>122</td>
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<td>193</td>
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<td>PTTOT Pearson Correlation</td>
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<td>.267**</td>
<td>.142</td>
<td>.393**</td>
<td>.126</td>
<td>1</td>
<td>.242*</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td>.002</td>
<td>.003</td>
<td>.119</td>
<td>.081</td>
<td>.001</td>
<td>.001</td>
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<td>122</td>
<td>193</td>
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<td>193</td>
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<td>SDTOT Pearson Correlation</td>
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<td>.119</td>
<td>.141</td>
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<td>.242*</td>
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<td>122</td>
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</table>

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).
Multiple regressions

The following equations have been considered for the data.

Self Efficacy = \( \alpha \times \text{Prior Teaching} + \beta \times \text{Current Teaching} + \gamma \times \text{Skills} + \delta \times \text{Self directed} + \text{Independence} \)

Semester 1 Result

= \( \alpha \times \text{Prior Teacher} + \beta \times \text{Current Teacher} + \gamma \times \text{Skills} + \delta \times \text{Self directed} + \epsilon \times \text{Self Efficacy} + \text{Independence} \)

The following table was obtained for Self Efficacy

**Figure 4.11. Multiple Regression: Self-efficacy**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig</th>
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</thead>
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<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>1.319</td>
<td>1.317</td>
<td>1.001</td>
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<td>.077</td>
<td>.920</td>
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<td>PTTOT</td>
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<td>.205</td>
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</table>

a. Dependent Variable: SETOT

Using Standardized Coefficients from the table, the following equation is obtained

Self Efficacy = 0.205 \times \text{Prior Teaching} + 0.077 \times \text{Current Teaching} + 0.284 \times \text{Skills} + 0.277 \times \text{Self directed} + \text{Independence}

The following table was also obtained for Semester 1 Results.

**Figure 4.11 Multiple Regression. Mathematics Mark**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
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<th>Sig</th>
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<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
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<td>(Constant)</td>
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<td>.998</td>
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<td>SETOT</td>
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<td>.695</td>
<td>.235</td>
<td>3.016</td>
</tr>
</tbody>
</table>

a. Dependent Variable: MATMARK
\textit{Semester 1 Result}
\[ = -0.085 \times \text{Prior Teaching} + 0.071 \times \text{Current Teaching} + 0.601 \times \text{Skills} \\
-0.021 \times \text{Self directed / Independence} + 0.235 \times \text{Self Efficacy} \]

As the Prior Teaching, Current Teaching and Self Directed coefficients are not significant the equation can be simplified to
\[ \text{Semester 1 Result} = 0.601 \times \text{Skills} + 0.235 \times \text{Self Efficacy} \]

While it is anticipated that the Current Teaching component will gain in significance later in Year 11, it is the effect of preparation on transition (specifically the skills and self efficacy) that is under consideration here.
Chapter 5

Results – Student and teacher perceptions

In addition to the sources of ‘valuative’ views of external practitioners and tertiary bound students, input was also sought from practitioners within the mathematical community (network) closely connected with these students prior to or following their transition.

Teachers of mathematics at the Senior College were asked for their opinions regarding the background preparation of students prior to transition. It must be stated that these teachers of mathematics did not have unrealistic expectations of students. These teachers have taught and obtained good results at some of the more challenging schools in the state, averaging twenty years experience in the classroom. They understood the problems that students faced in and out of school at this time of their lives; they have seen many students make this transition before. Their obvious frustration over the performance and effort of students entering Year 11 was a result of a shift in emphasis in middle school philosophies where preparation for upper school in mathematics had not been given a priority.

Teachers of mathematics who were closely connected with Schools A, B, C and ‘Other schools’ during the years of this study were interviewed primarily in the form of a taped, unstructured, open interview. Clearly the delivery of mathematics needed to be considered in perspective to the overall aims of these schools.

The chapter purports to provide a balanced view of issues surrounding the preparation of students in mathematics against the overall priorities of middle schools.
Dialogues from the National Council of Teachers of Mathematics, U.S.A

The Mathematics Education Dialogues (http://www.nctm.org/dialogues) was published by the National Council of Teachers of Mathematics, U.S.A. (1998 to 2001) to “provide a forum through which members can be well informed about compelling, complex, timely issues that transcend grade levels in mathematics education.” While the quotes from this source may have been included earlier in the literature review, they represent a ‘world view’ of some of the issues that students and teachers in the local system have faced during the last four years and hence are relevant to this research.

(November 1998)

“Is tracking (the separation of students by performance or perceived ability) advantageous for mathematics instruction?”

86% of the respondents favoured ‘tracking” for mathematics instruction. Interesting responses were:-

“Oh, come on - of course tracking is advantageous for instruction. It’s just not advantageous to the students in lower classes”

Eileen Kott, High School Teacher, Montana.

“By not tracking, the students at opposite ends of the class are not served properly. It is extremely difficult to teach three classes in one.”

Claude Henry, Middle School Teacher, West Virginia.

“Students get frustrated when the pace is too fast or bored when it’s too slow. I could better help all my students if they were tracked.”

Julie Knapp, High School Teacher, Ohio.
“How do you justify mathematics to your students?”

Interesting responses here were

“I don’t, except with future teachers. If you try to convince people that mathematics is important, they start wondering if it really is. I just assume it is and act accordingly”. Judy Roitman, University Professor, Kansas.

“Citing examples of when a particular strand of math is used seems to be enough at the elementary school level. When asked, students can often cite more examples than I can.” Jan Deaner, Elementary School Teacher, West Virginia.

“I often tell my students that mathematics unlocks the secrets of the universe. Most of them think I am joking, but a few seem to understand that I am quite serious.” Brent Bradberry, University Professor, Idaho.

“I don’t. The fact that they are in my class is justification enough. I communicate that math is important by my investment in teaching it and by my expectations that they will learn it”. Nancy Biasini, Secondary School Teacher, Arizona.

“Should high-stakes tests drive mathematics curriculum and instruction?”

“High-stakes testing will only tell us what we could figure out if we really wanted to know: that poorer districts can’t compete for current funding and that parental involvement is paramount to success.” Todd Clauer. Hyde School, Bath, Maine.

“If we are truly interested in measuring the success (or failure) of our mathematics instruction, we must test. However, we must ensure that the measurement instrument (the test) appropriately defines the scope of mathematics.” Jean Parker, Middle School Teacher, Boise, Idaho.
Teacher comments

Upper secondary teacher views

Comments made by teachers as part of a Mathematics Faculty Report on the transition of students from lower secondary to the Senior College are given below (each individual teacher comment, for 2003 and 2004, is given a separate paragraph):

2003.

“There are some talented students in the class. In previous years these would have made the transition to Upper School comfortably. Their background from Year 10 is varied but it is the general work ethic that has caused problems.”

“The (top mathematics) class was given a problem solving assignment which they had a week to complete. They knew that the item was worth 8% of the semesters’ marks, were instructed to begin straight away and not leave it until the ‘last minute’. In a demonstration of an immature approach towards (representing inexperience of) such assessment items a number of these students failed to heed advice. When questioned, student comments were: “I didn’t seek help from tutors”, “I left things to the last minute”, “I did not consolidate my work at home as I should have done”, “I did not prepare myself for it and left it too late”, “I did not start it when given to me. I left it all to one night and thought I would be able to do it.” “I could have approached the assignment better by ways of better preparation and organisation – by more study and starting it earlier.”
“It is all too easy to blame others for problems perceived in our own classrooms. It appears to be more a problem of the structure we are part of. For years it has been in a teacher’s best interest to promote T.E.E. participation at a high level. The focus has changed, but upper school has not. Nor should it, but what we are asking kids to do now is unfair. We need to have a stake in the mathematics of our students before they get to us because we are wearing the consequences. We need to be more involved with the middle schools but the middle schools need to first structure their classes and timetable to provide the background necessary for these courses.”

“Most students were surprised by the amount of workload in this course. They don’t have the commitment, work ethics and the background. I am still struggling to teach most of them even in my free period but results are not good. During tests, most of them are unprepared or not even turning up (but they are at school). Assessment results are unsatisfactory, only about 10 are passing. They were advised to see tutors in the library, some did but most of them didn’t. On the more positive side, there are those who told me they did not do anything last year or learn last year, but now they learn a lot. Some who struggled at the start are now beginning to get good marks because they work hard, are prepared to seek help and respond positively to advice. The time frame to do the course is also a worry for me. I struggle to teach and complete the whole course.”

“I have prepared and explained more for this group of students than I have ever done before and still their work ethic and results are pathetic. I originally thought
that approximately five students were suitable for the course but now I believe that only three students are coping.”

“More planning and preparation has been invested into this year’s cohort. However, I’m only receiving ‘half as much for twice of what I’m putting in’. This is extremely frustrating! Students were not adequately prepared at the start of the year, in terms of background knowledge and work ethic. They have come a long way but they are not reaching the expected standard. Given more time, many students would be successful in this course, but at the current pace, I’d say that only 9 out of 22 students are suitable for this course.”

2004

“Students are pleasant in nature but unprepared in terms of work ethic and pre-requisite knowledge. They needed to be taught how to study and organise their time. Inadequate preparation in Year 10 led to a very high drop out rate in this course.”

“I regard this class as ‘frustration plus’, they had very little of the prior knowledge required to complete the course successfully. With students’ lack of knowledge and reluctance to put in the work, there was a very high drop out rate. Students were very much under-prepared by middle schools”.

“Student background was inadequate, worse than in 2002 and 2003. Student application, in the main, was inadequate for the course and they were reluctant to do any ‘extra’ (to keep up). Work standards were below expectation and students were
not prepared to accept advice to improve. Some late entry of students into second semester was undesirable.”

“Apart from four, students were very weak, stopped trying and could not cope with examinations. They don’t have good study habits and, despite tutoring, results were extremely poor.”

“I am extremely disappointed with the number of students who dropped out. ‘Foundations’ is not that hard! While in some cases students had little hope, many failed to rise to the challenge”.

Middle (and ‘other’) school teacher views

Each of the participants was issued with the dissertation title (below) and asked to talk about their opinions of factors surrounding this topic.

**Student and teacher perceptions of preparation in mathematics in middle school and its impact on students’ self-efficacy and performance in an upper secondary school in Western Australia.**

Initially the series of prompts (below) were considered to be sufficient for the study. However additional factors, also considered in the literature review, were raised in the interviews and were pursued. Consequently the ‘rigour’ associated with the study of mathematics and other concerns associated with ‘the teaching and learning of mathematics’ have been included as participants addressed these topics in the interviews.
Prompts/ indicative questions.

(a) Where middle schools have provided an integrated curriculum please give your perception of the contribution made by this to the preparation of students for T.E.E. courses.

(b) What is your perception of the effects of the flexible curriculum on the preparation of students for the subject which you teach? How does this compare with the preparation of students prior to the introduction of the flexible curriculum?

(c) What you perceive to be the aims of outcome based education?

(d) How has the implementation of outcome based education contributed to the background of students arriving at the college? Omitted (Senior College staff not interviewed, judgements have been included in previous section)

(e) Have you detected any improvement in process skills or understanding for students entering the college? (If the content is less students should have gained in process skills.)

(f) In general can you list any perceived benefits or disadvantages to students of some of the initiatives associated with middle schooling. (These may involve the focus on pastoral care, self paced learning...).

(a) Mathematics in an integrated or cross curricula environment

Participant A was concerned about the credibility of courses delivered in cross curricula situations, preferring to promote the acquisition of skills in mathematics that can be used in a variety of situations later.
“I think that there is a concern when the responsibility for the integrity for the learning area goes into a cross curricula team where you don’t have an expert present. If you only taught mathematics in a cross curricula environment, there would be far too many gaps because there aren’t enough scenarios in the cross-curricular environment for essential skills to be taught and some of the essential skills can’t be taught in context. You have to take them out of the context, you have to do some didactic teaching, you’ve got to do skills development, you’ve got to do consolidation, then you might be able to put it back into a contextual situation and say, given that you now possess these skills, how can they be related to this particular situation which is what we tend to do when we look at higher order applications of mathematics. I think there are very poor attempts made at dealing with mathematics in a cross curricula sense and claiming that you’ve done justice to the curriculum”. (Participant A)

Participant B also believed that ‘subject specific’ skills should be emphasised and is clearly anxious that students be given the opportunity to work in classes where they are with others of similar ability.

“It depends how you use the integrated time. Last year we did ‘learning to learn strategies’ which was useful but still needs to be tightened up, more subject specific, (For example “You would do this in maths to help you do this in science.”) This year, after my prompting, we are using the integrated learning time to work on their maths skills. We’ve also called this ‘catering to the individual’s needs’ but really it’s streamed maths classes. I’ve got the kids to do a survey; it seems so far that they feel that this (arrangement) is more useful.” (Participant B)
So there are three hours of maths per week plus an extra hour which seems to be vastly different from earlier years of middle school when the integrated time actually came from maths lessons. There seems to be a realisation that students were disadvantaged in the time allocated to maths.

“We actually have a two hour block set aside for integrated work, how we use that is up to the team.” (Participant B)

Participant C also perceives advantages in focusing on skills in mathematics prior to transition to Senior School and also makes a case for streaming at this stage.

(Note: As previously stated on p.39, frequently when the word ‘streaming’ is used in Western Australia teachers tend to mean ‘setting’. i.e. A whole or part of a year group is timetabled as a block; pupils are then divided on the basis of attainment within each subject.)

“Our middle school talked about this, kids did cross-curriculum projects in which they did a bit of measurement or statistics. It’s O.K. for Year 8 or 9 but in Year 10 it’s not possible with harder content. I was never a big fan of that. Concepts of cross-curriculum is fine, practice of it is difficult. There’s a need for Year 10’s to do things according to their skill levels, especially in Semester 2, not just because they are going to the Senior College, but because the competition they get with students at a similar mathematical level has great benefits.” (Participant C)

Participant D had no experience in the middle school environment but has seen, and is concerned about, students with inadequate skills in mathematics, unable to cope with courses in Upper School.
The idea of integrated or cross curricula learning is certainly welcomed by teachers of mathematics where these relationships can be made effectively and efficiently. However participants appear to be concerned about the erosion of the time that should be spent teaching basic skills in mathematics,

(b) The Flexible Curriculum (Curriculum Framework)

This research is concerned with the possible disadvantages experienced by students during a time that the organisation of some middle schools did not regard the acquisition of skills in mathematics as a priority. Participant A acknowledges this. There was uncertainty and students, especially those who needed to establish a strong background and work ethic because they had aspirations to study mathematics at a high level, were not served in this environment.

“I think the biggest issue that faces Upper Secondary teachers at the moment is the change to an Outcomes Based Education where, in getting used to or working out what was important to teach kids to achieve outcomes in the outcomes and standards framework (Curriculum Framework), there was some uncertainty in what needed to be taught, what was important. Because that was the case, there was a mismatch between what was happening in middle school in Year 8, 9 and 10 and what was expected in Years 11 and 12 in which there was a completely different way of making judgements about student performance, a different way of assessing and kids moving from one particular way of going about the curriculum and assessment process to one which was completely foreign in some respects. The idea of having continuous assessment, no exams, less emphasis on tests (I think that tended to be the case in middle schools) would have been detrimental to those kids who were going
into Year 11 and 12 because they weren’t faced with the same rigours and the same requirements of the upper school education policy in terms of assessment. I think there’s an opportunity to be absolutely certain for those kids that we know have the ability to go on to those courses, that we give them the opportunity of working quicker, of working towards achievement of outcomes that build their understanding and provide pre requisite learning for those courses”.

The shortage of specialist teachers in mathematics and the lesser likelihood that schools, without appropriate attention to skills in mathematics, would attract (or retain) specialist teachers of mathematics has the potential to limit the achievement of students at these schools.

“Maybe it’s also got to do with the fact that we are bereft of maths teachers as well, particularly maths teachers who have a good understanding of the breadth of knowledge that kids require from Year 8 through to Year 12. If you haven’t had the opportunity of exposure to the courses in Year 11 and 12 then you are not in a position to understand what is important for kids and what pre requisite learning is important for them to have success in the more difficult courses in Year 11 and 12. I also believe that we needed to broaden the base at the lower end and give kids better access and success in mathematics because we learnt a lot about what kids could do at certain stages of intellectual development. For instance if you go back to the Unit Curriculum and you had the Algebra strand in Units 3.4, 4.4, 5.4, 6.4 it was only the very able kids who got through those units and obtained an A or a B. Very few kids that I ever taught managed to get through and complete those courses successfully but we had an expectation that a whole class would get through. We had to run classes full of kids. I reckon we could have taught concepts in 5.4 and 6.4 (say) to a
smaller group of kids in a shorter period of time if we didn’t have to drag the rest of
them along. The reality is that, if we could slow that process of teaching down and
introduce some concepts a bit later to the string of kids going to Foundations (then
Discrete) they would be better prepared. Instead we dragged them through and they
got C’s and D’s. The reason they got C’s and D’s was probably because they failed
most of the algebra and made up for this in other areas such as number. (Participant
A)

Teachers, who were extremely comfortable with the previous structure, were
suddenly thrown into a situation with which they were not familiar and they could
see that it would take considerable time to get used to the new structure. During this
time many students were making the transition without suitable preparation. This
new system did not, at least initially, involve the (spiral) approaches present in the
Unit Curriculum in which students would return to topics repeatedly, consolidating
previous skills and developing more complex concepts.

“Teachers in the middle schools were saying this is level 5 and those at the Senior
College were saying that they are not the skills that traditional Year 11 students have
had and we need to adapt to that. I think that originally there was a lot of ‘to and
fro’ (between the Senior College and Middle Schools) saying this is not happening
and that is not happening. It shouldn’t be surprising that it’s not happening because
we’ve got a new system in years 8, 9 and 10. We talked about negative numbers; we
talked about subtracting positive and negative numbers in a very broad sense. They
should be able to do -2-(-3). We may have discussed it in terms of a contextual
question; we may have done some simple ones involving temperatures. With student
outcome statements, sometimes you spend so much time deciding what levels you
think they are. The spiral approach that the Unit Curriculum had in which you kept coming back again and again, making things progressively harder was missing. It was up to the (middle school) teachers to design this and that was difficult. Although, say with fractions at level 3 you understand what a unit fraction is and by level 5 you can subtract fractions. That sort of process was fine for the big concepts but things like ratios, scale and negative numbers tended not to occur in statements at the lower levels and perhaps all of a sudden they appeared and, if you weren’t careful, you would find that they didn’t know anything about these things and they need to work with these concepts at a different level without taking six months to go through it. I guess they (the outcomes) weren’t user friendly, I still don’t think they are. I think good middle school teachers are using part outcomes and part experience. With year 10’s, I used to use relevant parts of the 5.4, 6.4 and, to a lesser extent 5.3 and 6.3 from the Unit Curriculum because I knew these were traditionally appropriate if students go onto T.E.E. (Foundations of Maths, Intro Calculus, G/T etc). So I split up the different strands and, by the end I was making up stuff that I knew they needed to know for the last half of year 10, trying to hone in on the transition stage. I was thinking in terms of what they needed for next year as opposed to the outcomes from the outcome statements of the Curriculum Framework.

While experienced teachers of mathematics were able to cope, inexperienced teachers struggled. Teachers at the Senior College observed the results of these problems in the early stages and, according to one of the participants in interviews, developed an inherent distrust of what was going on in middle schools. The literature on middle schools indicates that this is commonplace with a curriculum that “often looks disjointed, non sequential and trivial because important concepts and skills” have been omitted. (Schema quotes Stoel).
“The problem is that you have two systems trying to match up. They are not made to match up and the output of a year 10 is not necessarily the input of a Year 11 T.E.E. course. What middle schools are trying to achieve is not necessarily the same as what they are trying to achieve in a tertiary bound course so all these issues of transition, as important as they are, it’s understandable that they come up and they’ll continue to come up”. (Participant C)

Meanwhile students in most ‘other’ schools continued to receive the rigour (regular testing and a common, prescribed curriculum) that existed prior to the implementation of middle school approaches and were provided with a more suitable background with which to enter Year 11.

(c) The aims of Outcome Based Education

Teachers interviewed believed that the outcomes in the Curriculum Framework were worthwhile and they (the outcomes) also encouraged teachers to think about what they are going to teach. However teachers at middle schools felt the need to make certain that students learn what is necessary before moving on but, at the same time, the question needed to be asked about the amount of time they should spend ensuring students learn these concepts.

“It’s a different way of indicating what’s important. I think, in the past we used to say the curriculum was determined by what we were going to teach. Now outcomes say what we want as a result of the teaching/learning process-this is what we want kids to know, understand and do. This means we’re going to have to think about our teaching, what are we going to teach? How are we going to teach it, what sort of structures are going to be in place, what’s the classroom going to look like, what
materials do we have, what experiences do we give in order for kids to achieve the outcomes. So, when you look at the outcomes, you can’t argue that they’re not worthwhile outcomes, we can see everything that we know that is good about education in there. In terms of outcomes based education we needed to know what to do, what experiences we are going to provide, where to get the ‘stuff’ from to do this, where’s the teacher resources and materials that I used to have before in a textbook or whatever that allows me to get the kids where I want them to go. Before we were told that in Term 1 we’re going to do Unit 3.3 for example and in term 2 (...and so on). It wouldn’t matter whether we got there or not, we did it, we changed and we moved on. I think there’s now a greater emphasis on making certain that we know the kids are learning and then moving on but, at the same time we have to ask “ How long do we flog a dead horse, when do we change?”. There isn’t the same prescription anymore to say that now’s the time for a change regardless of where the kids are at. You have to make those decisions for yourself about when we change the learning, whether we change the topic or whether we do algebra at the same time as number etc. In the past those decisions were made for us because there was a specific syllabus. Now all we have is that at the end of this learning process we want kids to be able to do these things, you have to give them the experiences, you provide them with the structure and you provide the direction in order to get there. That’s where teachers are lost. The Department has made a big mistake in not looking at the inputs in order to achieve the outcomes and the inputs have become more and more important as this whole process of outcomes has rolled out. In order to achieve the outcomes you’ve got to have some good inputs, what are they? I think that’s what a few people have been trying to do to make this thing be a bit more sensible”.

(Participant A)
Most of the background to reforms is based on the need for every student to ‘understand’ before being moved on to another topic. Hence there is an obvious reluctance to specify how much time should be spent. This is a decision left up to teachers. Nevertheless classroom economies and the need to avoid tensions, including the potential boredom created by remaining on the same topic for too long, still dictate the need to move on.

Teachers indicate that there was insufficient support regarding the inputs needed to achieve the outcomes and the participants in interviews confess to struggling with this task. They also add that they spent too much time assessing the outcomes and very little time taking part in worthwhile teaching. The system suddenly appeared to move from no accountability at all to, what one teacher referred to as ‘nit picking’.

“I honestly don’t know, I struggle with this system, I really do. The outcomes themselves I guess are OK. I find that I’m spending too much time trying to tick certain boxes, too much time assessing and very little time doing good teaching. Then we’ve got the ‘Making Consistent Judgements’ stuff. They pick apart the words, it seems ridiculous. I don’t think that it needs to be that ‘nit-picky’, all the elaboration and the pointers. We appeared to go from no accountability to the other extreme. Science is different; we teach something in a way that we choose using the pointers. I was amazed that, instead of focusing on good teaching, even experienced maths teachers at the meetings are focusing on assessment, getting wound up in this little word, (getting sidetracked by the wordiness in the document, rather than concentrating on the skills students need). So it’s the actual levelling that is the problem, unless they (students) show all of the aspects in the strand, students don’t get the level”. (Participant B)
To another teacher, outcomes based education was regarded as involvement in action learning and allowed evaluation that was more individual while previous assessment involving grading was viewed as being limited and not very friendly. One problem is that there does not appear to be much movement over three years. In general, students take some time to move up a level.

“I guess it’s the involvement in action learning. You do something; you have a look what happens. Then you come back and think about what you did. You create some learning opportunities for them, go through them, have some sort of assessment and stand back and ask “How did it go?” More on an individual basis, when you’re setting up a learning task you can find out who can do it and who can’t, even before the start you have to have some idea of where the student is starting from. Outcomes were more individual for me and I was responsible for what they could and couldn’t do. Saying someone was a ‘C’ student didn’t have any meaning. (Within outcomes, we can be more specific in this regard.) Grading was very limited and not very friendly on an individual basis. If you tell me that someone is a ‘C’ student, I’ve got an idea of what they’re like but I don’t know what they can and cannot do whereas outcomes ideally do that, a student should be able to consistently do something if they have achieved the outcome. If you have students coming into your class, you would like to know that. The only problem is there’s not much movement over three years, generally three levels (level 3 to level 6).” (Participant C)

However, another perceives it as providing an artificial structure which has been created so that no one fails and the academic rigour vanishes.

“Everyone completes the program, no one fails, mediocrity reigns.”
(For those who have come from middle schools) this has been detrimental in terms of preparation for mathematics and these students tend to suffer in comparison with our students.” (Participant D)

(d) Middle schooling approaches

One participant in the interviews believed that, previously, the majority of kids couldn’t do some of the stuff we were expecting them to do. However the difficulty that exists now is how to cater for the varying ranges that exist in secondary school. Teachers of mathematics are not “masters of the craft” of working with mixed ability groups and don’t organise group work well. It may be that mathematics does not lend itself effectively to mixed ability and grouped situations.

I think the course writers, people who have looked at the capacity of kids at various stages of development, realised that the majority of kids couldn’t do some of the stuff we were expecting them to do. The difficulty for teachers is “How the hell do you cope with and cater for the varying ranges that we’ve got in any secondary school (not District High because there you have very small numbers and you’re having to cater for a far broader range) but you’ve probably got up to 3 levels in any one class (even if you stream). How is it that we are able to cater for the needs of the more able kids and what sort of things should you be putting in front of them”

I think, as secondary teachers, we’re not masters of the craft of working with mixed ability groups, we don’t do group work well, we don’t know how to manage that very well, there’s a lot of learning to be done there. It’s interesting that I’ve been looking for a long time at the debate that rages about mixed ability classes,
heterogeneous, homogeneous, streaming and all that sort of stuff. I’ve dug up some research on it over the last couple of years, there’s not a lot around. Recent stuff from the UK makes interesting reading.....

The research helps you accept maybe that there is a case for not streaming but it’s not a black and white argument. The most recent research indicated that more able students are not likely to do worse in a mixed ability class but less able students are most likely to do better. More kids are likely to do better when they are in a heterogeneous situation.

The beauty of an Outcomes Based Education, from my perspective, is that it does allow us to have a common course basically for everybody but, for some kids we only get this far and for others we can go further. The difficulty though is that we have to make those decisions for ourselves and, if we were teaching the Unit Curriculum, it would be more or less prescribed that this group of kids were going to do the maths development units and this group would do the maths for living, and we make those decisions relatively early in a kid’s education in middle school. Now we’ve got far greater responsibility as teachers to make those decisions for ourselves and that’s not an easy thing to do. I think that’s a very difficult thing to do and it’s also difficult because, certainly for people who are our vintage, who have come through the achievement certificate, unit curriculum and always had a sense that, when we had kids streamed, it made us concentrate on a certain aspect of something to deliver. It’s very difficult to work out how you actually structure a classroom to deliver more than one lot of information to a single group of kids. The other aspect is that under the old model, we boxed kids, we compartmentalised them relatively early and it was difficult to break out of that compartment. I think there is an opportunity to, maybe not have kids move as quickly as they can initially but, for those kids that are capable, to accelerate when they are ready. I would also contend that, if we have
kids going into Geometry and Trigonometry and we haven’t done very much specific teaching in Year 10 on solution of trig equations, you could probably teach what needed to be taught to a kid of that calibre in year 11 and not have them disadvantaged.” (Participant A)

Another teacher has a different opinion regarding mixed ability classes

“From my experience it’s a shame, not so much that it’s middle school, it’s that we’re not allowed to stream, the school is very, very anti streaming even in Year 10. The reason it happened last year was because we had to be secretive about streaming.

We called it ‘catering to the individual’ but really it amounted to streaming. I think those kids were really thankful that it was done because they would not be prepared without it. I’ve taught in Senior School so I know the kids were capable last year. When I got them at the beginning of year 10 they hadn’t even heard of Pythagoras, I was quite appalled when I arrived.

If a student hasn’t had some introduction to algebra in year 8 and year 9 it’s not surprising when it becomes an insurmountable hurdle in year 10 for most kids. Some of the kids in Year 8 are capable of doing Year 10 algebra and are fine with it, yet in the same class there are those who cannot do simple multiplication. I feel I’m not doing anyone any favours, not really helping either of these because of the lack of streaming. It really gets to me. For maths, mixed ability groups do not make sense. I’d rather have them in similar ability groups where you can discuss the same subject with the group because they are all doing the same. They can relate and have the opportunity to contribute to the subject”. (Participant B)

Another participant is willing to accept mixed ability grouping-up to a point….
“There are issues there as well. Middle schools are not streamed, common ability classes. I didn’t have a problem with that until Year 10. In the second half of Year 10 we put them into, not common ability classes, but groups where we could prepare them for reasonable entry level into Year 11 courses”. (Participant C)

In mixed ability classes, with self paced learning, the extra value of the specialist teacher appears to be significantly reduced. (It’s almost as if a more level playing field is ensured if the classes lucky enough to have a specialist teacher are not allowed to use this to their advantage. Having a class where lower ability students ‘hold back’ the more able, either by low level disruptions or ineffective conditions for content delivery, would seem to be the most common means of achieving equity again by removing a significant amount of academic rigour.

“In mathematics ‘No’ If I had 8 classes I would have 8 levels, the most disadvantaged groups are at the top and the bottom. It doesn’t make sense from a mathematical point of view to have a wide range of abilities in the same class; it does not make sense at all!” (Participant D)

(e) Self paced learning

If kids are only going to do what they choose, they will never improve because they are not being taught anything effectively and not being challenged. It’s understandable that, given a choice, many students will only do the stuff that they can already do. When a self-paced approach is used, some of the more capable students either choose to be lazy or do not take up the challenge because they get the feeling that, on their natural ability alone, they stay well ahead of the less able students in the class so they are less motivated and do not push themselves.
“The idea of saying ‘let kids choose’ is an easy way out for teachers, we’ve got to help them make the right choices and we’ve actually got to do some teaching too. To say we’re not going to do any teaching and kids are only going to do what they choose to do, they will never learn to improve because they are not being taught anything effectively and not being challenged. We need to find ways of motivating kids to want to learn, to understand etc. There’s a de-emphasis in teaching specific skills, teaching concepts and doing consolidation exercises, having kids only do stuff that’s presented to them in a worksheet or booklet is saying that “You’re level 3 at the moment, have a go at this stuff and you’re a level 4. It’s understandable that, given a choice, students will only do the stuff that they can already do. How were they going to do the stuff they couldn’t do without having some intervention by the teacher, some specific teaching, without being didactic in some way and I think because the classroom nowadays is seen as being far more complex and kids are moving at different rates, teachers don’t know how to cope with that. How do you cope in a classroom where there’s a range of ability levels”. (Participant A)

“As far as mathematics goes the program, instigated in 2003, requires us to do worksheets. It doesn’t work. In the year 10’s last year, the classic thing was they’d choose a level 3 worksheet (below their own level) and they would do it for weeks on end. They’d say “Get off my back, I’m working” but you know they’ve done the same sheet a number of times before. You can’t convince them to do a level 4 worksheet, so none of these were making any progress”. (Participant B)

In the student survey, students have commented that they were given the same sheet on a number of occasions but many actually chose the sheets for themselves. They
could have extended themselves in a self paced environment with these worksheets but many had chosen not to do this. Clearly this causes ‘tensions’. Streamed classes would make this more efficient, some may suggest that the competitive nature is unhealthy but “even with less able classes, if you tailor the course to suit the kids, the competition is still there. One of my students commented “You know Miss, no one really fails anymore but, when I asked how he’d feel if he obtained a level 2 for something, he realised that this would amount to a failure for him. Kids are very astute. We, as teachers seem to be keeping things from kids yet they compare their work with others naturally without our involvement. They’re not fooled by the system at all. It doesn’t make them feel good when they get a level 2. The first thing they do when you give things back is that they compare, you have to allow ten minutes while they check with others. There’s some naivety in thinking that a different approach will stop this. Good pastoral care involves being a good maths teacher as well. I have good rapport with the kids but it’s different from other systems.

The (less able) seem to get the most out of self-paced approach, the middle and higher either choose to be lazy or do not take up the challenge. It’s always been a big jump between Year 10 and Year 11, now it’s much worse, the jump they must make on the way to T.E.E. A lot of the kids who went to the Senior College this year probably have the ability but there was too much for them to catch up on in Year 10, I ran out of time. I was screaming through what they needed, perhaps they lost confidence. If they had normal classes in mathematics, as it was taught before, they would have felt really confident, there would be work that they recognised from before and this would improve their chances of survival in their Year 11 courses.

(Participant B)
Some teachers report greater success in the use of packages compiled for use by
students in mixed ability situations.

“Self paced packages were put together and teachers used these in different ways.
Some teachers who weren’t maths trained picked sheets at random, copied them and
gave them to the class. The teachers who were using it properly had a system in
place (perhaps some measure of rigour) in which students were expected to do so
much per week, there were consequences for them if they didn’t do the work. The
worksheets got progressively harder as they worked through a topic, much the same
as working out of a book (except it wasn’t a book that covered a lot of different
topics). Some teachers didn’t use it very well and if students don’t want to work there
are ways of them avoiding it. I know in my class it was all in black and white on a
board, if they hadn’t done anything it was really obvious. I contacted parents if a
student didn’t do it. It comes down to the teacher. If we surveyed students here we
could get comments coming from students, on how they relate to teachers and how
they see the work. They see some teachers as opening a book, take away the book
(the starting and end points) then even very experienced teachers would find
themselves well above their heads in water. If you’re trying to match up student
education, there is no one resource that you can use.” (Participant C)

(f) Pastoral care

The structures within middle schools were perceived to be advantageous to students,
providing smaller groups with which students moved through the school. While the
creation of middle schools automatically provided a smaller community (School B
went from a population of 1400 to one of approximately 500), the construction of learning groups formed even smaller entities. Students undoubtedly benefitted but participants in the interviews perceived a whole variety of problems for teachers, problems exacerbated by change and by society’s expectations.

“If you have a look at the structures in the middle schools (A, B and C) the idea of having schools within a school (sub schools) where kids have an identity, there is only a relatively small group, less than two hundred, in some cases not much more than one hundred, a group of teachers who were dedicated to their learning, an administrator and secretary attached to them, that’s usually advantageous and it’s absolutely fantastic for kids. What was important as well, and this was recognised early at two of the middle schools, the expertise in terms of the teaching of Maths, English, S.O.S.E. and Science needed to be retained in that team, a person who could do the job and knew that learning area well, I think that was important. Great for kids, there wouldn’t be a teacher around in middle school who wouldn’t say that, by the time those kids had got to Year 10, they hadn’t seen a huge change because the relationship that was developed in the main with all the teachers were absolutely fantastic. In terms of the way they responded to teachers, their connection with the school and the people at the school was very strong by the end of Year 10. For teachers, however, it was a stressful journey, it really was! The reality at the moment in middle school is that year 8 is a terrible year, a very difficult year. As a maths teacher you might be teaching every single year 8 and there’s no reprieve in terms of what they’re teaching, no big scope there, you can’t get away. The only hope you’ve got is to survive until you get to Year 10 because then it’s relatively plain sailing. So for kids it’s absolutely fantastic but for teachers really, really difficult and I think we’re seeing the result of that now. A large number have burnt out and wanted to move on, and find an opportunity where they can have a bit of a break, or wishing
they could take some year 8’s, some year 9’s and some year 10’s. So you’ve got these pools, the idea of the pastoral care, the growth, the development of relationships providing great opportunity for kids in that area but at the same time you’ve got this negative impact on teachers and their stress levels. Of course, at the end of Year 10, the teacher says “That was a good year that was fantastic!” But, guess what happens next year, we start all over again. That’s where it becomes pretty tough for teachers. Also if the teacher was a poor teacher of maths or any other subject, the group of kids could be stuck with that teacher for three years without the benefit of suitable expertise. There is the potential that a single teacher, working through with a group of kids for three years could have a significant impact (positive or negative). Somebody may be ‘dragged off the street’ (and that can be the case at the moment) we don’t know where they come from. They get in survival mode for three years and guess what comes out at the end, a product that you really question.

Teaching is becoming more and more difficult, the profession is not necessarily highly regarded, conditions are becoming eroded, it’s a lot tougher than it used to be, we’re lumped with a lot of society’s ills with an expectation that we’re there to solve those as much as we are to teach kids. The results of that are the associated stresses that go with the job, there’s not as much good will as there used to be, and because there’s not as much good will, relationships are probably not as strong as they used to be. We don’t have large amounts of people volunteering to do extra things for kids anymore and that’s really quite sad. The job has become very difficult and the expectations have grown and grown- the constant demands on teachers to keep up with change. Let’s face it we are in a rapidly changing world, the technology is making sure that change ticks along at a fairly healthy rate. Society is a lot different from what it used to be, far more questioning, we don’t have a compliant group of kids that we might have had in the past, we have family breakdowns, we
have a whole pile of things that happen certainly in public schools. It’s probably far worse for some learning areas because we don’t have the quality; quality is an issue all over the place. We’re also getting older; I think the average age of secondary teachers is close to 49, we’re getting tired. People see the erosion in standards and discipline. You can’t get away with the fact that, as a teacher you’re meeting out the discipline, but the kids’ll come right back at you”. (Participant A)

Other teachers also have high expectations of outcomes for students.

“Certainly pastoral care stands out, the fact that I have the kids for 3 years and they remain together. I expect the kids will tend to treat each other better”. (Participant B)

Teachers with expertise emphasise that, due to other pressures, it was difficult to get into classes to support inexperienced teachers and to make sure that students were getting opportunities at the level they needed. To a certain extent initially the whole thing could be described as “hit and miss”. Although there were tests, the idea of a whole class test, in which each student was focused on the same material, no longer existed. It was conceivable that most students in the class were doing different things at different times so traditional testing was not possible. Under ‘hit and miss’ conditions such as this it may be that the credibility of tests may be jeopardised.

Feedback from the Senior College on the performance of students who had moved there and discussions with staff from the Senior College emphasised that the needs of tertiary bound (T.E.E.) students were not being met.
The middle schooling process was really different, we had team situations so we had the same student/year group rotating through the classroom all year so coming to terms with that was a challenge. My first year I was just with Year 8, so the idea of transition and preparation for U.S. wasn’t as much on my mind as it was 2 years afterwards with Year 10’s but, being in a leadership position, I was interested in seeing how the year 10’s were prepared, the first year we didn’t have Year 10’s so it was the second year before a full book of Year 10’s came through. I think it was more difficult as a teacher in charge in a middle school keeping track of exactly what each teacher was doing in terms of preparation of students. You didn’t share a common staff room, you were in cross-learning teams so you spent more time with learning areas other than mathematics so we had a hour long meeting once a fortnight where we discussed issues such as transition and we looked at cross marking so you had to rely a fair bit on the professionalism and the knowledge of the subject of the teacher you were working with and, being in the position that the region was in 3 years ago (even now), the experience was at the Senior College, so it wasn’t wise to rely on the teacher’s knowledge and the fact that they know how to prepare their students for Year 11 and 12 with a good grasp of what needed to be developed for the courses. It was difficult to get into classes to make sure that students were getting opportunities at the level they needed and also in the initial stages we were trying cross-curricular, trying different learning strategies (Piaget’s thinking hats etc…). We tried all those methods of developing students’ thinking as opposed to strictly a content based subject nature which we traditionally followed. I think quickly we sort of turned it around. We had the second year of Year 10’s coming in, we had some feedback from the Senior College on how students were performing, discussions with staff from the Senior College in network and informal meetings, talking about your requirements and what we had. Then there were only
20% of our kids at the time doing T.E.E. courses so we had 80% of the students we were dealing with who had no intention of going to University. We had to come up with some way of dealing with those students in the system, given that they were in the minority, perhaps an important minority but still a minority.

I think it was hit and miss to be honest. The teachers who knew the Upper school courses and were keen on developing students as far as they could go, their students were fairly well prepared. We only had hour long lessons. We did tests but the idea of a whole class test was probably gone because of the idea of developing students at their own pace so it was conceivable that most students in the class were doing different things at different times, so the stuff you need for tests didn’t quite work.

Also, with the introduction of the Curriculum Framework, there was the thinking that buying single books and giving everybody in the class the same book didn’t do any justice to the students. Teachers didn’t have a clear pathway from a starting point to an end point without having the book there, turning the pages and going on to the next chapter. We struggled in terms of where to go to next. We developed a lot of work sheets and tried to get software packages to alleviate the problem but it depended on how comfortable the teacher was at using them or on how much they did so one of the main regrets was not being more prescriptive with other teachers in terms of what they should be doing in the classroom. I left it up to their professionalism to make sure they had a good content base happening in the maths classroom whereas in some cases there wasn’t. I think in the old days it was easier for teachers to use the unit curriculum books, they knew that they were doing a particular unit so they gave the book out, they had a nice program which they followed from start to finish so it was easier for the students to go through them. The problem with that is everyone has to start in the same place and finish in the same place, everyone gets the same amount of time to go through it, and really there are
no students who learn like that, so we moved out of a very structured system to a
system that wasn’t very structured (perceived by some as removing rigour) and it
was up to us to create that structure and it took us a while to change our thinking
and say good we can get rid of that stuff, we don’t need to do it anymore but we were
probably slow to come to a collective understanding of where we wanted to finish up
for kids at the end of Year 10. Students in my class were catered for all the way
through, only because I had upper school experience and ten years teaching before I
started, whereas the teachers who were furthest away from me physically, in terms of
the classroom and where they sat in the staffroom and things like that, went their
own way. If I didn’t see them on a daily basis and have a good idea of what they
were doing, they made the decision of what they do themselves rather than me tell
them what they’re doing. How individual students went depended heavily on
individual teachers. There was a lack of the kind of structure and resources that
existed in the unit curriculum. Some students could work at their own pace but
without a good content sort of package there for them to go through.

I think that students socially work very well when the move to the Senior College. If
you take the Year 11 and 12 influence from school, you would expect the maturity
level to drop. The Year 8’s don’t have the Year 12’s as role models showing them
how to behave. For them to turn up at Senior College as they do is a credit to the
Middle Schools and what is happening in terms of pastoral care. You might not see it
but without the influence of the Upper School kids you would expect them to be
extremely childish so it’s good to see (that this is not the case). For students to have
the ability to come into a class and get on with the work without prompting is a good
thing”
There’s a strong argument that Year 10’s should be part of the Senior College and year 7 should become Middle School. Of the transitional issues, the majority would be solved if that happened. However it would change the atmosphere of the Senior College. I don’t know if the staff would be ready for that. Having the Year 10’s there may make them more serious as they will associate with Year 11’s and 12’s”.

( Participant C)

There would still be transitional problems but, if Year 10 were regarded as a transitional year (or at least the focus on transition concentrated in the first semester), these problems could be spread out.

(g) Rigour

Perhaps a convenient starting point is the definition of ‘rigorous’ from the Oxford Dictionary which is “accurate, careful, conscientious, meticulous, detailed”

“Different places can have different aspects and emphases as well. It’s got a lot to do with who’s in front of the kids at the time and I reckon I could do justice in this outcomes world to the curriculum and give kids opportunity but I also think I can provide opportunity for kids to achieve to their full potential by providing the sort of materials and extension activities that make sure the rigour is there. I think that there has been a de-emphasis; we haven’t looked at rigour to the extent that we should have”.

In mathematics, rigour involves being really challenged. We make judgements about whether a kid has achieved a level 7 outcome by the difficulty of the concept. It’s different in English and other learning areas where you could put a piece of work in
front of a kid and get them to respond in writing. A kid could achieve a level 7 in that piece of writing or they could achieve a level 4. Some may argue that’s not the case but I think there’s an opportunity, providing a kid can read something and understand it, for them to respond in a level 4 way or level 7 way, depending on how skilled they were at writing but you couldn’t give a kid in mathematics a problem and expect them to have a level 7 response unless there was some teaching or intervention. If you take trig and you ask a kid to solve a 3 dimensional question in which you could build a model, draw a 3-D representation, do a scaled model, drawing or whatever but, to achieve a level 7 outcome, you would need to do that calculation as a 3-D trig exercise, you actually have to go out and teach the concepts and have the kids understand the concept really well and, in some respects, achievement of level 7 requires us to do some very specific teaching for them to achieve the outcome and in some learning areas that’s not necessarily the case. You may not have to teach specific concepts and get them to understand the concepts significantly to achieve. That’s my view, an expert might challenge that. If you really want to do a good job you have to attend to all these aspects of learning and, if you look at the Queensland model, one of the aspects of (productive) pedagogies- one of these is attention to rigour, that we don’t lose the rigour in what we do, we don’t water down. I think we need to push and challenge kids. When you look at the Curriculum Framework and the principals of teaching and learning, it’s well laid out in there that we expect what we do with kids challenges them. Maybe it’s not what the curriculum framework says that is at fault; it’s what we do as practitioners and how we have interpreted this idea. Allowing kids to move at their own pace in a way that says we don’t challenge any more, we don’t give kids the sort of things that allow them to progress at a rate that could be a bit faster. (Participant A)
Apart from certain small portions of mathematics that lend themselves to other subjects, important concepts in mathematics may be taught and not revisited for some time. Within Outcomes Based Education there is evidence that some topics (e.g. ratio) are dealt with once, to varying levels of effectiveness, never revisited and forgotten by students. The ‘spiral’ approach that existed within previous courses, in which students built on previous concepts, tends not to prevail although this approach would appear to exemplify the finest attributes of constructivism along with a structure (a rigour). English, in the form of writing is constantly consolidated across the curriculum. With due care, students can maintain a standard with everything that they write. Within mathematics, there are opportunities for students to comment and, although we tend not to level these comments or ask students to write long passages (because this can be a distraction from the actual mathematics), a maths teacher would certainly be able to identify students who are capable writers, even rank them all from a literacy perspective (including mathematical literacy).

“When you have a look at the totality of what we expect kids to do, you have to be judicious in what you teach because we don’t have the capacity to teach every single thing linearly and that’s why, in some of the recent work, we have looked at repackaging the content (so to speak) of the outcomes and having Space and Measurement as an entity, having Algebra and Number as an entity and having Chance and Data. Basically you have three strands so, when you teach Space concepts in two dimensions, you might bring in the Measurement concepts in too-area, perimeter, those sorts of things. When you break mathematics up, when you lay it out linearly, there’s too much, you don’t have the capacity to touch on every single concept for every kid and also we need to be able to provide a pathway for all kids and maybe not individual learning pathways because that’s practically impossible. In the ideal world that would be fantastic but unfortunately we compromise on the
ideal world all of the time because this has to be practically possible for teachers so we need to make those sorts of judicious decisions. I think we also need to be sure that we are challenging every kid. If I know I’ve challenged a kid to the fullest extent and I’ve only achieved level 3 outcomes then I need to be happy that that’s the case. If I haven’t challenged kids and I know by the end of Year 10 they’ve reached level 3 and I haven’t challenged them to go beyond that then that’s when the teacher needs to be a bit more introspective about what they have done and I think there’s probably a case for that to happen in some instances.

It’s true that a number of teachers that seem to be working from worksheets. Students can’t learn, they’re not learning new stuff. There’s also a change in practice in terms of assessment and tests or invigilated work don’t feature as highly as in the past. There’s a misconception about what it is that we want people to be doing in terms of assessment. If you read what is written under the principles of assessment in the Curriculum Framework, you’re left with no doubt as to what we’re required to do and, in making decisions about whether kids do, know and understand you have to give them an opportunity to do that in an invigilated way.

There seems to be an acceptance that we move away from traditional assessment methods. There’s probably a far greater move away than required because, from what I see of kids doing worksheets, even when these were completed, you were never sure they understood what they were doing or whether it was their own work, and there was no real measure of their understanding of that work and no real measure of the depth of understanding either. An assumption was made that because they did the work, they understood it and that’s a wrong assumption to make. There was a need to provide some other way of making judgements about student performance. (Participant A)
“I don’t mind rigour; I think there’s a place for it in mathematics. There should be rigour in the way that you want kids to set out their work, that type of rigour. The rigour should be based on what we want from students, perhaps it’s a misplaced rigour. When I go to the science (moderation) we have no trouble coming to a consensus. With maths we get “he’s done it as a tree diagram, not as a list therefore he’s not level 4. One problem is that students are often not exposed to enough earlier, enough structure and the spiral approach (as done in previous years), using appropriate tests etc”. (Participant B)

“I think as we progressed we developed a better package for students to go through, as teachers picked up that, then they were better off. There’s a lot of talk about a lack of rigour and things like that, I’m still not sure about the definition of rigour. We used to argue about that all the time. Does it mean doing twenty of the same questions, setting them all out nicely underneath each other? I guess we started to question “what were the values in mathematics, what was important. Is it important that kids can factorise quadratic equations, what was appropriate in terms of teaching the algebra or how we can use the technology to do this. Some of this is still being discussed now. I think it reflects a whole change in the nature of mathematics from the system we grew up with to the system we have now where kids aren’t as confident with the basic skills in mathematics but they have a lot more influence in terms of the technology they use to move around mathematics. In some ways we are saying we want to hold on to all the stuff we used to do, all the rigour plus we want to fit in all these application type questions because they can use the technology we’re using. So we really want them to have both but there’s not enough time in the day to learn that. If we are going to put more application and understanding type questions on the top we have to be prepared to get rid of some of the nuts and bolts
stuff that the technology now covers and throw that away to make a reasonable course. I think that’s what the middle schools were thinking at the start, and perhaps in some ways some teachers went too far and forgot about teaching the basics or giving them enough time with the basics, or enough time with drilling practice to push it home so that when they move to the Senior College they were perceived not to have a good understanding. Also, with people making perceptions, they need to remember where things have moved during the last ten years. In some ways they need to ask the question “is it realistic what they expect of students with this clientele that they complete the square, use quadratic formulae, factorise quadratics…. There are a lot of different parts of mathematics we could discuss. Is it reasonable for us to still expect them to do that considering that, with other means, they can do it more quickly and far more accurately, they could do it and still be in the scope of the courses. There are two different ways of looking at it. One could say kids can’t do this and can’t do that, and in some ways we need to question whether they need to do it. Some of the social education is not as easily measurable as some of the curriculum based issues. It’s easy to see how good they are doing algebra but you can’t measure the social relations they develop and how they work co-operatively in groups and things like that. I think the emphasis of middle schooling went too far perhaps into some of the social interactions and social education, and worried about holistic education of students as opposed to the specific subject matter.

The Unit Curriculum which provided the spiral approach originally was a good idea, they never put time schedules forward and they never said this would be done in Year 8 or Year 9. It was just a series of discrete units that students could do and one could flow to the next one in that style of approach. I guess the restrictions of schools
meant that you needed to do it in ten weeks, you do this in Year 8 and that in Year 9, that’s what killed it”. (Participant C)

Some of the perceptions have been that outcomes are O.K. but the levelling is a mess with inconsistency and ambiguity. Some students have achieved levels one year from a generous teacher and they are found to not be up to that level in the next year, this leads to conflict and confusion (tensions) especially when parents get involved via reports. They (previous teachers) have seen something in the student that is not there and has not been rigorously demonstrated.

“If that’s rigour then I agree, there should be some standards of assessments, I’m not saying tests. It wouldn’t be bad if there was an equivalent group to the ‘T.E.E. hit squad’ in lower school. They could come around and assess standards, assess students at random. By spending thirty minutes with a student, they can ask enough questions to get a reasonable idea of where they are at. If a kid is supposed to be level 6, they could find out pretty quickly if they weren’t at level 6, then feed that information back to teachers. (There has to be common understanding of these levels). Each school is different, each teacher is different. I’d hate to be a primary teacher over 8 different learning areas; we’re only discussing the problems in one learning area. (Participant C)

So even though they may not have the content, as long as they have the perseverance and perhaps an ability to handle the ‘rigour’ in Year 11 (they may be able to cope). How would one define this rigour?

“Being able to follow through an argument mathematically or logically (mathematical literacy etc).” (Participant D)
Another meaning tends to be taken that allows for rigour without content, a bit of a compromise but, if students possess that, even without all expected content and skills, this may be where this self efficacy comes from as well.

“When kids come to Geometry & Trig, Calculus in year 11 and 12, I like them to have done some background in Year 10, things like a fair understanding of proofs (which comes up in vector proofs) some identities, rationalising the denominator which are very specific to the course”.

Students in many cases choose against the wishes of the teachers, some battle away, others don’t because they do not approach the work in the correct manner. If a student chooses the right course they can usually survive on what they do in the classroom, along with assignments, preparation for tests, (a strict homework regime, checked rigorously by the teacher, seems to be a disappearing requirement in favour of more independence, acceptance of responsibility by students which extends to life long learning.)

(h) Expectations of mathematics learning, maths time, maths teachers...

We may be on the verge of making real use of technology, we haven’t quite got there yet, there’s been a real push to use it (maybe driven by commercial interests and educators paid to promote certain products) but, as yet it has not reached expectations in some areas, it’s still not interactive enough especially at higher levels.

“We don’t have large numbers of kids that love maths and I think that’s a function of a large number of teachers who are out there who are not able to turn students on to
maths, who are relatively dry and stodgy in their teaching method. In today’s world, have a look at what turns kids on, you’re pushing it uphill, we have to look at the way we use technology in the classroom because the kids are right into technology. Bring a bit more of a human face to the classroom, no question to get kids turned on, especially in Middle School, there’s a fair bit we need to do to get them where we want them”. (Participant A)

Students, even those who are extremely capable, may not say that they like mathematics. They say “maths is maths”, believe it’s important but it’s not ‘cool’ to like it, peer pressure may prevent it, it’s something that’s a means to an end. It may sound arrogant, because maths teachers have been assured of work; other subjects may have to entice students but is it part of a maths teacher’s job to sell something that can be ‘dry’? Few people have success at selling unattractive things; people in business and industry can ‘write their own ticket’ if they can do this. With the shortage of maths teachers it may be expecting too much to look for those who are also entertainers or who can sell the subject by deception, do we really want that to happen anyway? One of the first things you learn in teaching is that students see right through the teacher who is not being genuine. Maths teachers should be encouraging kids to be precise, maintain credibility, integrity, and be reliable, rigorous and trustworthy. Any other emphasis would be alien, especially to those who have been there for decades. It’s a matter of establishing certain mathematical skills in students. In recent years these people have been rare enough; it would be a mistake to ask them to do ‘a con job’ as well because education would lose far more than it could ever hope to gain.

*We’re all faced with the same problem, how do you turn kids around? If you look at the population as a whole doing that, there are still kids that do well despite all sorts*
of things but there’s an increasing challenge for us all to do something a little bit
different. We know in maths that there are a whole pile of skills that kids need to
know, there’s some direct teaching that needs to be done, some ‘basic’ things to
remember. Maybe the way we go about teaching it needs to change.

“Some learning areas have advantages; the best learning area to be in is S.O.S.E.
There are world events occurring by the week that can determine your curriculum.
That’s how free the SOSE curriculum can be. This year alone you have had teaching
and learning about tsunamis, earthquakes, elections, hurricanes- it’s real, it’s alive,
with graphic footage that helps to consolidate. What a rich environment in which to
learn! Mathematics does not have that rich environment. If it does I’m not aware of
it. (Of course) you could pull the mathematics out of each of these things (but this
does not conjure up the same interest especially for those who do not have the skills
in mathematics)”.

It is not necessarily in the name of middle schooling but decisions were being made
about how relevant or how important each learning area was. The reality is and, if
you have a look at the latest statements coming out of central office and where the
curriculum emphasis is to be in the schedule of CIP II (Curriculum Improvement
Program, Phase 2), there is an acceptance that the curriculum emphasis should not
be equal across all learning areas and it changes with each phase of schooling so
those people who are using a purist model that says all learning areas are equal, and
have divided the curriculum up so that it was in terms of the amount of time have
changed their minds and realise that there are areas of the curriculum that need
greater emphasis. I think if you look at numeracy, literacy and ICT, they are the
three things in which greater emphasis is being placed. It’s not a stand alone for ICT
Across all learning areas, the medium of ICT for learning has taken off in a big way, we can’t emphasise enough the importance of literacy and I can see that in my position in the primary school now. Most of the resources in the school should be placed at early literacy intervention because we know when kids can read and write it helps in all learning areas including mathematics. So the curriculum emphasis has de-emphasised some areas (T & E in Junior High is almost non-existent, as you go through it builds up but you never get to the point that we could say that every single learning area would be required to have the same amount of time.) That decision was made very quickly”. (Participant A)

There has been a high correlation between the skills test and subsequent performance. It’s interesting to see that some things in the skills test (congruent triangles) were poorly done but they tend not to be that important nowadays at the point of transition and can be done at the time in the Upper School curriculum if or when they are required. A number of things can be eliminated from the middle/lower school course but it was left up to teachers (sometimes generalist teachers) to make the decision and wrong decisions have been made. More complex algebra may have been eliminated because the generalist teacher may not have felt competent to present it to students, even within a less threatening environment that no longer required exhibition of an algebraic calculation to the class. We needed people to make those decisions for us so that there was consistency. Maths has been swept into making changes at middle school level that didn’t suit it in order to be part of an overall package. However the reaction against similar changes at senior level provides an indication that the same thing is less likely to happen there.

In terms of preparation, speaking for myself in middle school, I did a better job for my students than I ever did before. I know a lot of people have different ideas of what self-paced learning means and the advantages of it. There are students who have
moved on far better in Year 10 mathematics by giving them the freedom to do it themselves. I probably didn’t have long enough to judge the impact of that over a period of time. The biggest issue that we have in the region is the lack of availability of teachers of mathematics. We’re not attracting quality maths staff. With all respect teachers are doing the best they can but they’re not coming with ten years history in teaching mathematics so it’s difficult to work within the restrictions and what they’ve been told to do, and also cater for what we’re asking them to produce for us so we can take students through to the end. No-one seems to care how a vocational or maths in practice kid comes into Year 11, it’s only a T.E.E. kid that we are worried about.

In some middle schools, there must be a lot less than 20% of Year 10’s moving into the Tertiary bound courses, then there’s the drop out rate so perhaps it’s not just the Middle schools perhaps it’s the whole society in terms of mathematics is becoming less important to some of these students. The region we’re living in, maybe the Middle schools are going for more holistic education. Whether it’s been successful or not I don’t know but they are certainly not covering as much content as before. We’re down to 3 hours, 8 learning areas, 24 period week, doing 3 hours of maths per week whereas traditionally it used to be 4 hours, straight up you’re losing 25% of your maths time so you’ve got to drop some content. (Participant C)

“That’s another thing that we’ve noticed, it’s the misreading of the Curriculum Framework. For example negative numbers at what used to be level 6. Negative numbers, you’ve got to do that in Year 8, first up, irrespective of where it is in the Curriculum Framework, it impinges so much on other parts of mathematics. The literal reading of the Curriculum Framework is not what we’re about. The one thing
that the Curriculum Framework has done is redress the balance between the strands in mathematics. What we’re trying to get is a much more even spread across mathematics to provide a better balance in the student’s background.”

(Participant D)

Self Efficacy, Independence and Tensions

The caring approach (in the U.K. it’s classified as the ‘Nanny State’) as applied within schools can have a detrimental effect on students who are less prepared to take risks and ultimately their self efficacy and independence suffers. People who are efficacious, when they experience a problem they regard it as a challenge, a hurdle that can be overcome with greater effort, persistence etc. whereas someone who lacks self efficacy tends to offload the blame elsewhere (their teacher, not enough time, bad luck…)

“Returning to self efficacy, does this involve being an independent learner?
I think it’s not just part of maths teachers’ roles, it’s part of learning and what’s important, being persistent and trying to overcome challenges, thinking of new ways and not giving up without a reasonable effort. We have a world where kids get a lot of stuff handed to them and there are expectations for this to happen. Some of these have mitigated against them being efficacious, being independent. In some ways society allows kids to become quite powerful in their own families because they have other people doing things for them, they don’t do it for themselves, they don’t make their own mistakes, they don’t then pick up and sort them out for themselves, they
aren’t adventurous, or risk takers. Part of the process of learning is to get kids to take risks, not be afraid to get things wrong and realise there’s more than one way to go about getting a solution to a problem.

There’s a lot of things in early education that contribute to kids not being efficacious because there is a sense in which there is only one way and you will do it this way (and in some cases this is not necessarily the best or the most efficient). One of the most interesting things you can do is to ask a kid how they did something, particularly in problem solving. Ask them, there can be a few different ways. We need to give kids the opportunity to do that, provide the support. Marking T.E.E., you need to spend time working out how kids do something, they can be extremely resourceful. There’s something about what we do in teaching that can help our kids to be more independent, be more persistent, take risks, take more responsibility for their own learning but that’s not just the domain of maths teaching, that’s the role of all of us and we probably have kids more mollycoddled than in the past. (Participant A)

Clearly this provides additional tensions to those discussed by Mason (p. 22.) Mathematics suffers more than most because of the nature of the subject especially when you have experienced teachers, who stay structured, rigorous, on a set course and use the time efficiently. In the teacher dialogues one teacher avoids discussion about whether mathematics is important. Much of the time experienced teachers carry on regardless, where kids ask about applications etc, these can be explained (or even better it may be suggested that kids research this for themselves) but generally teachers have continued, some have addressed parts of the curriculum framework, perhaps they have observed mistakes made by others and have not fallen into the same trap for themselves. Those who erred on the side of caution and delayed
implementation probably did the right thing by their students at the time despite the risk that “compliance and conformity are rewarded while resistance is penalised”
Humes. (2000)

Student comments from the survey administered 2002 to 2005

1. I am doing all I can to succeed in my chosen courses.

There are a significant number of students who acknowledge that they need to provide more effort and indicate an intention to do so. There was some mention of the pace of the courses in Year 11 and the need to have access to extra tutoring in mathematics which the College has managed to make available during the first few years of operation. However limited resources restrict the availability of tutoring and any additional tutoring has recently been provided on a voluntary basis by individual teachers. The steady increase in other commitments that distract students from their studies such as part time work or sport has been mentioned by a number of students.

Selected quotes:-

*I am getting settled in (everything is different).* (2004)

*Sometimes I get distracted and procrastinate.* (2004)

*When the exams come up I shall really knuckle down.* (2004)

*I’m finding it difficult to cope with the speed of this course.* (2005)
2. **In general I am confident that I can succeed in the courses that I have chosen.**

As with the first statement this statement relates to the entire field of study and not just mathematics. A significant number of students also choose to indicate here that they are yet to start applying themselves. While some of these will improve their effort as the year goes by, most (who feel the need to comment here) tend not to respond and will later require a change of course.

**Selected quotes:-**

*Only if I try harder, especially maths and English* (2002)

*Once I get used to studying I will hopefully succeed.* (2004)

*I think I am doing well in most subjects except maths.* (2004)

3. **My background in Mathematics was suitable for my chosen Year 11 course.**

There have tended to be a significant number of comments regarding the quality of teaching. As most experienced mathematics staff moved to the Senior College in 2001, there may have been difficulty attracting specialist teachers to middle schools or, as indicated by some comments in 2002 where students experienced up to four different teachers, it may have been difficult to retain suitable specialists. There may have been some advantage in achieving (Stiff 2000) “flexibility in assigning teachers to a variety of classrooms” in some of these middle schools and, in these cases, there may not have appeared to be an urgency in employing specialist teachers. However, with concerns regarding appropriate preparation for the courses under consideration, there appear to be significant attempts to rectify this situation in recent years.

In the last few years, comments regarding ‘self paced’ work (or working from sheets that students choose for themselves) have appeared.
Selected quotes:-

*We didn’t do enough work with algebra, that’s why I’m struggling.* (2002)

*I had 3-4 teachers for maths.* (2002)

*My year 10 maths teacher didn’t know much.* (2004)

*(School named) is far behind in maths than other schools.* (2004)

*We did self paced in year 10, some of the work was 'dodgy' and people tend to slack off.* (2005)

*I believe we were left short at the end of Year 10 with different teachers etc.* (2005)

*I was told Foundations would be difficult for me and it is.* (2005)

4. **I am coping very well with my Mathematics.**

Students who commented that they were not coping had concerns about difficulties in tests or that most work was new to them. As mathematics (and constructivism as a theory of learning) tends to require background skills on which to build, it is important that students are given the opportunity to make a connection with their previous learning experiences. In some cases this may affect ‘the level to which students apply themselves’ as they lose motivation, continue to make mistakes and become disillusioned or simply fail to apply themselves because they have a mindset that may have previously allowed them to avoid work without consequences. However it is clear that students who were taught the background skills in Year 10 appreciated this.

Selected quotes:-

*Some things I don’t understand because I haven’t done maths like this.* (2004)

*My Year 10 teacher made sure we knew the basics for TEE maths.* (2005)
5. The level to which I am applying myself in Mathematics is

Very High   High   Satisfactory   Poor   Inadequate

Selected quotes:-

*I* need to consolidate more but I don’t have much motivation. (2002)

*I* should just do my best, but sometimes I get too determined. (2002)

*I’m* working harder as it is getting closer to exam day. (2002)

Family commitments have reduced the amount of time available for study. (2005)

Other subjects are more time consuming. (2005)

6. My current Mathematics teacher knows and teaches the subject extremely well

Comments of interest here include the (frequent) observation that the pace of the work is fast, much quicker than before. As students may have chosen the pace for themselves prior to entry into Year 11, they take some time to understand that there is a schedule of work that needs to be completed (much like in the workplace) and that they can no longer be allowed to dictate the speed for themselves to the extent that they did previously.

Selected quotes:-

*(S)he* makes it easy to understand. (2002)

*Bit* too fast because it’s all new to me (2003)

Explains things a few times for us to understand (2004)

*(S)he* shows/explains things well but sometimes goes too fast for me (2004)

*We* don’t get our own freedom to do the work (2004)

Explains everything well. Uses whiteboard notes not just referring us to the book (2005)

*I* actually listen. *(S)he* holds my attention (which is very hard). (2005)
7. My Year 10 Mathematics teacher knew and taught the subject extremely well.

Comments here also draw attention to the self paced approach in recent years. There are also perceptions of poor communication of the subject, not a proper maths teacher, teachers who covered topics possibly because of ease of cross curricula connections rather than the future needs of students in further education. During 2002, the comment “(S)he would explain it too fast then leave” almost implies that someone with some knowledge of mathematics went into the classroom to introduce a topic, then leave to go to another class (similar to a consultancy).

Selected quotes:-

Knew it well but had trouble expressing it to students. (2002)

Kept changing teachers (2002); (S)he wasn’t even a proper maths teacher and I had 2 or 3 in the year. (2002); In year 10 I had 3 different teachers (2003)

They had to teach 4 pathways at once. (2002)

...tried to be our friend, not our teacher (2002)

(S)he could hardly speak English. (2002)

(S)he only taught the same thing for the whole term and focused on things I don’t need to know. (2003)

(S)he was good but we mostly got work sheets all the time and not explained. (2004)

It was the same thing over and over in a million different ways. (2004)

(S)he was very helpful and taught extremely well but taught us the wrong work. (2004)

(S)he knew maths well but tells us (s)he was made to teach us self-paced work, where we were taught from books. (2005)

(Teacher named, ‘other’ school) knows maths and how to teach it to kids our age. (2005)
8. I work in the library during my free time

Not at all   Once a week   Twice a week   Three times a week   More than 3 times a week

This did not discriminate according to the data analysis; student comments provide an insight into the reasons for this. These include students deciding that they were more comfortable working at home, students not having the available time during the day, students having other commitments or choosing to use the library only for specific work requirements, not as a regular resource.

9. My Mathematics teacher is doing everything possible to help me succeed.

Comments again mention the speed of the course. However most comments indicate an appreciation for the help and the capacity of the specialist teachers of mathematics in the College to make their study of mathematics easier and provide assistance. One comment, possibly made by a student who was comfortable with self-paced work and possessed a need to be independent (hopefully not one who ‘slacked off’) indicates that there are some students who benefit from choosing the pace of work for themselves.

Selected quotes:-

(S)he is giving tutoring lessons. (2003)

(S)he does teach maths very well I just have to put in extra time at home. (2004)

I know if I need help I can ask. (2004)

Needs to slow down and allow us time to process information. (2005)

10. I realise that, no matter how much my teacher helps me, it is my own determined and consistent effort that is important for me to achieve success.

Comments here indicate, what I must say is a desirable result, that some students readily accept responsibility for their own learning. Perhaps the recognition of
teachers who have the expertise to help students with difficult topics has encouraged students to regard teacher’s help and encouragement as extremely important.

Selected quotes:-

*But teacher encouragement is vital.* (2003)

*At the moment I feel I’m struggling but I’m slowly getting there.* (2004)

*It goes both ways, the teacher is important too.* (2004)

*I am the one who has to sit the exam.* (2005)

*You only get out what you put in.* (2005)

For 2005 only, for items 11 to 20, students were asked to comment on liking mathematics, whether their interest was increasing, whether they and their parents believed mathematics is important, if their success depends on their teacher in maths, whether they are losing interest in maths, if they think that maths is relevant for their future, whether their confidence increases when they have a teacher who teaches the subject well and whether maths has been one of their favourite subjects. (Some of these were used to check the validity of the instrument being used.)

Students who commented tended to say that they liked mathematics at certain times in their education, when they achieved success in it or said that they’d never really hated it. In general they stated that the subject was getting more difficult but the teacher’s help gave them hope in overcoming these difficulties. Comments about whether mathematics is important indicate that many (who commented) do not believe that some of the work that they are doing is going to be of use to them, neither do their parents. (There is clearly a need for students to have a better understanding of the power of mathematics which has been considered in the literature review and technology may have a role to play in this regard).
The comment was made that mathematics was important because most jobs required it. Students recognise that their personal commitment is vital for success but that they need their maths teacher to assist them. Specifically students appreciate the potential for the teacher to motivate them, that a good teacher encourages the student to try.
One of the main principles of constructivism referred to in the literature review which lends itself readily to the learning of mathematics (which is sequential) is that the effective learning is more likely to take place if there is a foundation on which to build (von Glaserfeld, Baroody and Ginsburg). (Even if the foundation is false, people use whatever they have and attempt to construct on this. This can lead to misconceptions that may take some time for students to overcome. Some of these students may not recover from this setback.). Teachers discuss cross curricula programs, which cannot be relied upon to deliver the necessary skills in mathematics because not enough connections are available to cover these skills. Where connections with previously learned material can be readily made, which is possible in a limited number of situations, teachers have used these to demonstrate the power and value of mathematics. In the N.C.T.M. dialogues, one elementary school teacher indicates that students are often able to ‘cite’ more examples (of these connections) than the teacher can. Students who have experienced an over-emphasis on mathematics within a cross curricula environment tend to miss out on other vital skills in mathematics because of the gaps that exist. The example involving negative numbers, described from p.15 and included in the table on p. 18, illustrates an important set of concepts and skills that may be overlooked in favour of mathematics that may be connected with other subjects. One example with cross curricula mathematics involves tessellations, which has a ready connection with art yet has little connection with T.E.E. mathematics. Another participant in the interviews confirms this by stating that it is extremely valuable to be able to establish a connection and tell students that you are doing this topic now because it will be
relevant to a specific topic in science (or other subject). Unfortunately, in many cases, the student may not see the application until the topic is studied later in science or elsewhere. Negative ions is an example of an application in science that requires a knowledge of negative numbers which ‘should’ ideally be taught two or three years earlier in mathematics.

Another point made in interviews was the absence of a spiral approach (returning to a topic “again and again, making things progressively harder”) in outcomes based education. Of course, as a flexible curriculum is advocated within Western Australia, it could be argued that teachers themselves should have created this type of structure involving a spiral approach. However teachers, when placed in positions such as this, where they are required to implement a number of new initiatives while still performing their demanding “primary task, namely interactions with students”, cannot be blamed for overlooking these complexities when they are presented in verbose, ambiguous language that provides teachers with extra “illusory challenges” (Matthews). This point has been considered on Page 14 of the literature review and will be considered in more detail later in this chapter.

The major problem in transition involved “two systems trying to match up”, one involving a flexible curriculum and less testing, the other involving more rigour and high stakes testing culminating in an external examination which, many people believe, will determine the future for these students. While students from middle schools A, B and C received a less rigorous, flexible curriculum with limited exposure to tests, some ‘Other’ schools, that did not have a middle school structure, maintained the rigour in all areas of study because the established belief in these schools was that “courses in Upper School (should) dictate what you should actually do in lower school”. Some unfortunate students discovered, (in class, in the skills
test and in assessment tasks including examinations) early in Year 11 that their skills in mathematics were not as good as those students from ‘Other schools’ and students themselves observed that they were left at a disadvantage. Comments in the survey, including “(School named) is far behind in maths than other schools (2004)”, confirm this observation.

Many of the situations mentioned with regards to constructivism apply to the implementation of Outcomes Based Education. In interviews, the uncertainty in what needed to be taught is again emphasised, so is the mismatch between “what was happening in middle school in Year 8, 9 and 10 and what was expected in Years 11 and 12”. Students, having been deprived of the rigours and other requirements that would have later been useful to them in year 11 and 12, were always likely to be significantly disadvantaged. Comments from students, interviews with and judgements of teachers acknowledge this deficiency.

The outcomes are still perceived by participants in interviews as not being “user friendly”. Teachers were not familiar, even confused, regarding the provision of expected learning experiences and, in the absence of a textbook, had to organise the resources and materials to provide these learning experiences. This was a difficult enough challenge for experienced teachers of mathematics but for those who were not maths teachers (and there were many of these in schools A, B and C) it is not surprising that they were “lost”. This is emphasised by the response “I honestly don’t know, I struggle with this system, I really do. The outcomes themselves I guess are O.K.” when a participant, an experienced teacher of mathematics, was questioned about the aims of outcomes based education.
However, there are those who appreciate the involvement with “action learning”, in which a teacher provides a learning experience, observes what happens, reflects on this and makes necessary adjustments to the learning process. Another positive characteristic is that the student should be able to consistently demonstrate the outcome and, for new students to a class, a genuine record of the achieved outcomes are something a teacher should find of value. Experienced teachers of mathematics may argue that this action learning, consistent demonstration of outcomes (or skills) or any other aspect associated with outcomes based education already existed in mathematics education in most schools in Western Australia, and could be confirmed by results of World-wide testing.

One problem occurring in outcomes based mathematics involves the fact that, with approximately three or four levels over three years (e.g. Level 3 to Level 6) there does not seem to be a great deal of progress (movement between levels) being made. Another problem is the possibility of the teacher seeing something in a student that is not actually there. With group work being encouraged, the work may not belong to the individual credited with demonstrating the outcome. Also the student may do something within a class situation and be recorded as having demonstrated the outcome yet not be able to repeat this under genuine invigilated conditions. If a student arrives in a new class after receiving a ‘false’ level there is the potential for ‘tensions’ between the new teacher, former teacher, student and parents. There is also a genuine major concern expressed by a participant that, with outcomes based education, “no one fails, mediocrity reigns” (a concern also expressed in the term ‘dumbing’ down).
Some educators, including participants in the interviews, are extremely anxious about the image of mathematics and students often question the **relevance** of mathematics. The need to provide students with skills in mathematics with which to face certain challenges continues to be an important consideration. There is a realisation that “*some direct teaching needs to be done and some ‘basic’ things to remember.*”

Having to compete with subjects that provide a rich learning environment, consolidated by experience, presented in the media or on the internet, appears to be a consideration for teachers of mathematics. Nevertheless most students and their parents still regard mathematics as important.

The move towards a richer, more interactive environment in the teaching of mathematics by the **use of technology** promises much but, until this technology becomes more powerful in its capacity to readily present these connections, the need to justify the study of mathematics to students may prove to be an unnecessary distraction for classroom teachers that is best overcome by assuming a position where mathematics is assumed to be important and acting accordingly (as stated in the Dialogues p.88) or remaining *unrelentingly focused* as the subject has been throughout history (according to the Guardian, p 20).

**Change and the possible new content in mathematics** is closely connected to relational knowledge, and once technology provides mathematics with the richer environment discussed previously, some of the present content may be unnecessary. The literature asserts a need to frequently review the content and approach to the teaching of mathematics. In fact the use of technology means that approaches in teaching and learning in general have to be reconsidered on a regular basis.
At present, within a flexible curriculum, decisions regarding the content of mathematics are left to individual teachers some of whom do not have a “good understanding of the breadth of knowledge that kids require from Year 8 through to Year 12” (a view expressed by a middle school participant in the interviews). Even experienced teachers of mathematics may not feel comfortable about making decisions that remove content that could be required by students in further education and a return to content that is provided (by Universities or industry sources such as Engineering) as a pre-requisite for further courses is sought. One of the participants in the interviews is anxious to receive information of this type with regard to new courses of study and does not relish the task of converting to new courses without a clear statement regarding content. Considering the problems that have been encountered in middle school mathematics it is not surprising that teachers are cautious regarding further reforms.

In the literature, in interviews with middle school teachers and in student comments attention is drawn to teachers who are not specialists in mathematics. The structure of middle schools, with teachers moving through with their group of students to Year 10, before returning to Year 8 again may also not provide teachers, who could contribute much to mathematics education, with the motivation to continue. Teachers, with an affinity for mathematics and a capacity to demonstrate it to students, have moved from other subjects to take classes in mathematics. In some cases these teachers have been extremely capable of communicating the subject. On the other hand there have also been teachers who have been ‘coaxed’ into teaching mathematics who may function well in Year 8 but would be severely tested by higher order concepts in Year 10. Some adjustment should be made within middle schools
to ensure that the expertise is available at the appropriate stage. One of the Senior College teachers, who advocated changes to middle school structures, may regard this as an important element for consideration.

However this would need to take place without affecting the ‘sub school’ structure participants in interviews value so much, asserting that this structure “is fantastic for students”, providing them (students) with an identity in a smaller sub group in which students “will tend to treat each other better”.

The statement by a teacher at the Senior College “Students are pleasant in nature but unprepared in terms of work ethic and pre-requisite knowledge” may be seen to support the sub-group structure while still expressing concerns about the way that mathematics is presented. Matthews (as quoted on P.7 in the literature review) asserts that this may be using ‘feel-goodness’ to determine theory choice and educational policy, while the researchers referred to in the literature review might cite this as a case in which “social validation” is used as a de facto measure of success in the absence of “hard evaluation criteria”.

Participants perceive that, in any mathematics class there could be up to three levels in a class even if the class is streamed. Within such an environment the question of how to cater for the more capable students, a focus of this research, is a major problem. Many secondary teachers of mathematics, including those considered in Dialogues and interviews, are not comfortable with mixed ability groups and also have concerns about group work. Another participant is extremely disappointed in the absence of streaming (and an environment that is openly “anti streaming.... even in Year 10”). A third states that (s) he has no problem accepting mixed ability classes until Year 10, believing that they need to be placed in groups at that stage so that preparation for Year 11 is optimised and students do not suffer mathematically compared with students from other schools. The fourth participant believes that
having a wide range of abilities in a mathematics classroom “doesn’t make any sense at all”.

The reason why teachers of mathematics specifically do not feel comfortable with mixed ability classes is because there a need for frequent “interventions- some specific teaching” in order to effectively deliver the subject. It is extremely difficult to do this effectively and consistently in a mixed ability environment in which there is a wide range of abilities. The biggest drive for mixed ability grouping appears to have occurred in the U.K. in the 1970’s (Literature Review p. 39, 40) and the disadvantages of mixed ability groups, relevant to the discomfort of teachers in the delivery of mathematics, were given by the Schools Council Working Group (1977) as

1. The difficulty of providing for the less able and very able, in terms of finding suitable work.
2. The difficulty of providing and organising a variety of materials in the classroom.
3. Problems associated with continuity: how to introduce a topic for the second time.
4. The problem of finding an efficient allocation of the teacher’s time in the classroom.
5. The resulting heavy demands made on the teacher both inside and outside the classroom.

Nevertheless teachers at the schools considered in the group of schools in this current research have tried with the use of worksheets where students completed a sheet containing exercises in mathematics then moved on to the next sheet when ready. This may have been a strategy that was believed to overcome the five disadvantages
listed above. However the response of one of the participants in interviews was “It
doesn’t work. In the year 10’s last year, the classic thing was they’d choose a level 3
worksheet (below their own level) and they would do it for weeks on end. They’d say
“Get off my back, I’m working” but you know they’ve done the same sheet a number
of times before.” Also a response to group work, another concern for maths teachers
is, “As far as maths is concerned group work is not really successful. Some students
say “I’m sick of carrying those (who won’t make an effort) they wait for me to come
up with the answers.”

Participants have major concerns with the expectations that society breeds in
children that cause new ‘tensions’ within schools, and the consequences have a close
connection with the self efficacy and independence of students. It is an important
component of learning to encourage students to be persistent, “trying to overcome
challenges, thinking of new ways and not giving up without a reasonable effort”.
Within an environment where children may have expectations to get their own way
and have things handed to them, ‘tensions’ may occur when later they are required to
provide a genuine effort or to work to reach their full potential in a more rigorous
environment. This expectation, sometimes encouraged by approaches, attitudes and
provision of choices resulting from the reforms considered in this research, does little
to develop self efficacy or independence in students unless they accept responsibility
for their own learning and live up to their stated intentions. The provision of life-long
learners will require something more than wishful thinking or visions of ‘an
educational promised land’.

Teachers of mathematics at the Senior College report on problems caused by general
work ethic, lack of commitment, inadequate pre-requisite knowledge, poor
background and study skills. They also consider that students also needed to be taught how to study and organise their time properly, and that it is a mistake to leave this to the short time spent in Senior School. A significant number of students were not prepared to accept advice to help them improve and the consequences of inadequate preparation in Year 10 led to a very high drop out rate in courses.

While many of these concerns would have existed before to a certain extent, teachers at the college indicate a significant increase in these cases that can be associated with changes in approaches to middle school mathematics.

Student comments confirm the difficulty of adjusting to transition, stating “everything is different”, “that it’s difficult to cope with the speed of this course” and of a need to “get used to studying”.

They also profess great intentions of improving their approach (later or closer to examinations). Unfortunately, according to judgements of teachers at the Senior College and the number of students who ‘drop out’ of courses, many of these students do not live up to these good intentions. Self paced work also was a concern and some student comments, especially “We did self-paced in year 10, some of the work was ' dodgy' and people tend to slack off” (2005), indicates that some students had established insincere work patterns that would be of no use to them in a more challenging environment.

Thamraksa (2003) supports recent reforms in education which seek to move from teacher centred or teacher direct (in which learners may be perceived as being passive and dependent) to a student centred approach. The aim of new approaches is to produce “competent, independent, life long learners who can keep pace with global competition (and) increasing demands of knowledge based economy in a world of information and communication technology.” Thamraksa (2003)
While some students “have reacted by becoming sullen and hostile” believing that these reforms “impede their progress”, according to Thamraksa (2003), this is due to “the failure, not of the approach per se, but of the teachers’ misinterpretation, misuse and abuse of the concept.” However many teachers will be very familiar with this attempt to pass the blame on to them, and may respond by insisting that, if there is a suspicion by experts in the field, who advocate reforms, that teachers may misinterpret the literature, then the writers should be less ambiguous and emphasise anticipated difficulties to teachers.

There is “much confusion and mistrust of the pedagogical movement behind the new model” Thamraksa (2003). Certainly there is a distinct possibility “that the approach will lessen the significant role that they (teachers) play in class”. The kind of environment encouraged by some reforms has the potential to reduce the effect of the experienced specialist teacher who has functioned effectively within ‘streamed classes’ but perceives the mixed ability situation as inefficient, chaotic and not advantageous to the learning of mathematics. The extent of this reduction will, of course, be difficult to ascertain in most cases because a number of other factors limit evaluation, including alternative methods of assessment and reporting that have tended to cloud the issue.

Student centred learning evolves out of constructivism and also from experience or sharing ideas. Therefore active learning is involved and takes place in a real context linking “school experiences to real world experiences”. Students are given increased responsibilities “to identify and self-direct” within aspects of learning. Learners are provided with a variety of choices (learning experiences and environments) from which to select according to their needs. Theoretically students
develop more self-motivation (from within) rather than doing something to gain the approval of others.

While these outcomes (self motivation, independence and lifelong learning, perhaps even enjoying mathematics) are extremely desirable, this research questions whether this can be achieved for all of our students in mathematics. Within this research, students and teachers have indicated that mathematics is important but is not regarded as ‘rich’ by most students, and rarely provides the direct connection with experience that other subjects enjoy. The hope for students of all levels of ability is that they can accumulate skills by practice in mathematics that will allow them to construct their knowledge of mathematics and later use these skills to apply, and relate to the world around them. Perceptions of teachers indicate that the conditions that optimise the acquisition of these skills, at least for students beyond middle school age (which must include Year 10), require specialist teachers who can communicate the subject, classes set/streamed according to ability and a structured, unambiguous curriculum that genuinely prepares students for future challenges. The repeated significant relationships demonstrated (Ch. 4 Results Quantitative Data) between background skills (assessed using the skills test) and performance in T.E.E. courses emphasise the importance of these skills for senior school performance and self efficacy. Multiple regression analysis (Ch. 4 Results) also confirms the contribution to self efficacy and results for the first semester made by these background skills and contributions of the Year 10 teacher.

Criticism of traditional systems, including the previous structure in Western Australia (the Unit Curriculum) frequently concentrates on students who get locked into a certain pathway, set, stream or track at an early age and find it impossible to move up.
In previous learning structures for mathematics, the content for students who struggled tended to be different from that for more capable students from approximately mid-Year 9 onwards. The reason for the different content involved factors connected with relational mathematics. Those who struggled in mathematics were given less demanding problems in mathematics because the connections of this mathematics with the real world were easily established and Wheeler D. (Literature Review) declares that “the amenable ones often connect only with trivial mathematics.” Mathematics applied to vocational areas, where it is ideally related to a context, has become a growing consideration and addresses the question of relevance for these students.

Unfortunately, for some time, there have been distractions as teachers of mathematics have been enticed into the futile act of making the subject fit in with a package that involves priorities that suit other subjects. The approach that sees teachers proceed, delivering these skills at appropriate levels to different classes has been condemned, the word ‘streaming’ appears to have been censured in some environments so, what many teachers of mathematics locally and in the U.S.A. (N.C.T.M. dialogues) regard as the most effective way of developing these skills, is openly discouraged.

However the writings of Chamraksa which succinctly puts over the advantages of student centred learning (considered above) advocates a new approach in Thailand, a country that could possibly continue to deliver its education in a traditional manner for some time to come. It may be that, once the initial “sullen and hostile” reaction has been overcome, the high value placed on education by students in other environments will provide Thailand with an advantage over the students from Western Australia considered in this research. Another factor that is prominent in the
writing is the aim to produce life long learners who can keep pace with global competition. The U.K. system also has emphasised competition but much of the new (perhaps wisely diminishing) ‘egalitarian rhetoric’ within Western Australia appears to have discouraged competition, challenge and rigour, taking up a radical constructivist/post modernist posture with an integrated, flexible curriculum, less testing, and mixed ability classes. However, as Participant A states, “There seems to be an acceptance that we move away from traditional assessment methods. There’s probably a far greater move away than required because, from what I see of kids doing worksheets, even when these were completed, you were never sure they understood what they were doing or whether it was their own work, and there was no real measure of their understanding of that work and no real measure of the depth of understanding either.” There seems to be little point in creating an environment that supports “an egalitarian desire by teachers to avoid competition” (Lerman) within one school while students at ‘other’ schools are given a clear advantage that can be readily observed by teachers and the students themselves following transition.

The belief that students will live up to whatever expectations we might place on them (an idea, that this research confirms, frequently does not approximate to reality) is a dominant concept within some of the reforms that are taking place in education. To allow students in middle schools additional responsibilities, to avoid providing students with frequent feedback in a form that would allow them to explicitly rate their own potential and to adjust the assessment process to eliminate real challenges may be regarded as naïve. On the other hand it may be regarded, at least by those who wear the label ‘radical constructivists’, as a positive step which could provide ‘the educational promised land’ for students whose self efficacy previously would have been affected by a readily observed comparison with others. Unfortunately, the judgement of teachers of mathematics at the Senior College indicates that there are
many students who make the transition with inferior skills in mathematics and an unsatisfactory approach to study. Naturally, by informal methods, students come to the same conclusion for themselves.

Teachers are being asked, not only to accept reforms, but also to ‘sell them’ to the community, including parents and students. This expectation, which also tends to involve some of the characteristics of what some researchers refer to as ‘radical constructivism’ but, more precisely, can be regarded as constructivism under the influence of humanism and post modernism where subjectivism and open ended-ness are key features, does not lend itself very well to the teaching of mathematics. If one of the aims of these reforms is to provide “life long learners who can keep pace with global competition” (Thamraksa), it is extremely difficult to turn out resilient students if they do not face challenges in an environment where genuine feedback describes their progress in clear terms. Worse still, expecting teachers to promote something that they may not support may be perceived as encouraging them to surrender the integrity which has been a vital attribute in the traditional teaching model.

Participants in the interviews had varying opinions on mixed ability teaching of mathematics ranging from the fact that “More kids are likely to do better when they are in a heterogeneous situation( but) there’s a lot of learning (for teachers) to do (to be able to handle these situations)”, “having to be secretive about streaming” to “It doesn’t make sense from a mathematical point of view to have a wide range of abilities in the same class; it does not make sense at all!” Comments from the Dialogues are even more in favour of ‘tracking’.

Much of the literature states that adolescence spans Years 7, 8 and 9 while the Middle Schools in this research have involved Years 8, 9 and 10. Teachers who
choose to remain in these Middle schools move up with the students, as discussed in interviews, only to return to teach Year 8’s the following year. This means that the potential for consistent expertise at Year 10 level is restricted. Also, in some schools, teachers of mathematics have to fit in with a learning team in which they may need to teach another subject for up to fifty per cent of the time. One of the recommendations of this research must be that this expertise is not wasted in the way that it has been. Even if there is the prospect of a capable teacher of mathematics tolerating this situation and remaining in a middle school, it would seem to be a considerable waste.

The possibility of Year 10 being regarded as a transition year, in which students could be progressively prepared for the demands of Year 11 courses, would seem to be a more practical alternative that could make use of the expertise at a time when it would be most useful.

Students of mathematics at all levels are entitled to be taught by teachers of mathematics who, at the very least, can readily complete all problems that they give to students so that the competence and confidence in completing the problem may be conveyed to the student. Also, within the classroom situation, the teacher should be able to communicate alternative methods of solving problems in order to provide students with the opportunity to achieve a much better understanding. The following two quotes from students exemplify the desired consequences of this

“Explains everything well. Uses whiteboard notes not just referring us to the book”

“I actually listen to him. He holds my attention (which is very hard)”. (2005)
Conclusion

Student and teacher perceptions of preparation in mathematics in middle school and its impact on students’ self-efficacy and performance in an upper secondary school in Western Australia

As there are many influences that have led to the reforms for students in Years 8, 9 and 10, and specifically from Year 10 and the transition to Year 11 being considered in this research, there must be many components of this conclusion.

Constructivism has to be considered to some extent but, as stated on p.7 in the literature review, it is a mistake for the purposes of this research to get involved in discussions that consider more than the simple (von Glaserfeld calls it ‘trivial’) constructivism which states that knowledge is actively constructed by the learner, not passively received. Nevertheless it is tempting to get distracted by the many constructivist articles in which “it is rare to find ones with fully worked out epistemology, learning theory, or ethical and political positions”. The subjectivism of radical or social constructivism/ post modernism (and other extensions to the ‘active learner’ statement above) may provide worthwhile debates in other areas in education but can be a hindrance, with illusory challenges that complicate situations in mathematics education.

Mixed ability classes are also perceived to be a challenge for teachers of mathematics and this is emphasised in the interviews. During the first year of this research students responded with comments in the survey that indicated that teachers had to teach four pathways at once. Of course, as students were not exposed to classes grouped by ability within middle schools, from 2001 onwards there were no
further references to this. However there were comments that may be construed as relating to the consequences of mixed ability environments that were also confirmed by teacher interviews as being undesirable elements.

Some of these were

**(S)he was good but we mostly got work sheets all the time and not explained.** (2004)

**It was the same thing over and over in a million different ways.** (2004)

Clearly the debate that has raged since the 1970’s (at least), with regard to mixed ability teaching, has not been conclusive. There are teachers who are capable of communicating effectively (to students in a ‘streamed’ class) worked solutions to very complicated mathematical problems in a way that provides students with an understanding of these and, to a great extent, make these problems easier to understand. These specialist teachers have also traditionally provided a peaceful working environment for students to practice and extend these problems. However the same teacher, taken into a mixed ability environment, may meet up with chaos for the first time and may justifiably feel threatened at this change to what they perceived to be an effective teaching environment. One of the participants in the interview states “I think because the classroom nowadays is seen as being far more complex and kids are moving at different rates, teachers don’t know how to cope with that. How do you cope in a classroom where there’s a range of ability levels?”

At ‘Other’ schools, students receive the effective delivery of skills in mathematics together with accompanying rigour and gain an advantage over students of similar ability involved in a mixed ability situation where social, egalitarian practices may require more capable students to help the less able. Some students express dissatisfaction with this process because they get the feeling that their progress is being affected due to the time they spend helping others.
The flexible curriculum has provided misconceptions that exist even for experienced teachers who genuinely believed and operated under the belief that negative numbers should not be taught until level 5. These teachers were victims of a curriculum that was not structured and sequenced in the same way as previous syllabi. Verbose statements, regarded as not ‘user-friendly’ presented distractions, illusory challenges for teachers of mathematics that added to the poor preparation and compounded the problems for students when they entered senior school.

Following transition, students compared their preparation with others and, where this was deficient, some lost confidence stating

*I wasn’t taught most of the things we learn now so I feel behind.* (2004)

*I’m trying all I can but it’s a challenge.* (2004)

*From what we were taught he knew what he was doing, but we weren’t taught some of the stuff we needed for Year 11.* (2005)

The benefits of being placed in a middle school environment where each student was nurtured and made to feel empowered may have instilled a confidence in some that was unrealistic. For those with high outcome expectation who lose confidence resulting in low self-efficacy the outcome can involve self-depreciation and depression. (Pintrich and Schunk p 44 of the literature review)

Although the Year 11 courses can be (and have been) ‘tapered back’ to effect a smoother transition for students, teachers remain aware of the consequences of taking this too far. Feedback from the Curriculum Council certainly makes Senior School teachers accountable for inadequate preparation for Tertiary Entrance Examinations.
Hence the major concerns identified across the varying sources is the mismatch in approaches and skills between Middle Schools and the Senior College, including the reliance on students making suitable choices for themselves, the absence of specialist teachers in middle schools, mixed ability classes in which teachers find it difficult to operate efficiently and a flexible curriculum that failed to prepare many students for senior school.

**Recommendations**

There is clearly a need to provide students with an appropriate background in mathematics prior to transition together with a work ethic and the resulting self-efficacy that will sustain them during, and beyond, the short time that they spend in Year 11 and 12. The increasing possibility of a Year 13 provides an extra opportunity for students who need and are prepared to spend extra time in Senior School. However it is important for the retention and participation of the students arriving from middle schools to make sure that they are confident that their skills will compare favourably with students from other schools. Students should have clear and genuine ideas of their ability, and how they are likely to cope with the transition. The only way that this can achieved is by providing genuine (rigorous) challenges in Year 10.

There is a need to use Year 10 as a ‘transition year’ in which students are provided with a steadily increasing rigour in a course that is consistent with mathematics content at ‘other’ schools, placed in groups with similar ability where the subject can be delivered more effectively by teachers who have an affinity with the subject and can present it with or without the aid of technology. These students need to be reassured that they will be given credit for their effort and performance, and students,
such as those who choose work that is too easy for them or rely solely on the contribution of others in group work, must also receive what they deserve as they have done in mathematics education in the past.

There must be consideration of the consequences for students, who believed that they were prepared for a transition, only to find out that they were not. Undoubtedly the potential of technology to provide more lively and exciting situations will increase. Whether this will make mathematics as accessible to all as some would hope is yet to be seen but teachers of mathematics will certainly welcome a means to do this as long as a genuine contribution to the learning of mathematics is provided. Until then teachers of mathematics having tried some of the recommendations of ‘change merchants’ may decide to remain “unrelentingly focused” on the fundamentals.

Unfortunately the seemingly good intentions to make the subject accessible to all may have caused (and may continue to cause) irreversible damage in some situations for some students, even further disadvantaging students who are already disadvantaged. Teachers must avoid at all costs a repeat of the kind of mistakes and misinterpretations that have caused problems for students involved in transition from middle school to Senior College which has been a focus for the four years of this study.

**Limitations**

As this research was undertaken in a group of schools within one region of Western Australia, and the structure within this region involved middle schools from which students moved into the Senior College, some of the findings of this research may
not be readily transferable into other environments such as those involving Senior High Schools. However there will be some portions that teachers of mathematics will relate to their particular situation and this may assist during times when ‘tensions’, ‘low level disruptions’ or ‘illusory challenges’ impact on their ‘primary task’.

The limitations involved in the survey have already been discussed. Nevertheless, within schools, there are many surveys conducted which are valuable in providing schools with information that allow programs to be refined to suit current students. The recommendations of this research are also limited to the study of mathematics and it should be recognised that the requirements of mathematics are frequently different from those of other subjects.

**Future Research**

Surveys such as the one conducted in this research can provide information that allow teachers an opportunity to create an environment in which students may feel comfortable. The suggestions of Pintrich and Schunk and other publications, including the Curriculum Framework, provide further guidance for teachers. Some of these provide teachers with options for them to try, others confirm that the adjustment they made to their teaching method a while ago has been introduced effectively elsewhere and a few will remind them of something they tried but dispensed with because they didn’t suit the students or the situation at the time. The gentle transformation (referred to on p. 30 in the literature review) in which teachers make subtle adjustments to their approach as they see fit is likely to be the most genuine, successful and enduring type of change.

Any future research should either investigate the appropriate conditions for meaningful choice or produce outcomes that ‘resonate’ in a way that teachers can be
certain that they will not be expected to accept the blame for misinterpreting vague expectations. Students who have been nurtured and ‘supported’ within the type of environment described by middle school teachers may have lost some of the resilience and determination that could prove important in some of the more competitive, less comfortable environments that they may later encounter.

Participant A in the interviews (p.131) insists that we need to “help our kids to be more independent, be more persistent, take risks, take more responsibility for their own learning.” Of course, the provision of support where it is absent elsewhere, including the home, will undoubtedly provide a significant number of disadvantaged students with the opportunity to complete their education successfully. These successes have been documented within other research and will be consistently targeted in future research.

This research has shown that many students have made the transition to senior school mathematics without background skills. It has questioned the self efficacy and independence of students who have made this transition. There is much scope to enhance the research in this area with a view to ensuring that the holistic education of each student remains balanced and that students are adequately prepared for future challenges.
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Curriculum Framework for Kindergarten to Year 12 Education in Western Australia.


Appendix A.

The Kalamazoo model.

In the 1970’s a complex accountability system involving ratings (by peers, students, principals, teachers themselves and tests) was introduced in the district of Kalamazoo in Michigan. However the Education Association, acting on behalf of teachers, surveyed teachers regarding their opinions of the accountability system using a questionnaire. Results of a survey of staff indicated that many teachers disagreed with the view of the authorities with regard to the accountability system. While the Associations’ own survey included quantitative data, teacher’s qualitative responses (comments about the accountability system) added a dimension that the authorities could not ignore. All comments were typed verbatim and included in the report. These ‘open-ended questions’ returned ‘rich quotations’ that provided quality information supporting the quantitative results of the Education Associations’ questionnaire. Patten includes a number of these comments in his text including (Teacher response No. 257) “This system is creating an atmosphere of fear and intimidation. I can only speak for the school I am in, but people are tense, hostile and losing their humanity. Gone is the good will and team spirit of administration and staff and I believe this all begins at the top. One can work in these conditions but why, if it is to ‘shape up’ a few poor teachers. Instead, it’s having disastrous results on the whole faculty community.” Other comments, some of which Patten includes in his text, highlighted similar concerns from teachers.

School board members, who initially doubted the value of the results of the questionnaire, now perceived the teacher’s words as having “face value and credibility”. Although the effect of the quantitative data in this case is secondary in comparison to qualitative data, there are situations where a balance between the two has the potential to provide better quality of information (rich quotations) along with increased validity and credibility. Also quantitative data has the potential to identify important features, such as outliers, that may become a major focus of any research.

The model used in the survey (the major focus of this thesis) blends the qualitative method used in the Kalamazoo study with quantitative methods (including graphs to compare responses and correlations to emphasise further the “face value and credibility”).
On the Answer Paper (NOT on this paper) place a cross (X) on the letter that represents the correct answer.

(1) Find the value of $x$ in $2x + 5 = 12$
   a. 30
   b. 3.5
   c. 1.2
   d. 5
   e. 8.5

(2) Express $3\frac{1}{9}$ as a recurring decimal
   a. 3.19
   b. 3.1\overline{9}
   c. 3.9
   d. 3.1
   e. 3.9\overline{1}

(3) Find the length of a cubic box which holds 29.791 litres:
   a. 3.1 cm
   b. 14.89 cm
   c. 5.46 cm
   d. 9.93 cm
   e. 31 cm

(4) Estimate the radius of a circle with area 28cm$^2$:
   a. 3 cm
   b. 4.5 cm
   c. 14 cm
   d. 6 cm
   e. 9 cm
(5) Simplify \((a + 4) (2a – 3)\)
   a. \(2a^2 - 12\)
   b. \(2a^2 + 11a + 7\)
   c. \(2a^2 + 11a - 12\)
   d. \(2a^2 + 5a + 1\)
   e. \(2a^2 + 5a - 12\)

(6) Factorise \(6x^2 + 12xy + 18x^3\)
   a. \(1296x^6y\)
   b. \(6x(x + 2y + 3x^2)\)
   c. \(36x^3y\)
   d. \(3x(2x + 4y + 6x^2)\)
   e. \(18x(x + y + x^2)\)

(7) Factorise \(p^2 + 5p + 6\)
   a. \((p + 3)(p + 2)\)
   b. \((p + 6)(p - 1)\)
   c. \((p + 6)(p + 1)\)
   d. \(p(p + 5 + 6)\)
   e. \(12p^3\)

(8) A bike marked at $156.80 is sold at a discount of 13%. How much is paid (to the nearest 5c)?
   a. $20.30
   b. $177.20
   c. $13
   d. $136.40
   e. $156.80

(9) 30% of an amount is equal to $46.80. Find the full amount.
   a. $156
   b. $140.40
   c. $468
   d. $15.60
   e. $163.40

(10) Simple Interest can be calculated using the formula \(I = P \times R \times T\). If $5500 is invested (P) at 9% p.a. (I) for 5 years (T), calculate the Simple Interest:
   a. $7975
   b. $247500
   c. $2475
   d. $5595
   e. $247.50

175
(11) If $3x + 5y = 36$ and $4x + 7y = 49$ which of the following values for $x$ and $y$ are the correct simultaneous solutions.
   a. (5,4)
   b. (6,4)
   c. (8,1)
   d. (7,3)
   e. (6,6)

(12) Find $3^6$.
   a. 18
   b. 2
   c. 216
   d. 729
   e. 9

(13) Write 0.000023 using scientific notation.
   a. $2.3 \times 10^{-5}$
   b. $23 \times 10^{-6}$
   c. $2.3 \times 6$
   d. $2.3 \times 10^{-5}$
   e. $2.3 \times 10$

(14) Find the rule

<table>
<thead>
<tr>
<th>X</th>
<th>0</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Y</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>16</td>
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</tbody>
</table>

   a. $y = 3x + 1$
   b. $y = 4x$
   c. $y = -3x + 1$
   d. $y = 3x$
   e. $y = x$

(15) 5 men take 1 day to complete a job. Working at the same rate, how long would it take 10 men to complete the same job?
   a. 2 days
   b. 11 days
   c. 0.5 days
   d. 0.2 days
   e. 1 day

(16) Find the circumference of a circle with radius 5m.
   a. 15.7m
   b. 31.4m
   c. 10m
   d. 20m
   e. 78.5m
(17) In a class of 32 students there are 12 boys. The ratio of girls to boys (in simplest form) is
   a. 32:12
   b. 5:3
   c. 3:8
   d. 8:3
   e. 3:5

(18) From the diagram, state the size of AD
   a. 6m
   b. 7m
   c. 8m
   d. 5m
   e. 9m

(19) Find XY (to 1 d.p)
   a. 13.0m
   b. 8.5m
   c. 4.2m
   d. 18m
   e. 12

(20) Which of the following is not a reason for congruence:
   a. SSS
   b. AAS
   c. RHS
   d. SSA
   e. SAS
(21) In a green box there are 5 blue marbles, 3 red marbles, 6 green marbles and 10 white marbles. A marble is selected at random. Find the probability that the marble is green:

a. \( \frac{6}{23} \)

b. \( \frac{15}{24} \)

c. \( \frac{1}{4} \)

d. \( \frac{3}{5} \)

e. \( \frac{5}{8} \)

(22) Find \( x \)

![Diagram](image)

a. \( 75^\circ \)

b. \( 285^\circ \)

c. \( 15^\circ \)

d. \( 105^\circ \)

e. \( 150^\circ \)

(23) What was your reason in No. 22

a. Vertically opposite angles

b. Alternate angles

c. Corresponding angles

d. Co-interior angles

e. Complementary angles
(24) Find $x$ in the triangle below (to 2 d.p.)

![Triangle with sides 8m and 5m and angle $32.00^\circ$]

a. $32.00^\circ$
b. $51.32^\circ$
c. $6.24$ m
d. $38.68^\circ$
e. $57.99^\circ$

(25) Find $x$ in this triangle (to 2 d.p.)

![Triangle with side 5m and angle $43^\circ$]

a. $5.36$ m
b. $7.33$ m
c. $6.84$ m
d. $3.41$ m
e. $4.66$ m
(26) Solve for \( x \); \( 4(x + 4) - 2 = 8 \)
   a. \( x = 0 \)
   b. \( x = -2.5 \)
   c. \( x = 1.5 \)
   d. \( x = -1.5 \)
   e. \( x = 2 \)

(27) Find \( x \) in this right triangle (to 1 d.p).

![Right Triangle Diagram]

a. 8.5 cm
b. 11 cm
c. 7.4 cm
d. 3.3 cm
e. 55 cm

(28) If \( a = -3 \), \( b = 2 \) and \( c = -4 \) find \( \frac{b^2 - c^2}{a^2} \)
   a. \( -\frac{7}{9} \)
   b. \( -1 \frac{1}{3} \)
   c. \( -2 \)
   d. \( -2 \frac{2}{9} \)
   e. 2

(29) Find the gradient of the line joining \((0, -2)\) to \((8, 14)\).
   a. \( m = \frac{1}{2} \)
   b. \( m = 2 \)
   c. \( m = 18 \)
   d. \( m = 29 \)
   e. \( m = 6 \)
(30) State the equation of the line joining (0, -2) to (8, 14).
   a. \( y = 0.5x - 2 \)
   b. \( y = 6x - 2 \)
   c. \( y = 1.63x \)
   d. \( y = 2x - 2 \)
   e. \( y = x - 2 \)

(31) Simplify \(\frac{(x^2)^{-1} \cdot (x^3y)^2}{(x^0y^2)^3}\)
   a. \(\frac{x^6}{y^4}\)
   b. \(\frac{x^2}{y^4}\)
   c. \(\frac{1}{x^2y^3}\)
   d. \(x^2y^3\)
   e. \(\frac{1}{x^2y^3}\)

(32) Factorise \(6x^2 + x - 12\)
   a. \((2x - 3)(3x + 4)\)
   b. \((2x + 3)(3x - 4)\)
   c. \((6x - 1)(x + 12)\)
   d. \((6x + 1)(x - 12)\)
   d. \((3x - 3)(2x + 4)\)

(33) Solve for \(x\): \(2x^2 + 7x - 4 = 0\)
   a. \(\{-4, \frac{1}{2}\}\)
   b. \(\{-\frac{1}{2}, 4\}\)
   c. \(\{-4\}\)
   d. \(2\)
   e. \(\{-2, -7, 4\}\)

(33) State the turning point of \(y = (x + 3)^2 - 2\)
   a. \((3, -2)\)
   b. \((3, 2)\)
   c. \((0, 7)\)
   d. \((-3, -2)\)
   e. does not exist

(35) State the \(y\) intercept of \(y = (x + 3)^2 - 2\)
   a. \((0, -2)\)
   b. \((-2, 0)\)
   c. \((0, 7)\)
   d. \((-3, 0)\)
   e. \((0, 4)\)
(36) Use the table below to find the rule:

<table>
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<tr>
<th>X</th>
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<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Y</td>
<td>-1</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>15</td>
<td>24</td>
</tr>
</tbody>
</table>

a. \( y = (x - 1)^2 \)
b. \( y = -x^2 + 1 \)
c. \( y = (x + 1)^2 \)
d. \( y = x^2 - 1 \)
e. \( y = x^2 + 1 \)

(37) Use the diagram to find the rule for the function:

a. \( y = (x - 2)^2 \)
b. \( y = (x + 2)^2 - 3 \)
c. \( y = 2(x + 2)^2 - 3 \)
d. \( y = -(x + 2)^2 + 3 \)
e. \( y = (x + 3)^2 - 2 \)
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APPENDIX C

Student Survey Transition from Year 10 to Year 11

1. I am doing all that I can to succeed in my chosen courses.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

2. In general I am confident that I can succeed in the courses that I have chosen.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

3. My background in Mathematics was suitable for my chosen Year 11 course.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

4. I am coping very well with my Mathematics.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

5. The level to which I am applying myself in Mathematics is
   Very High  High  Satisfactory  Poor  Inadequate
   Comment_____________________________________________________________

6. My current Mathematics teacher knows and teaches the subject extremely well.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

7. My Year 10 Mathematics teacher knew and taught the subject extremely well.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

8. I work in the library during my free time
   Not at all  Once a week  Twice a week  Three times a week  More than 3 times a week
   Comment_____________________________________________________________

9. My Mathematics teacher is doing everything possible to help me succeed.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________

10. I realise that, no matter how much my teacher helps me, it is my own determined and consistent effort that is important for me to achieve success.
   Strongly Agree  Agree  Slightly Agree  Slightly Disagree  Disagree  Strongly Disagree
   Comment_____________________________________________________________
Items 11 to 20 included only in 2005 survey.

11. I have always liked mathematics.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

12. My interest in mathematics is increasing.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

13. I do not believe mathematics is important.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

14. My parents believe that mathematics is important.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

15. My success in mathematics depends on my mathematics teacher.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

16. I am losing interest in mathematics.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________

17. I do not think that mathematics is relevant for my future.
   Strongly Agree      Agree      Disagree  Strongly Disagree
   Comment__________________________________________________________
18. My confidence in my mathematics ability increases when I have a mathematics teacher who teaches the subject well.

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19. I feel confident in my ability in mathematics

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20. Mathematics has never been one of my favourite subjects.

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Appendix D – Alpha 1

***** Method 2 (covariance matrix) will be used for this analysis *****

### RELIABILITY ANALYSIS – SCALE (ALPHA)

#### Correlation Matrix

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### RELIABILITY ANALYSIS – SCALE (ALPHA)

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Reliability Coefficients 20 items

Alpha = .5932

Standardized item alpha = .5295

N of Cases = 138.0

#### Alpha 2.

### Reliability Analysis - Scale (Alpha)

#### Item-total Statistics

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N of Statistics for Mean Variance Std Dev Variables

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Reliability Coefficients  17 items

Alpha = .8014  Standardized item alpha = .8201
# Appendix E - Regression

## Variables Entered/Removed

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<th>Method</th>
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a. All requested variables entered.
b. Dependent Variable: SETOT

## Model Summary

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a. Predictors: (Constant), SKTEST, SDTOT, PTTOT, CTTOT

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a. Predictors: (Constant), SKTEST, SDTOT, PTTOT, CTTOT
b. Dependent Variable: SETOT

## Coefficients

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a. Dependent Variable: SETOT
Variables Entered/Removed

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a. All requested variables entered.
b. Dependent Variable: MATMARK

Model Summary

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a. Predictors: (Constant), SETOT, CTTOT, PTTOT, SDTOT, SKTEST

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a. Predictors: (Constant), SETOT, CTTOT, PTTOT, SDTOT, SKTEST
b. Dependent Variable: MATMARK

Coefficients

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a. Dependent Variable: MATMARK
## Nonparametric Correlations

| Spearman's rho | YEAR | Correlation Coefficient | Sig. (2-tailed) | N   | SCHOOL | Correlation Coefficient | Sig. (2-tailed) | N   | SKTEST | Correlation Coefficient | Sig. (2-tailed) | N   | MATMARK | Correlation Coefficient | Sig. (2-tailed) | N   | SETOT | Correlation Coefficient | Sig. (2-tailed) | N   | CTTOT | Correlation Coefficient | Sig. (2-tailed) | N   | PTTOT | Correlation Coefficient | Sig. (2-tailed) | N   | SDTOT | Correlation Coefficient | Sig. (2-tailed) | N   |
|---------------|------|--------------------------|----------------|-----|--------|--------------------------|----------------|-----|--------|--------------------------|----------------|-----|---------|--------------------------|----------------|-----|--------|--------------------------|----------------|-----|--------|--------------------------|----------------|-----|--------|--------------------------|----------------|-----|
|               |      |                           |                |     |        |                           |                |     |        |                           |                |     |         |                           |                |     |        |                           |                |     |        |                           |                |     |        |                           |                |     |
| Spearman's rho | YEAR | Correlation Coefficient | Sig. (2-tailed) | N   | SCHOOL | Correlation Coefficient | Sig. (2-tailed) | N   | SKTEST | Correlation Coefficient | Sig. (2-tailed) | N   | MATMARK | Correlation Coefficient | Sig. (2-tailed) | N   | SETOT | Correlation Coefficient | Sig. (2-tailed) | N   | CTTOT | Correlation Coefficient | Sig. (2-tailed) | N   | PTTOT | Correlation Coefficient | Sig. (2-tailed) | N   | SDTOT | Correlation Coefficient | Sig. (2-tailed) | N   |
| **.**         | .000 | .408*                    | -.182*         | .097 | .008*  | -.145*                    | .156*          | .162* | .193*  | .165*                    | .165*          | .165 | .165*   | .156*                     | .156*          | .156 | .156*  | .156*                     | .156*          | .156 | .156*  | .156*                     | .156*          | .156 |
| **.**         | .045 | .097*                    | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .165 | .165*                    | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*   | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 |
| **.**         | .288 | .000*                    | .000*          | .026 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .165 | .122                     | .122           | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*   | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 |
| **.**         | .045 | .097*                    | .033           | .026 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .165 | .122                     | .122           | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*   | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 |
| **.**         | .156 | .313*                    | .285**         | .143 | .385*  | .385*                     | .385*          | .385 | .385*  | .385*                     | .385*          | .385 | .385*   | .385*                     | .385*          | .385 | .385*  | .385*                     | .385*          | .385 | .385*  | .385*                     | .385*          | .385 |
| **.**         | .030 | .000*                    | .001           | .117 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .165 | .087                     | .015           | .089 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .026 | .924*                    | .015           | .089 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*   | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 | .000*  | .000*                     | .000*          | .000 |
| **.**         | .193 | .122                     | .122           | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*   | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 | .122*  | .122*                     | .122*          | .122 |

**.** Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).
In general I am confident that I can succeed in my chosen courses. (confidence overall)

I am coping very well with my mathematics. (coping)

I have always liked mathematics

My interest in mathematics is increasing.

I do not believe that mathematics is important

I am losing interest in mathematics.

The graph of student’s perception of their confidence is skewed to the right. This means that if students perceptions are reliable, students have generally chosen courses to which they are suited. There are more who ‘strongly agree’ in 2004 and Semester 1 results, especially for those enrolled in the more challenging subjects, indicate that this confidence is justified.

Comments from students and teachers, considered later, provide more detail. 2002 students had some reservations, possibly because these students, during Year 8 and 9, worked under the Unit Curriculum and had a clearer idea of expectations in a more ‘rigorous’ course.

There are a significant number of students who disagree (to some extent) that they are not coping with their mathematics.

Using graph 12 and 16 more than half of these students were becoming more interested in mathematics, with 14% losing interest. Also 85% (approximately) disagreed with the statement (13) that mathematics is not important.
Responses to statement 17 are consistent with Statement 13. There is a significant number of students who do not feel confident in their ability in mathematics. There are 40% of these students have never placed mathematics amongst their favourite subjects so, while students tend to respond positively to the relevance and importance of mathematics, they perceive it as something that they need to do rather than something that they look forward to.

This confirms some of the considerations in the literature and qualitative data from interviews should provide more details.
6. My current mathematics teacher knows and teaches the subject well. (Present teacher)

9. My mathematics teacher is doing everything possible to help me succeed.

Although there are fewer students who strongly agree, the shortfall is made up by those who agree. There are no major concerns at the other extreme.

While there are a few who disagree with the statement, it would be a concern if any students continued to perceive that teachers were not helping. With tutoring available and the classroom teacher able and willing to help, the few who disagreed with this statement probably needed to avail themselves of the support. At the same time there is a need for students to develop independence. (As Mason observes ‘pushing may help students get through a barrier’ but they also need to develop a responsibility for their own learning.)

Student’s Perspective on Current Teaching.

Unfortunately there is an increased perception by some students who disagreed that their background in mathematics was suitable and this requires further investigation in interviews.

Compared with the pattern on the previous graph, there are some undesirable features. The graph is not as skewed to the right as we would expect. 52% of students in 2002 disagreed with the statement. In 2003 and 2004 this decreased to 38% but, in 2004, ‘strongly disagree’ increases by 15% on 2003. Student comments and teacher interviews may provide some insight.

Student’s Perspective on Prior Teaching
1. I am doing all that I can to succeed in my chosen courses. (work ethic overall)

Elements of Self Directed Regulation. (Control over Learning, Independence)

2. While there are variations over the years, the graph is skewed to the right as we might expect for this statement. Students in general believe that they are doing all that they can to succeed (working to capacity).

3. There is some variation in the perceived level of application in mathematics over the 4 years. Confirmation that this level of application is genuine can be investigated using the judgements teachers of mathematics at the Senior College.

4. My success in mathematics depends on my mathematics teacher.

5. My parents believe that mathematics is important.

6. My confidence in my mathematics ability increases when I have a mathematics teacher who teaches the subject well.

7. While there are variations over the years, the graph is skewed to the right as we might expect for this statement. Students in general believe that they are doing all that they can to succeed (working to capacity).

8. This item was originally included to ascertain whether students, especially those who were not coping, showed a determination to rise to the challenge by utilising the College library. However student comments indicate that there were other considerations. Time available during the school day, the need to catch buses, other commitments and preference to work at home made it difficult to consider students' library use as a guide.

9. Omitted
Appendix G

Berger T.R. (2000, P. 61, How Do We Describe an Interdisciplinary Curriculum)

Goals for Process.

The world expects our students to have skills usually not explicitly taught in school. Might it not be time to make some of these explicit? Let me state some particular skills so that you can react to them. These types of skills involve general competencies applied particularly to the mathematical enterprise. Frequently in English courses students learn how to use the campus library. But when asked to do so in a mathematics course, the students are often unable to perform the simplest tasks. That is our assumption that “English can take care of this issue” is not valid. Knowledge does not transfer quite as easily as we hope. So we may want to help our students learn process skills in the context they will use them within our discipline for the first two years (of University). Are there ones on the list that are optional? Are there missing ones that are crucial?”

1. Learning Skills.
   a. Students should be able to join a team and learn the basic principles of a new topic from a given body of text or referenced material.
   b. Students should, on their own, be able to learn the basic principles of a new topic from a given body of text or reference material.
   c. Students should be able to acquire the basic principles of a new topic from a lecture at the appropriate level.

2. Resource skills
   a. Given a specific mathematical topic, students should be able to
      i. find resources at the appropriate level on the given topic in the library.
      ii. find resources on the Web and know how to check for validity and accuracy,
      and iii. find resources within the community
   b. Students should be able to appropriately organize the results of research for the task at hand.
   c. Students should know about standards for plagiarism, bibliographic style and presentation style within their area of concentration.

   a. Students should be able to write solutions to problems in a way that communicates to a general mathematical audience.
   b. Students should have experience in writing extended reports on mathematics.
c. Students should be able to orally present mathematics of the appropriate level to a group of peers.

4. Working skills.
   a. Students should be able to learn to use computer tools and have some knowledge of their own learning curve for such tools (i.e., how long will it take to learn and what level of effort must be invested?)
   b. Students should work effectively as a member of a team on an extended mathematical problem.
   c. Students should have experience working on an interdisciplinary team or interdisciplinary problem.

5. Problem Solving Skills.
   a. Students should have experience in working on extended mathematical problems.
   b. Students should understand problem-solving processes and be able to articulate and apply these processes?

And also

6. Summarise skills.
   Students should have experience working on a team and bringing together most of their process skills and much of their knowledge. The experience should involve problem clarification, resource gathering, problem solving, application of mathematics, use of appropriate technological tools, report generation, and written and oral communication of results.