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# Prior achievement, effort, and mathematics attitude as predictors of current achievement

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## Abstract

*A sample of Australian secondary school students was used to explore the relationships among a set of standardised Year 7 numeracy and literacy tests, measures taken at Year 10 of mathematics attitude and schoolwork effort, and Mathematics and English scores in a state-wide Year 10 examination. Additionally, the predictive capacity of the numeracy and literacy tests, together with the attitude and effort measures, were examined in relation to the Mathematics and English scores. A correlation analysis showed that the numeracy and literacy tests were positively and significantly related and had similar relationships with the two Year 10 examination scores. Mathematics attitude was significantly associated with Year 10 Mathematics but effort did not correlate significantly with either of the Year 10 examination scores. Multiple regression analyses demonstrated that the relevant Year 7 test results contributed to a considerable amount of the total variance in the two Year 10 examination scores. A sub-sample of the students was interviewed and four case studies were selected to interrogate the notions of achievement, mathematics attitude, and effort. Although these case studies act as a source of qualitative evidence to supplement the quantitative findings, they also indicate that effort, in particular, is a notion worthy of further investigation. Other implications for researchers, as well as school personnel, are noted.*

## Introduction

According to Georgiou (2008), beliefs about achievement fit into two categories. The first category places an emphasis on *ability* (the Western tradition) and a second underscores the importance of *effort* (an Eastern tradition). Although Georgiou concedes that “this bipolar categorisation may be an oversimplification [as] there are many different countries within each of the two basic cultural frameworks” (2008, p. 121), the two

categories are arguably pivotal in any examination of achievement per se but particularly in a study of the predictors of school achievement.

### **Ability**

With respect to ability, previous research has shown that the achievements of both primary school and secondary school students are strongly influenced by ability and/or a proxy measure of ability referred to as prior achievement. To illustrate, Spinath, Spinath, Harlaar, and Plomin (2005) found that general mental ability was the main predictor of achievement in a large sample of nine-year-old British children. In another British study, Aubrey, Dahl and Godfrey (2006) concluded from their analysis of longitudinal mathematical data that early mathematical abilities and skills were highly advantageous for later mathematical success.

Researching in an Australian school setting and utilising a two-year longitudinal design, Yates (2000) noted that prior achievement in mathematics was strongly predictive of later achievement in mathematics. Her South Australian state study focussed on students aged between 8 and 12 years. Hemmings (1996) demonstrated that previous school achievement in English, Mathematics, and Science, based on state-wide Year 10 examinations in New South Wales (NSW), Australia was a very positive and significant predictor of Year 12 Tertiary Entrance Rank. In fact, the Year 10 composite measure accounted for over 60 percent of the variance in the Year 12 result.

North American studies have also pointed to a clear relationship between ability (or prior achievement) and current achievement. For example, Aiken (1972) showed that linguistic abilities affect the mathematical performances of primary school students. Reynolds (1981) revealed that prior achievement was a salient predictor of both mathematics and science knowledge at Year 8. More recently, Thomas (2002) has highlighted the importance of previous results in English and how these impact on reading performance at the junior secondary school level.

In summary, all of the studies reviewed in this section indicate that ability (as often measured through previous achievement in contrast to more general ability measures such as IQ tests) is a predictor of school achievement in a range of Western contexts. And, that it can have a dominant and positive influence on later performance.

### **Effort**

“Effort refers to the energy expended on a task (whether that effort is general and typical or specific to the task)” (McInerney & McInerney, 1994, p. 359). One measure of general effort with regard to schoolwork that has been reported in the research literature is the Effort scale comprising part of the “Inventory of School Motivation” (e.g.,

Ali & McInerney, 2005). This inventory has been validated trans-nationally and across various cultural groups, including Aboriginal Australian and Navajo. The Effort scale, like the other scales forming the inventory, has been shown to be psychometrically sound and, when used as an independent variable, to be a positive and significant predictor of English rank with Australian and North American secondary school samples. Furthermore, this measure of effort had a consistent positive influence on Grade Point Average for most of the samples. Interestingly, effort did not have a significant effect on mathematics achievement for the same cohorts.

Even though effort is a construct that is frequently considered in educational contexts, and is the focus of school reporting for parents (e.g., Woolfolk, 2005), relatively few direct references are made to a measure of the construct in the research literature pertaining to school achievement. What tends to be reported in the research literature are references to terms such as academic engagement, motives, self-worth, and causal attributions associated with the construct (e.g., Covington, 2000; Covington & Omelich, 1979; Yates, 2000). Additionally, descriptions of the effort construct periodically appear in educational psychology textbooks as a means of linking the construct to a practical application or a theoretical perspective such as expectancy theory (e.g., Slavin, 1994). To elaborate, Woolfolk (2005), in her textbook, discusses the link between effort and the likely expected return for the individual student, but directs her discussion to particular domains and specific tasks.

In short, the notion of effort is widely used by writers, researchers, teachers, students, and others with an educational stake, particularly in relation to student motivation. However, its relative influence and predictive capacity in terms of school achievement has been rarely reported in the research literature.

### **Mathematics attitude**

A relationship between achievement in mathematics and attitude towards mathematics has been shown to exist. Vachon (1984) noted that a small but positive association was evident in a series of studies he reviewed, with correlation coefficients ranging from .15 to .4. Through his own empirical work, he was able to demonstrate, for a sample of Year 9 students studying in North America, a similar finding ( $r=.21$  to  $.25$ ). Results of this magnitude have generally been replicated during the last decade. For example, Ai (2002), drawing on the Longitudinal Study of American Youth database for students in Years 7 to 10, found that attitude towards mathematics was one of a number of factors that was significantly related to success in mathematics. Similarly, and using a cohort of comparable age, Bouchey and Harter (2005) reported that students' perceived mathematical confidence was a good predictor of mathematical achievement. And, Singh, Granville and Dika (2002), focusing on a random sample of

Year 8 students selected from the United States National Education Longitudinal Study (NELS), demonstrated a significant and positive association between mathematics attitude and mathematics attainment.

Researching in a New Zealand context, Grootenboer and Hemmings (2007) showed that a sample of students aged between 8 and 13 years who indicated a positive view of mathematics were more likely to be rated by their respective mathematics teachers as performing highly in mathematics ( $r=.36$ ). Moreover, when this variable was entered in a logistic regression with a set of other predictors, including ethnicity, SES, and other measures of mathematics affect, *positive view of mathematics* was shown to be a highly significant contributor to a model designed to explain and predict differential mathematical performance. Although the amount of explained variance, as measured by a pseudo- $R^2$ , was relatively substantial, these researchers suggested that a measure of prior achievement, using standardised test results, would have potentially strengthened the model being posited and tested. Indeed, mathematics attitude may be a moderator variable between prior and current achievement.

To sum, there is strong and consistent evidence that attitude towards mathematics and mathematical achievement are inextricably linked. That is, the more positive the attitude a student holds towards executing mathematical tasks, the better the achievement on those tasks and vice versa.

### **Literacy and numeracy relationships**

In spite of the large-scale use of standardised literacy (e.g., reading and writing) and numeracy (e.g., number, space, and geometry) tests in schools, not much information has been reported in the research literature about the relationship between these tests and their various parts. The information that has been shared has three main characteristics: first, a dominance of North American studies; second, a tendency to draw on data from primary school cohorts; and third, a reliance on dated sources. To exemplify, Mehta, Foorman, Branum-Martin and Taylor (2005) documented a set of relations based on data from a sample of mostly African American primary school students. They found significant correlations between word reading and writing ( $r=.59$ ), word reading and spelling ( $r=.73$ ), and spelling and writing ( $r=.52$ ) amongst the Year 4 cohort. These researchers also carried out the same correlation analysis with Year 3 data and the results were strikingly similar. In an extensive review of language and its association with the learning of mathematics, Aiken (1972) reported correlations between reading ability and mathematics achievement ranging between .40 and .86. Some of the studies chosen in his review were conducted in the 1960s and used predominantly Californian data sets. His analysis of these particular data revealed that spelling and specific arithmetic tests correlated, on average, at .60; a finding in line with those reported by Thomas (2002) who found a relationship between mathematics and reading

proficiency ( $r=.46$ ). It needs to be noted, however, that this result was based on data collected in the 1988 NELS.

While literacy and numeracy testing is commonplace in Australian schools, only one study acknowledging the relations between the tests has appeared in the research literature. This study was carried out by Marks and Ainley (1997) and investigated data across a 20-year time span. The sole correlation coefficient noted in their work was that reading comprehension and numeracy had a correlation of .60 for a sample of 13 to 15 year olds.

It is surprising that although an Australia-wide testing scheme, namely, Literacy and Numeracy National Assessment (LANNA), developed by the Australian Council of Educational Research, has been implemented from 1999 to 2007, no analysis of these data has been published in the research literature to show the relationships between and among the different LANNA tests. The literacy component was measured by three tests – reading, writing, and spelling – and numeracy was assessed by one test examining number, space, measurement, and, chance and data. Students enrolled in Years 3, 5 and 7 in non-government schools could have sat these tests.

To cap, little is reported in the research literature about standardised literacy and numeracy tests and the relations among these tests. What is reported tends to be dated, North American, and based on data gathered from primary school students. An obvious gap exists in the research literature and especially in Australian reporting as no study detailing correlations or more elaborate statistical analyses has been published since 1997, despite the advent of a national testing scheme referred to as LANNA and the emergence of other basic skills testing regimes.

### **Theoretical Framework**

The theoretical framework underpinning the current study is that ability, as indicated by previous achievement, is a predictor of subsequent school achievement. And, that this relationship may be sustained over a lengthy time-frame. Moreover, it is anticipated that this relationship between previous and later achievement, particularly during the period of adolescence, will be mediated by the influence of general schoolwork effort. However, in the case of particular subjects, specific attitudes may represent a further moderating factor to the relationship between previous and later achievement in that subject. In the present study, Year 7 achievement in literacy and numeracy areas, along with self-reported schoolwork effort, were used to predict Year 10 Mathematics and English results. With respect to Year 10 Mathematics, an additional measure, namely, attitudes towards mathematics, was used as a predictive factor.

The present study had a number of aims. Firstly, it sought to explore the relationships among the Year 7 LANNA tests, namely, reading, writing, spelling, and numeracy.

Secondly, it aimed to examine how the various LANNA tests, along with measures of schoolwork effort and mathematics attitude taken at Year 10, were related to Mathematics and English scores in a state-wide Year 10 examination. Thirdly, as an extension of the previous aim, it investigated the predictive capacity of selected LANNA tests, together with the attitude and effort measures, in relation to Year 10 Mathematics and English scores. And fourthly, it sought to interrogate further the notions of effort and mathematics attitude, and how they might influence school achievement, by constructing case studies based on both statistical information and interview data.

## **Method**

### **Participants**

The participants were drawn from all students (N=78) who were enrolled at Year 10 (in 2008) in an independent co-educational secondary school situated in regional NSW, Australia. Most of these students had sat Year 7 LANNA tests during 2005 and then continued their schooling to Year 10. As an independent school this school draws from a somewhat higher SES background and this is reflected in the LANNA results showing that only two students failed to reach the Year 7 benchmark in Numeracy and one in Reading.

During Year 10, the participating students, aged between 15.7 and 16.8 years, completed state-wide, compulsory School Certificate (SC) examinations in both Mathematics and English. Apart from sitting these examinations, the participants also completed a short questionnaire (see Appendix A). A breakdown by gender indicates that the students were approximately evenly split with regard to males and females.

A sub-sample of the participants (N=10) was chosen for interview based on two criteria, namely, gender balance and achievement spread. As a result, this sub-sample was comprised of five males and five females with scores in Year 7 and 10 ranging from low to high.

### **Instrumentation**

The development of the questionnaire involved a literature review, piloting, and expert panel advice. This developmental process was in accord with suggestions made by methodologists such as de Vaus (2002) and Cohen, Manion and Morrison (2007). The questionnaire was divided into two sections. The first section sought information on gender but was principally designed to have LANNA test and SC examination results added to the instrument by a school representative so that the results of both sections could be matched for subsequent analysis. Although the LANNA and SC results were supplied by the participating school, these results were based on data either tallied by

the ACER or the NSW Board of Studies. The LANNA and the SC Mathematics and English results are scaled scores.

Section two consisted of 14 items that were devised to tap into two dimensions, namely, *attitudes towards mathematics* and *schoolwork effort*. All of these items were drawn from the “Kids’ Ideas about Maths” instrument (see Grootenboer & Hemmings, 2007) and the “Inventory of School Motivation” (see Ali & McInerney, 2005). The items asked participants to indicate their level of agreement or disagreement with a statement, using a 5-point scale. A measure, referred to as Maths Attitude, was derived from a scale analysis (using SPSS, Version 16.0 and the “Reliability” program). Maths Attitude was formed from six items, namely, items 2, 4, 7, 8, 10, and 11 and had a Cronbach’s alpha of .89. One item was recoded and Item 6 was deleted. In hindsight, this particular item tended to fit with a utilitarian or practical viewpoint and it was not overly surprising that its psychometric properties were not consistent with the other items forming the scale. A measure known as Effort was prepared in a similar fashion. This measure consisted of items 1, 3, 5, 9, 12, 13, and 14 and had a Cronbach’s alpha of .76. Both scales were produced by summing the respective item scores and then dividing by the total number of items.

It needs to be noted that all of the measures, with one specific exception, had kurtosis and skewness values within or reasonably close to the range -1 to +1 and thus deemed to be appropriately normally distributed and suitable for analysis using bivariate and multivariate techniques (see Hair, Anderson, Tatham, & Black, 1998). The kurtosis and skewness values, as well as the number of cases, mean, and standard deviation of the respective measures, are presented in Table 1. Additionally, the highest possible scores for the four LANNA tests and their respective benchmarks are shown in Table 2.

Measures								
Measures	Numeracy	Reading	Spelling	Writing	Maths Attitude	Effort	SC Maths	SC English
N	60	58	58	58	78	78	77	76
Mean	127.97	118.40	120.38	123.97	2.65	3.60	75.48	78.95
Standard Deviation	12.95	8.69	9.09	9.81	.94	.56	10.36	7.79
Skewness	.72	.03	.25	.28	.52	-.05	-.03	-.39
Kurtosis	2.87	.08	1.52	-.31	-.14	.24	-.85	-.53

**Table 1: Descriptive Statistics of the Measures**

An interview schedule was also prepared. Its development was similar to that of the questionnaire in that the related literature and advice from experts were used. Where appropriate, the interview questions corresponded with particular questions in the questionnaire such that the interview acted as a source of qualitative evidence to

supplement the findings of the quantitative analyses undertaken. It was also expected that the interview would contribute to the view of the total picture being sketched.

Tests				
	Numeracy	Reading	Spelling	Writing
Score	178	155	149	166
Benchmark	110	99	Not calculated	105

**Table 2: Highest Possible Scores and Benchmarks for the LANNA Tests**

### Procedure

A delegated school representative administered the questionnaire during normal lesson time. This representative then added the LANNA scores and SC examination results to the completed questionnaire. Following these additions, the names of the participants were removed from the questionnaires. However, before the researchers were able to collect the questionnaires a coding system was developed by the school's representative in order to permit a link between the completed questionnaires and the 10 participants who were interviewed about their attitudes towards mathematics and the effort they expended in regards to their general schoolwork. The interviews averaged 20 minutes and were conducted by the senior author. Hand-written notes were taken as audio-taping with participants of this age can be both distracting and intimidating (Cohen et al., 2007). These notes were later expanded to permit a more thorough and systematic analysis of the interview data so that individual case studies could be constructed by using LANNA scores, SC results, and Maths Attitude and Effort measures. To assist in this process, the four LANNA scores, two SC results, Maths Attitude, and Effort for each interviewee were standardised.

### Results

A correlation matrix is presented in Table 3. This matrix was produced by using the *Correlate* program in SPSS via the Pearson-product moment method. An inspection of the correlation coefficients revealed that all the LANNA tests were positively and significantly related ( $p < .01$ ) and, in addition, had significant correlations with the two SC measures. Interestingly, Effort was significantly associated with Maths Attitude but did not correlate significantly with SC Maths and SC English.

In order to ascertain the predictive capacity of the different LANNA tests coupled with the two survey measures, and the results in Mathematics and English at Year 10, several multiple regression analyses were run using the *Regression* program in SPSS. Given the relatively small size of the samples involved, it was decided to restrict the number of independent variables in each regression equation. That is, only variables with a strong



conceptual link to the dependent variable were included. Nevertheless, using Cohen's (1988) statistical power tables, the sample size (N=56), for four predictor variables and significance at .05 level, indicated power of approximately 60% for medium effect sizes and 90% for large effect sizes, which were expected to occur in this study.

Measures	1	2	3	4	5	6	7	8
1. Numeracy	1							
2. Reading	.742**	1						
3. Spelling	.573**	.586**	1					
4. Writing	.596**	.586**	.569**	1				
5. Maths Attitude	.326*	.352**	.247	.275*	1			
6. Effort	-.134	-.018	-.032	.059	.552**	1		
7. SC Maths	.774**	.795**	.572**	.553**	.444**	.035	1	
8. SC English	.506**	.697**	.643**	.671**	.250*	.161	.618**	1

\* $p < .05$ ; \*\* $p < .01$  (2-tailed)

**Table 3: Correlation Matrix**

When SC Maths was the dependent measure, only Numeracy and Reading added significantly to the explained variance, accounting for 70.6% of the variance (see Table 4). Both Maths Attitude and Effort did not make a significant contribution. In other words, a student's performance in the LANNA Numeracy and Reading tests in Year 7 was a significant predictor of his/her performance in Year 10 Mathematics.

In relation to SC English, Reading, Writing, and Spelling all contributed to the total explained variance, explaining 63.2% of the variance (see Table 5). Effort did not make a significant contribution. Further analysis was undertaken to investigate the interaction of effort with Numeracy and Reading scores but these failed to enhance the predictability of the SC Maths and English results. Once again, performance in selected Year 7 tests was the main predictor of performance in a Year 10 examination.

Predictor Variable	Beta Model 1	$p$	Beta Model 2	$p$
Numeracy	.40*	.001	.34*	.005
Reading	.50*	<.001	.48*	<.001
Maths Attitude			.18	ns
Effort			-.16	ns
$R^2$	.706*	<.001	.724*	<.001
$R^2$ Change	.706*	<.001	.018	ns

\* $p < .05$   
ns - not significant

**Table 4: Multiple Regression Model of Predictors of SC Maths (N=56)**

Predictor Variable	Beta Model 1	p	Beta Model 2	p
Reading	.37*	.002	.37*	.001
Writing	.32*	.006	.31*	.007
Spelling	.25*	.023	.26*	.021
Effort			.07	ns
$R^2$	.632*	<.001	.637*	<.001
$R^2$ Change	.632*	<.001	.005	ns

\* $p < .05$   
ns - not significant

**Table 5: Multiple Regression Model of Predictors of SC English (N=56)**

As noted earlier about the data used to prepare Table 1, standard scores on each measure were calculated for individual interviewees. Case studies of four of the interviewees are introduced below. The case studies incorporate both interview data and the individual interviewee's standard scores on relevant measures.

### Case Study A (Interviewee #1)

This case study was chosen as she fits the relatively common pattern of someone whose prior achievement has been generally high, has a positive attitude towards mathematics, but does not overly extend herself with respect to schooling effort. These factors in combination have led to high current achievement in both Year 10 Mathematics and English. A summary of this pattern is presented in Table 6 and parts of the interview illustrate aspects of the overall pattern.

Interviewee #1 is particularly attracted to things mathematical as the following interview excerpt exemplifies:

I like maths. I understand it and I can use formulas. It is a break from other subjects and you get to solve everyday problems. I could be a mathematician if I put my mind to it. I am attracted to problem-solving tasks. I like trying to find answers to problems or reaching solutions.

Measures								
	Numeracy	Reading	Spelling	Writing	Maths Attitude	Effort	SC Maths	SC English
Standard Score	1.16	.76	-.60	1.43	.73	-.05	1.11	.52

**Table 6: Standard Scores on Eight Measures for Case Study A**

Despite expending a slightly below average amount of effort in her schoolwork, she has attained relatively high marks in both SC Mathematics and English. Interviewee

#1 is mindful that her effort is an issue and knows that she has been distracted by others near her in class as well as a mix of other things, including the upcoming Year 10 formal. She also revealed in her interview that she will need to alter her schooling practices somewhat as senior secondary school emerges.

I neglect homework sometimes. It is not always highest on my to-do list. It may change soon however. I am taking introductory Physics [in Year 11] and the effort I put in will affect my final school results.

Interviewee #1 has obvious natural ability in mathematics and this has yielded some praiseworthy results despite little effort. Her reading and writing skills at Year 7 also indicate that she possesses ability in the literacy area and her performance in Year 10 English is consistent with earlier indicators.

This case study is best summarised as an example of effortless achievement. That is, a pattern of high achievement has been set for many years. As she moves to the final two years of schooling, known as the senior secondary years in Australia, she may give greater effort to her overall studies or to particular subjects she elects.

Measures								
	Numeracy	Reading	Spelling	Writing	Maths Attitude	Effort	SC Maths	SC English
Standard Score	3.86	2.72	1.28	2.55	1.44	.20	1.31	1.67

**Table 7: Standard Scores on Eight Measures for Case Study B**

### Case Study B (Interviewee #8)

The second case study has many similar characteristics to the previous one. She is a very high performing student who has an impressive record of achievement across her secondary schooling. In fact, she reached the highest possible score in the LANNA Numeracy test and gained the highest score in the school for her SC English examination. Her attitude towards mathematics was quite positive but, in a similar vein to Interviewee #1, her schoolwork effort expended was only average. A summary of these results appears in Table 7.

Measures								
	Numeracy	Reading	Spelling	Writing	Maths Attitude	Effort	SC Maths	SC English
Standard Score	1.16	-.39	.51	-.80	.91	.72	.34	-.12

**Table 8: Standard Scores on Selected Measures for Case Study C**

The interview transcript was also consistent with the scores reported in Table 7. Interviewee #8 enjoyed her schooling and was motivated by her previous successes.

I want to do well. I like to pass. I don't revise much but I study for my tests. I also make reasonably good use of my class time.

This case study is an instance of someone with high ability who works efficiently. The effort expended is only a bit above average, which she readily acknowledges, but in keeping with her goal of doing well.

### **Case Study C (Interviewee #9)**

This case study has been selected to show a different picture but one that is still consistent with the overall findings described earlier. Interviewee #9 has achieved well in mathematics during his schooling. He has an above-average result recorded in the LANNA Numeracy test, holds a positive attitude towards mathematics, and gained a creditable mark in the SC for Mathematics. In contrast, he scored below the average for his LANNA Reading and Writing tests and scored relatively poorly in his SC English examination. A summary of these findings is presented in Table 8.

In conjunction with these results, Interviewee #9 has indicated spending a reasonable amount of effort in his general schooling. On closer inspection, this effort has been directed towards specific activities as exemplified in the ensuing quote:

Maths is a challenge. It makes my brain grow and keep working. I need maths for radiography which is my preferred university course. I want a good mark to get a good career. Maths and Science are challenging...They are what I want to do in the future. English does not interest me. It has too much writing and is repetitive.

This case study describes a student who is very goal-oriented and, as a result, channels energy into prioritised subject areas. His approach focuses on mastery goals in the belief that effort leads to success.

### **Case Study D (Interviewee #5)**

The final case study is an example of a student who in the first four years of her secondary schooling has performed generally below-average. However, Interviewee #5 is someone who perceives school in a positive light. She rated her performance in mathematics per se as above average but this was at variance with her SC Mathematics result (see Table 9). She also indicated that her best friend in class and her friends in general find school enjoyable and she was motivated by nearly all aspects of her schooling. This is illustrated by the following quote:

I try as hard as I can. You only get out what you put in. If I find it boring it is because I make it boring.

The interviewee likes teachers who are passionate about their subject area and she exerts strong effort in her general schoolwork. Her SC Mathematics and English results, while below average or average, are better than would be predicted from her Year 7 achievement measures.

Measures								
	Numeracy	Reading	Spelling	Writing	Maths Attitude	Effort	SC Maths	SC English
Standard Score	-1.16	-.51	.51	-.80	-.51	.97	-.24	.26

**Table 9: Standard Scores on Selected Measures for Case Study D**

As a way of concluding the results section, the direction of the relationships, among the four case studies, for the standard scores for Effort and SC Mathematics and English are summarised in Table 10. Given that all the implicated measures were taken at approximately the same time during Year 10, a period when students are beginning to consider what subjects they will study in their senior schooling, it is not surprising that the relationships between effort and specific subject performance are beginning to differ. While the relationships between effort and SC Maths tend to be weak, the relationship between Maths Attitude and SC Maths tends to be relatively strong.

Case Study	SC Maths	SC English
A	achievement far exceeded effort	achievement moderately exceeded effort
B	achievement far exceeded effort	achievement far exceeded effort
C	achievement and effort above average	achievement below, but effort above, average
D	achievement better than expected and effort relatively high	achievement better than expected and effort above average

**Table 10: Relationship Between Effort and Performance in Two SC Subjects**

## Discussion

This study had four aims. The first aim was to explore the relationships among the four LANNA tests. Each test was significantly and positively related to the others, with the correlation coefficients ranging from .57 to .74. The strongest correlation was between Reading and Numeracy and this finding is in accord with earlier research reported by Aiken (1972) and Marks and Ainley (1997). This particular result adds further evidence to a claim that although mathematics is a special language it has a substantial literacy base and this foundation is established throughout the early years

of schooling (e.g., Aubrey et al., 2006). Interestingly, the level of association between Reading and Spelling and between Reading and Writing was high and of similar magnitude, and Numeracy was also highly correlated with both Spelling and Writing.

A second aim centred on an examination of the relationships among the Year 7 measures and those taken at Year 10. A key finding was that the four standardised test results in Year 7 were significantly correlated with the Year 10 state-wide examination results in Mathematics and English. These correlation coefficients varied from .51 to .80. Not only did the Year 7 Reading test result have the highest correlation with Year 10 English, but it also correlated highest with Year 10 Mathematics. Not unexpectedly, Year 7 Numeracy was highly related to Year 10 Mathematics. While previous studies (e.g., Reynolds, 1981; Spinath et al., 2006; Yates, 2000) have emphasised the link between previous achievement and current achievement, very few if any have used a four-year differential to show the extent and strength of the link. Normally, the time-frame set between measures is much shorter for secondary school cohorts.

The correlation analysis also revealed that Effort was basically unrelated to all other measures, with the exception of Maths Attitude. On the other hand, Maths Attitude was positively and significantly related to all the measures used, except for Spelling. However, the magnitude of most of these relationships was relatively moderate. Predictably, the highest correlation for Maths Attitude was with SC Maths (.44). This result is consistent with the findings of earlier research cited by Vachon (1984), Singh et al. (2002), and Grootenboer and Hemmings (2007).

Another aim of the study was to investigate the predictive capacity of the Year 7 tests, and the measures of Maths Attitude and Effort, in relation to Year 10 Mathematics and English. A clear pattern was evident in that the measures taken at Year 7 in literacy and numeracy emerged as the critical predictors of Year 10 achievements. To expand, Year 7 Reading and Numeracy test results were the main predictors, accounting for more than 70% of the total variance in Year 10 Mathematics; while, Year 7 Reading, Writing, and Spelling results explained approximately 63% of the variance in Year 10 English. It needs to be noted that the respective contributions of Maths Attitude and Effort, if entered later in these regression models, was minimal. Overall, these results suggest at least two related points: firstly, that, in terms of Year 10 achievement in Mathematics and English, the “die has been cast” many years earlier; and secondly, that ability (for which prior achievement is a proxy) is not greatly modified by instructional and/or curricular methods currently used, compared to Maths Attitude and Effort.

Since a measure of mathematics attitude had some prominence in relation to Year 10 Mathematics performance, it could be argued that a measure (or measures) of effort with more focus on specific subject areas should be derived. In other words,

instruments purporting to measure Mathematics effort and English effort could be developed and tested and then utilised in a follow-up study. Nevertheless, it needs to be kept in mind that the general schoolwork effort measure used in this study has been validated previously (see Ali & McInerney, 2005) and its predictive (or concurrent) validity, in particular, was confirmed by the results of the present study in that it correlated significantly and positively with attitude towards mathematics ( $r=.55$ ). Its correlation with Year 10 English and Mathematics was non-significant ( $r=.16$  and  $r=.04$ , respectively). This is only partly consistent with the findings reported by Ali and McInerney (2005) as they found a significant relationship with English rank across a range of student cohorts.

In addressing the fourth and last aim of the study, a methodological technique combining standard scores and interview data, borrowed from Hemmings, Hill, Low, and Jin (1998), proved to be very useful. The technique permitted the authors to highlight similarities and differences among some of the students forming the wider sample. More specifically, relationships between and among schooling effort, mathematics attitude, and current school performance in Mathematics and English were explored; while, at the same time, an individualised assessment of the potential influence of previous achievements in literacy and numeracy was made. What became apparent from this work was that general effort expended by a student was often seemingly unrelated to current achievement. The more salient determinants of this achievement were previous achievements from four years earlier. However, particular motives and beliefs were also seen to be influential and ongoing. For example, subject selections for Years 11 and 12 were driven by: a desire to find areas of study which built on personal strengths and thus engendered confidence; a commitment to a set of future-oriented goals e.g., university entrance; and, a view that more effort would be required as the workload and difficulty of the tasks increased.

An obvious limitation of the present study is that no observations of student effort or feedback from teachers regarding student effort and attitude towards mathematics were included in the design of the study. That is, a sole reliance on self-reported data is problematic and a verification process using other data sources would be a worthwhile addition to a future study. A second limitation is that only one school was involved and the overall sample size was small. However, it was determined that adequate statistical power in the design allowed for the conduct of the multiple regression analyses. Future studies need to replicate and extend the current research by using government school students and students from other jurisdictions in order to create a less truncated sample.

This present study represents the first published report of the relationships among the four LANNA tests at any year level. Given that at least 80 000 students completed these tests in the past decade, it is surprising that no information has been relayed, apart from the results being fed to participating schools via their principals, to a broader

research-oriented forum. It is anticipated that this current study sets the scene and a firm base for other studies to report on the relationships between Australian standardised tests in literacy and numeracy and the capacity of these tests to predict schooling outcomes such as Year 10 and Year 12 university entrance results. This anticipation is fuelled by the fact that, from May 2008, all Australian students enrolled in Years 3, 5, 7, and 9 sit standardised tests in reading, writing, language conventions, and numeracy under the scheme referred to as The National Assessment Program – Literacy and Numeracy (NAPLAN). While the present investigation has focused on the predictive power of the LANNA test results, this testing scheme is representative of an international trend towards systematic testing at a number of stages throughout schooling in order to demonstrate accountability.

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## Appendix A: Students' Ideas about Maths and Other Schoolwork Questionnaire

Name: \_\_\_\_\_

.....  .....

*Office Use Only*

Gender: Female / Male (circle one)

N	R	S	W	SCM	SCE
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Thank you for sharing your ideas about mathematics and other schoolwork. You do not have to complete this questionnaire if you don't want to, but if you do then we really want to know what you honestly think. Your answers will be kept private and your name will not be used in any reports.

For each of the prompts tick the response that best represents what you think.

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. I am always trying to do better in my schoolwork.					
2. I like maths.					
3. I work hard to try and understand new things at school.					
4. I would like to be a mathematician.					
5. I try hard at school because I am interested in my work.					
6. Maths helps me in my life.					
7. Maths is boring.					
8. Maths is cool.					
9. I try hard to make sure that I am good at my schoolwork.					
10. Maths is fun.					
11. Maths is interesting and fascinating.					
12. The harder the problem, the harder I try.					
13. When I am improving in my schoolwork I try even harder.					
14. I don't mind working a long time at schoolwork that I find interesting.					