LANNA tests and the prediction of Year 10 English and Mathematics results

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There is a dearth of published information about the Literacy and Numeracy National Assessment (LANNA). This study was designed to explore the relationships among LANNA test scores at Year 7 and, in addition, to examine the predictive capacity of these scores in relation to Year 10 School Certificate English and Mathematics results. As a way of meeting these aims, data were used from one New South Wales secondary school across the period 2001-2007. An examination of these data, drawing on correlation and multiple regression analyses, showed that Reading results are closely associated with Spelling and Writing scores and that there is a strong relationship between Reading and Numeracy scores as evidenced by the fact that the correlations across the various cohorts between Reading and Numeracy averaged .62. Additionally, very strong relationships were found between specific LANNA tests and Year 10 results. In general, Year 7 Reading scores were the best predictor of Year 10 English and Year 7 Numeracy scores were the best predictor of Year 10 Mathematics. Across the different student cohorts, the average amount of variance in Year 10 English explained by the LANNA tests was 59 percent; whereas, the average amount of variance for Year 10 Mathematics was 72 percent when using the same set of predictors. The authors of the study conclude their paper by discussing the implications of the findings for school administrators who have access to LANNA scores or who used other nationally-benchmarked Literacy and Numeracy assessments.

Introduction

As stated in the Ministerial Council on Education, Employment, Training and Youth Affairs information guide for parents and other community members entitled *Assessing Student Achievement in Australia 2008*, from May 2008 and onwards all Australian students in Years 3, 5, 7, and 9 will complete a set of annual tests in literacy and numeracy (referred to as The National Assessment Program – Literacy and Numeracy [NAPLAN]). The main purpose of this testing regime is to further support student learning and to highlight for school administrators any strengths or weaknesses in their instructional programs so that they can derive interventions (such as targeted professional development) to produce improved student outcomes. This initiative represents the first attempt to have both government and non-government school systems from all states and territories participate in a common testing regime. Prior to this initiative, there had been no coordinated approach across and between states, territories, and school systems. There has been a national testing scheme in place since 1999 – Literacy and Numeracy National Assessment (LANNA) – however, this was only used sporadically within the non-government school sector. The Literacy assessment measures reading, writing, and spelling; whereas, the Numeracy assessment measures number, space, measurement and choice, and data. All of these assessments are based on multiple-choice and open response tasks that address the National Curriculum Profile Outcome Statements.

LANNA was designed by the Australian Council for Educational Research (ACER) to meet national reporting guidelines through a benchmarking approach. To illustrate, in 2004 the maximum achievable Year 7 LANNA score for Numeracy was 175 and scores of 110 and less fell below the Numeracy benchmark set by the Benchmark Equating Steering Committee. Since the first use of LANNA for students enrolled in Years 3, 5, and 7 until its last administration in 2007, participating schools, through their administrators, in all Australian states and territories have received feedback on their school's performance as well as the results for each student sitting the various tests. For the greater part of this period, students in non-government Australian schools could have sat four specific tests, namely, Reading, Spelling, Writing, and Numeracy, with approximately 15 000 primary and secondary school students involved in 2005. Although specific population figures for 2007 are not known, over 280 primary and secondary schools were expected to participate in the testing during the last year of its application.

As a way of offering feedback about LANNA to a range of stakeholders, the ACER furnishes four different reports for the administrators of participating schools: a school report, a year level report, a student report, and a diagnostic report for Reading and Numeracy. What is surprising, however, about this degree of reporting and extensive use of LANNA tests in the Australian non-government school sector is that not one scholarly publication that discusses the impact and the relevance of the test results, including their explanatory and predictive power for later school performance, is cited in the research literature. Interestingly, the only material that was freely available for consideration was information of a more general nature supplied by the ACER at one of its websites. This website has now been removed.

There is a very large corpus of literature pertaining to the factors that influence school achievement (see, for example, Ali & McInerney, 2005; Hemmings, 1996). Despite some evidence that gender (Peng, Lee, & Ingersoll, 2002; Rothman and McMillan, 2004), ethnicity (Dickie, 2000; Walker & Chamberlain, 1999), socio-economic status of students (Wilkins & Ma, 2003), motivation (Reynolds & Walberg, 1992; Spinath, Spinath, Harlaar, & Plomin, 2006), attitude towards specific school subjects and school more generally (Ai, 2002; Grootenboer & Hemmings, 2007; Singh, Granville, & Dika, 2002), and academic engagement (Akey, 2006) are linked to achievement, often the chief determinant of current school achievement is previous school achievement (see, for example, Reynolds, 1991; Yates, 2000). This finding has been reported in studies of both primary and secondary school students in a range of varying contexts. To exemplify, Hemmings (1996) showed that the performance of a sample of Year 12 students in New South Wales (NSW), Australia was significantly affected by their results in English, Mathematics, and Science at Year 10. In fact, over 62 percent of the variance in the Year 12 Tertiary Education Rank was explained by a composite measure of the three Year 10 subjects. Yates (2000), drawing on a younger school-age sample in another state in Australia, found that achievement in Mathematics in Years 3 to 7 was highly predictive of achievement in Mathematics for the same cohorts two years later. Reynolds (1991), researching in a North American context, reported similar relationships for Year 8 Mathematics and Science. Once again, the largest predictor of achievement was prior achievement.

Despite the extensive use of literacy (e.g., reading and spelling) and numeracy (e.g., number and measurement) tests, little is reported in the literature about the relationship between these tests and their respective components. What is reported tends either to be North American-based studies or work conducted many decades earlier. For example, Mehta, Foorman, Branum-Martin, and Taylor (2005), using a predominantly African American and high poverty sample, showed that the correlations in Grade 3 for word reading and writing were .52, word reading and spelling were .68, and spelling and writing were .52. Similar findings were also reported for the same correlation measures taken at Grade 4. Aiken (1972), in his review of language factors involved in learning mathematics at the intermediate grades in the United States of America (USA), noted that correlations between reading ability and mathematics achievement ranged between .40 and .86. One of the studies comprising his review was based on results obtained in 1963 from California State Achievement Tests at Grade 5. This study reported that the correlations between spelling and arithmetic reasoning and spelling and arithmetic fundamentals were .61 and .59 respectively. More recently, Thomas (2002), who drew on Grade 8 data collected for the 1988 USA National Education Longitudinal Study, found that the association between mathematics and reading proficiency was .46. An extensive analysis of Australian literacy and numeracy data that spanned a 20-year period was carried out by Marks and Ainley (1997). They revealed that the correlation coefficient between reading comprehension and numeracy was .60 for a sample of 13 to 15 year olds. This finding was the only correlation reported.

Given both the paucity of information published about LANNA and the small number of Australian studies that have reported correlations between literacy and numeracy measures at the secondary school level, it is timely that LANNA is interrogated from several levels. As a consequence, this study sought to achieve two aims: first, to explore the relationships among LANNA test scores at Year 7; and second, to examine the predictive capacity of these scores in relation to Year 10 School Certificate (SC) English and Mathematics results. This form of interrogation will help to supply valuable information that can further support the developments around NAPLAN and other secondary school assessment matters.

Method

Participants were students who had enrolled at Year 7 (from 2001-2004) in a non-government co-educational secondary school located in regional NSW. These students had sat LANNA tests during their first year of secondary school and then continued their schooling, in most cases, to Year 10 at the same school (from 2004-2007). During Year 10 these students sat the state-wide SC examinations. The subjects relevant to this study were the compulsory ones of English and Mathematics as the purpose is to determine if the LANNA tests are valid predictors of performance in these two subjects. The number of Year 10 students who sat these two examinations and the LANNA tests four years earlier varied from 28 to 74. It needs to be noted that the 2004 Year 10 cohort who had sat LANNA in 2001 only completed Reading and Numeracy tests. The students forming the other cohorts in the study, that is, cohort 2002-5, 2003-6, and 2004-7, sat Spelling and

Writing tests as well. A breakdown by gender indicates that the four cohorts were about evenly split with respect to males and females. In addition, the students entering the school were aged between 12.4 and 13.8 years.

Even though all the measures needed for the study were supplied by the participating school, they were based on data either initially computed by the ACER or the NSW Board of Studies. Both the LANNA test scores and the SC English and Mathematics examination results are scaled scores based on raw scores. The scaled scores or measures were accessed through the school's student records and then entered into an Excel spreadsheet for transfer to SPSS (Version 16.0) and then checked for accuracy.

Results

A correlation analysis was chosen to examine the relationships among the LANNA test scores. This analysis was conducted using the *Correlate* program in SPSS via the Pearson product-moment method. The results, which excluded cases listwise, are summarised in Table 1. An inspection of the correlation coefficients revealed that nearly all the measures were positively and significantly related ($p<.01$), and of a moderate to strong magnitude. The strongest relationships were observed between Reading and Numeracy, with a weighted average correlation across the four cohorts of .62. Reading was also associated with Spelling and Writing. The weighted average correlations were .52 and .50 respectively. Further, Spelling and Writing were highly correlated as indicated by a weighted mean correlation across three cohorts of .50. The weakest relationships, as indicated by weighted mean correlations, were between Numeracy and Writing ($r=.39$) and Numeracy and Spelling ($r=.39$), but these were still at a moderate level.

Table 1: Correlation matrix of LANNA tests (2001-2004)

	Yr	N	Reading	Numeracy	Spelling	Writing
Reading	01	28	1			
	02	40	1			
	03	73	1			
	04	55	1			
Numeracy	01	28	.690*	1		
	02	40	.706*	1		
	03	73	.571*	1		
	04	55	.597*	1		
Spelling	01	-	na	na	na	
	02	40	.516*	.594*	1	
	03	73	.574*	.395*	1	
	04	55	.444*	.234	1	
Writing	01	-	na	na	na	na
	02	40	.472*	.309	.521*	1
	03	73	.495*	.418*	.450*	1
	04	55	.537*	.404*	.543*	1

* $p<.01$ (2-tailed)

In order to determine the predictive capacity of the LANNA tests and the results in English and Mathematics at the SC level, a multiple regression analysis was performed

using the *Regression* program in SPSS. Separate regression analyses, using the hierarchical entry method, were run for each cohort under investigation with either SC English or Mathematics as the dependent measure. Generally, variables were entered on the basis of their anticipated influence, for example, Numeracy was entered first for models predicting SC Mathematics.

In relation to SC English, Reading was generally the best predictor of SC English but the overall result varied between the four student cohorts (refer to Table 2). This result is probably linked to the small numbers in the cohort, particularly in 2004 and 2005. For some cohorts, both Spelling and Writing test results did add significantly to the total explained variance in SC English; however, no significant contribution from Numeracy was apparent.

As a way of making the findings with regard to Reading more understandable, it is useful to consider the performance of individual students in Year 7 and compare their performance at Year 10. To illustrate, of the 15 students in the bottom quartile of Reading results in 2004, nine (i.e., 60 percent) remained in the bottom quartile in SC English four years later. Of the others in this cohort, five (i.e., 33.3 percent) moved to the second bottom quartile and one jumped to the next quartile (or one below the top quartile). Similarly, of the top 8 students in the Reading test in Year 7, 5 (i.e., 62.5 percent) remained in the top quartile, whereas the others slipped one quartile.

Table 2: Proportion of variance for LANNA tests as predictors of SC English

SC cohort	N	Reading	Numeracy	Spelling	Writing	Total R^2
2004	28	.784	ns	–	–	.784
2005	40	.122 (.388*)	ns	.393	ns	.515
2006	74	.534	ns	.035	ns	.569
2007	56	.434	ns	ns	.044	.478

– Tests not administered
ns Not significant
* If entered first

The Year 7 Numeracy results were by far the strongest predictor of SC Mathematics (refer to Table 3). Across the three years (2004-2006), about 70 percent of the explained variance in SC Mathematics was predicted by the Numeracy result. Using the 2007 cohort and their Numeracy results as an example, 66.7 percent of the students in the bottom quartile in Year 7 were still in the bottom quartile for SC Mathematics. The remainder were distributed in the bottom second and third quartiles. For the top students, 58.3 percent of those performing highly in Year 7 Numeracy were in the top quartile for SC Mathematics. Most of the others were in the second top quartile.

One other finding worthy of noting is that Reading for most of the cohorts was a significant predictor, behind Numeracy, of the variance in SC Mathematics. And, except for the 2002-2005 cohort, the other two predictors, namely, Spelling and Writing did not contribute to the total explained variance in Mathematics.

Table 3: Proportion of variance for LANNA tests as predictors of SC Mathematics

SC cohort	N	Numeracy	Reading	Spelling	Writing	Total R^2
2004	28	.717	.074 (.626*)	–	–	.791
2005	40	.682	ns (.385*)	.051	ns	.733
2006	73	.726	.025 (.380*)	ns	ns	.751
2007	55	.506	.081 (.427*)	ns	ns	.587

– Tests not administered
ns Not significant
*   If entered first

Discussion

The study had two main aims. The first aim was to explore the relationships among Year 7 LANNA test scores. From 2001-2004, the results of nearly all the available tests were positively and significantly related. The correlations ranged from .23 (for Numeracy and Spelling) to .71 (for Reading and Numeracy). The strongest relationships were consistently seen between Reading and Numeracy. This finding parallels those found by Marks and Ainley (1997) in an Australian study. The result is also consistent with the work of Thomas (2002) with Grade 8 students from the USA and the findings reported by Aiken (1972) who found correlations, in his review of selected North American studies, between reading ability and mathematics achievement in the range .40 and .86. It needs to be emphasised that both these studies drew on data sources that are very dated, that is, at least 20 years old and set in another political/educational environment.

The relationships found among the LANNA Reading, Spelling, Writing, and Numeracy scores are similar to those cited by Mehta et al. (2005) in another North American study. However, making comparisons across different tests and educational jurisdictions is fraught with difficulty. One way of further validating the findings of the present study is for other Australian schools and, perhaps clusters of schools, to make available their LANNA results for comparison purposes.

The other aim of the study was to examine the predictive capacity of the LANNA scores in relation to SC English and Mathematics results at Year 10. Two prominent patterns emerged from the data analysis. Firstly, Reading was found to be the best predictor of SC English and for some cohorts both Spelling and Writing results added significantly to the explained variance in English. Secondly, Numeracy was clearly the main predictor of SC Mathematics. In fact, the Numeracy measure in 2004-2006 explained more than two-thirds of the variance in Mathematics. A subsidiary finding, in relation to the explained variance in Mathematics, was that Reading was generally a significant predictor behind Numeracy. This result supports a view that Mathematics has a strong language component and, in particular, a key reading component. Aiken (1972), for example, has argued that "linguistic abilities affect performance in mathematics ... [and that] mathematics itself is a specialised language" (p. 359).

The findings of the current study imply a need to explore further the relationships between and among the four Year 7 standardised tests. It could be argued, for example,

that a common factor underpins these test measures, and that traditional factor analysis or structural equation modelling would be ideally suited to test such an argument. Carroll's (1993) study, including the work he reviewed, would suggest that a factor termed *crystallised intelligence (Gc)* might be involved here. This speculative view is based on the fact that Carroll (1993) showed how verbal ability, reading comprehension, spelling, language development, and numerical facility were frequently loading on *Gc.*

Taken together, the findings pertaining to Year 10 English and Mathematics demonstrate that previous achievement in related areas, namely, reading, spelling, writing, and numeracy, has high predictive capacity. Although some other Australian studies (see, for example, Hemmings, 1996; Yates, 2000) point out that prior achievement is an excellent predictor of current achievement, these studies focus on a two-year time span. The study reported here is based on a four-year differential and the average explained variance in English and Mathematics is 65 percent. An obvious question that arises from this finding is 'What can explain the unaccounted variance?' Known at this juncture is that motivation, academic engagement, and attitudes towards English, Mathematics and school in general are potential contributors to the unexplained variance. Unquestionably, further study is required to fill a gap. Such future research could start by examining the previously-mentioned variables through a survey of students who sat LANNA tests in 2006 and 2007 as these students would be sitting SC examinations in 2009 and 2010. Another worthwhile study could involve the use of Year 7 test results from the NAPLAN to ascertain how well these tests might predict SC English and Mathematics. However, the earliest these calculations could occur would be 2011 as the first administration took place in 2008.

In the meantime, other worthy research could take advantage of the stores of data currently held by school administrators. These school administrators, with the help of researchers, could draw on their existing school records, including their past LANNA scores, and explore the relationships described earlier. Given that many non-government school administrators, across the nation, have access to such results from 1999, and even more complete data sets from 2000, there is a rich source to be mined. No doubt, individual school administrators have used the LANNA test scores in a range of ways. For example, at the student level, individuals might have been monitored from Year 7 to the SC at Year 10 or even earlier through their various achievement tests in Years 8 and 9. An illustration of this tracking of student progress was presented above in the results section where students were positioned in quartiles and matched against their peers from Years 7 and 10 as a way of measuring positional gain or loss. This is just one example of what is possible with the LANNA data. However, what is very apparent is that the literature is silent on the topic and, as a consequence, little or no information has been exchanged on a broader scale between school administrators, teachers, parents, and other stakeholders on this topic. In other words, a potentially important educational topic has been virtually left untreated; a topic which would greatly support any new developments in secondary school assessment and learning such as the NAPLAN or the Basic Skills Testing instigated about a decade earlier. Clearly, one way of validating a new testing regime is to examine its predecessor schemes and to find out if the new regime is standing on a solid foundation.

Despite the present study contributing worthwhile information and adding to the existing literature relating to school achievement, there are nevertheless limitations inherent in the study. Firstly, only one school was involved and the numbers of students, especially in the early cohorts, were small. This fact would bring into question the legitimacy of generalising the findings to other settings and educational jurisdictions. And secondly, no qualitative data were collected to supplement the quantitative data. In hindsight, interviews with a group of Year 10 students, before and after the time of sitting the SC examinations, would have potentially revealed some insights about their views towards English and Mathematics and what, in their view, contributed to their achievements in these two subjects. Although they might not have focused their thinking on the notion of prior achievement, they would have offered some ideas as to what other factors contribute to their successes and failures at the subject level. This is a critical point since 35 percent of the variance, on average, in both English and Mathematics at Year 10 was left unexplained.

This proposed study and the others identified earlier need to be given serious consideration if inroads are to be made regarding the study of literacy and numeracy at the secondary school level. This call is supported by Rothman and McMillan (2003) who argued that if literacy and numeracy were to stay at the top of the agenda for Australian education, research concentrating on the literacy and numeracy skills of our middle school students is essential. The time is now opportune as new developments in literacy and numeracy testing and benchmarking emerge to investigate the impact of these tests and their forerunner tests, including LANNA.

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