



MINISTRY OF EDUCATION

Te Tāhuhu o te Mātauranga

Measures of Adult Literacy and Numeracy

*Comparing the Adult Literacy and Life Skills
Survey and the Literacy and Numeracy for Adults
Assessment Tool*

The Tertiary Education Occasional Papers provide short reports on research, analysis and statistics relating to tertiary education in New Zealand. These papers include short original works and summaries of published research and analysis.

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MEASURES OF ADULT LITERACY AND NUMERACY

Introduction

This paper explores the relationship between two different measures of adult literacy and numeracy. The Adult Literacy and Life Skills (ALL) Survey was an international survey of literacy, numeracy and problem solving skills undertaken in New Zealand in 2006. It provided information on the skills of the population, as well as wide range of background information on employment, qualifications and demographic characteristics. The Literacy and Numeracy for Adults Assessment Tool was developed to measure the literacy and numeracy of learners in New Zealand adult education settings. It was implemented from 2010. It provides results that are aligned with the Adult Literacy and Numeracy Progressions (Tertiary Education Commission, 2008a).

Exploring the relationship between these two measures can give us a clearer understanding of the Assessment Tool results by comparing the results with internationally referenced information.

Background

These two measures were set up for different purposes. The ALL survey was intended for population analysis. Its purpose was to accurately measure the skill distribution of groups within the population. It was based on a representative sample of the national population and intended for research purposes and international comparison. The Assessment Tool is intended for individual testing. It is designed to provide an accurate measure of the skill of each respondent that can be used to inform teaching and learning (Yamamoto, 2013).

Both measures are based on a similar methodology, using a range of test items to infer the literacy or numeracy abilities of the respondents. They both use Item Response Theory to relate the test items to scales of literacy and numeracy ability (Darr, 2010; Statistics Canada & Organisation for Economic Cooperation and Development, 2011). This approach makes several assumptions about literacy and numeracy, namely that:

- literacy and numeracy proficiency can be quantified
- it is meaningful to say that one person has more proficiency than another person
- the amount of proficiency a person has is reasonably stable across time and place (i.e. it won't be different for the same person a day later or in a different location, unlike measures such as happiness or cash in the bank)
- a person can demonstrate their proficiency by responding to a range of test items of varying difficulty
- the responses to the test items reflect differences in literacy and numeracy proficiency, rather than other factors, such as linguistic or cultural understanding.

These assumptions require that the measures have rigorous design and development. Particular attention is required to develop, test and scale test items to ensure that each item correctly tests an aspect of literacy or numeracy proficiency and provides valid and reliable results.

The literacy and numeracy scales derived from the ALL survey have been proven to have good correlation with education, employment and earning and health and well-being (Earle, 2009; Lawes, 2009; Smyth & Lane, 2009; Statistics Canada & Organisation for Economic Cooperation and Development, 2011). An analysis of the Assessment Tool results to 2011 found that “although groups of learners assessed using the Assessment Tool were clearly not

representative of the adult population, the variations in Assessment Tool reading and general numeracy scores followed the same patterns as the total adult population according to the ALL survey 2006, in terms of age, gender, ethnicity, first language and educational participation” (Lane, 2012).

Two approaches to measuring literacy and numeracy

The ALL survey and the Assessment Tool are based on somewhat different definitions of literacy and numeracy. The ALL survey started with general definitions of literacy and numeracy and then developed more precise gradations of ability. The Assessment Tool is based on a set of learning progressions that describe how learners develop their skills. The two measures also have different approaches to dividing the continuous scale scores into discrete levels or steps. They have also been administered in different circumstances.

The ALL survey

The purpose of the ALL survey was to develop a measure of the literacy and numeracy skills and knowledge people have to enable them to participate in society. Literacy was defined as “using printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential.” The key feature of this definition is that literacy has purpose and enables people to contribute to society. Similarly, numeracy is defined as “the knowledge and skills to effectively manage and respond to the mathematical demands of diverse situations,” and numerate behaviour is “observed when people manage a situation or solve a problem in a real context; it involves responding to information about mathematical ideas that may be represented in a range of ways; it requires the activation of a range of enabling knowledge, factors and processes” (Statistics Canada & Organisation for Economic Cooperation and Development, 2011).¹

Literacy and numeracy were measured on a continuous scale from 0 to 500. The ALL survey measured two concepts of literacy – prose literacy, the ability to understand and use continuous text, and document literacy, the ability to use text combined with charts, graphs and maps. For New Zealand, 90% of document literacy scores fell between scale scores of 185 and 355 and 90% of numeracy scores fell between scale scores of 175 and 360 (Satherley, Lawes, & Sok, 2008).

The ALL scale was divided into 5 levels of proficiency. The descriptors for each level are summarised in the Appendix. When ALL was released, there was an emphasis on level 3 as the level “deemed as a minimum for persons to understand and use information contained in the increasingly difficult texts and tasks that characterize the emerging knowledge society and information economy” (Statistics Canada & Organisation for Economic Cooperation and Development, 2005). However, in the subsequent Programme for International Assessment of Adult Competencies, this approach has been rethought. The proficiency levels have a descriptive purpose “to aid interpretation and understanding ... by describing the attributes of the tasks that adults with particular proficiency scores can typically successfully complete.” The levels are no longer seen as normative and representing standards for participation in society or education (Organisation for Economic Cooperation and Development, 2013).

The ALL survey was administered as a research survey, under strict international protocols. The survey was conducted within the respondents’ homes by trained interviewers. The literacy and numeracy items were presented in booklets and answered on paper. They included both multiple choice and write-in responses. Scores for individuals were modelled using multivariate analysis and weighted to the population. The modelling produced a range of probable scores for each individual. These are presented in the data as a set of five plausible values for each

¹ There was also a problem solving domain, which is not discussed in this paper.

individual on each domain. It was not possible to test all participants across all areas in the time available for the interviews. Multivariate modelling, drawing on the background variables and the cognitive responses, was used to impute the scores for the areas that individual respondents were not tested in (Statistics Canada & Organisation for Economic Cooperation and Development, 2011; Yamamoto, 2013).

The Literacy and Numeracy for Adults Assessment Tool

The purpose of the Assessment Tool was to develop a measure that would inform what individuals may need to learn in order to improve their literacy and numeracy skills and knowledge. The Assessment Tool is based on the Learning Progressions for Adult Literacy and Numeracy. These progressions “describe the main elements or strands of learning adults require in order to listen with understanding, speak to communicate, read with understanding, write to communicate, make sense of number to solve problems, reason statistically and measure and interpret shape and space” (Tertiary Education Commission, 2008a). The strands describe a continuum of learning development and reflect the cumulative nature of learning. Each strand is divided into six steps, which denote significant stages of learning. The steps are not always evenly spaced, as learning doesn’t always occur at the same rate.

The Assessment Tool provides assessments against three main strands: reading with understanding; making sense of number to solve problems (general numeracy) and writing to communicate. The reading and numeracy assessments have been used most extensively and have counterparts in the ALL survey.

The reading with understanding strand addresses the “text-based demands of being a worker, learner and a family and community member ... to read a range of everyday material with understanding” (Tertiary Education Commission, 2008a). The progression starts with decoding and moves through language and text features, reading with comprehension and reading critically. At step 4, readers are introduced to a wider range of materials and taking a more critical approach to things they read.

The numeracy strands are “based on the belief that in order to meet the demands of being a worker, a learner and a family and community member, adults need to use mathematics to solve problems” (Tertiary Education Commission, 2008a). The making sense of number strand is largely based around number strategies. These are the mental processes that learners use to solve operational problems. These strategies cover addition, multiplication, proportional reasoning, sequence, place value and number facts. The progressions start with simple single step problems and build to multi-step problems, which include justifying the reasonableness of the answers. At step 5, learners are introduced to more sophisticated strategies and looking at how they got to their answers (Tertiary Education Commission, 2008b).

The Assessment Tool provides a continuous scale score from 0 to 1000 for each assessment. Scores are reported with a standard error. These tend to be greater at the top of the scale. These scores are then divided into sections that represent the steps on the progressions. The cut points for the steps are different for reading and general numeracy, reflecting the different makeup of the two progressions. The scale score ranges for each step are set out in the Appendix.

The development team for the Assessment Tool drew on knowledge and experience from the ALL survey. For example, the context categories for items were adopted directly from the survey. The Tool was trialled with over 10,000 learners. These learners were drawn from programmes that were likely to use the Tool and were not representative of the whole population (Mendelovits, 2010).

Whereas the ALL survey was administered in a standardised manner, the Assessment Tool is administered in a variety of educational contexts, which include classrooms, computer labs,

community locations and prisons. There are varying degrees of supervision and explanation given to learners about the assessments. It can be administered either on-line or using a paper version. There is a full version of the assessment, as well as a shorter snapshot. All of the items require a multiple choice response (Haggland & Earle, 2012).

Comparing the results

The purpose of the analysis in this report is to examine the relationship between the scale scores produced by the ALL survey and the Assessment Tool, the extent to which these are correlated and to see whether any correspondence can be mapped between the literacy and numeracy levels in the ALL survey and the steps in the Assessment Tool and Learning Progressions. If such a mapping is possible, it would provide a way of relating Assessment Tool results to wider population data and international results.

The ideal way to compare the two measures is to have a group of the same individuals who have been assessed using both instruments within a short period of time.

We almost have this. In 2006, when the ALL survey was conducted, respondents were asked for permission to match their details to the National Student Index. From this their ALL survey results can be related to their National Student Number (NSN). All assessment using the Assessment Tool must have a NSN. Of the 7,131 people in the ALL survey, we could identify 254 who had undertaken reading and numeracy assessments on the Assessment Tool by December 2013. Of these 222 undertook reading assessments and 141 undertook general numeracy assessments.

This provides a reasonably sized comparison group. The comparison is made with the first assessment for each individual on the Assessment Tool. This reduces the likelihood of any confounding effects that could come from their engagement with learning programmes. However, the comparison may be weakened by the elapsed time between the survey and the assessments. The assessments were spread between April 2010 and December 2013. This means there was a four to seven year gap between the 2006 ALL survey and Assessment Tool results.²

The group that is most likely have the greatest difference in scores between the survey and assessment are those aged under 25 at the time of the ALL survey. They would still have been undertaking school or tertiary education and developing their work experience. Both of these factors are likely to have increased their numeracy and literacy skills. In international longitudinal research, this age group has been observed to have the greatest increase in proficiency over time (Reder, 2009). One strategy to reduce the age effect is to just focus on people who were aged 25 and over at the time of the ALL survey.

The following analysis is just based on comparing actual scores on the Assessment Tool and the ALL survey. In each case, these scores have a margin of error and these margins of error can be substantial at the individual level. It was decided not to incorporate the margins of errors into the analysis as this adds a level of complexity to the techniques required to analyse the data. This does not invalidate the results, but does mean they do need to be interpreted with caution.

The comparison group

The group who were assessed on the Assessment Tool were younger than the overall sample for the ALL survey. Eighty-nine of the 254 were aged under 25 at the time of the ALL survey. Figure 1 shows the age distribution of the people who were assessed on both the Assessment

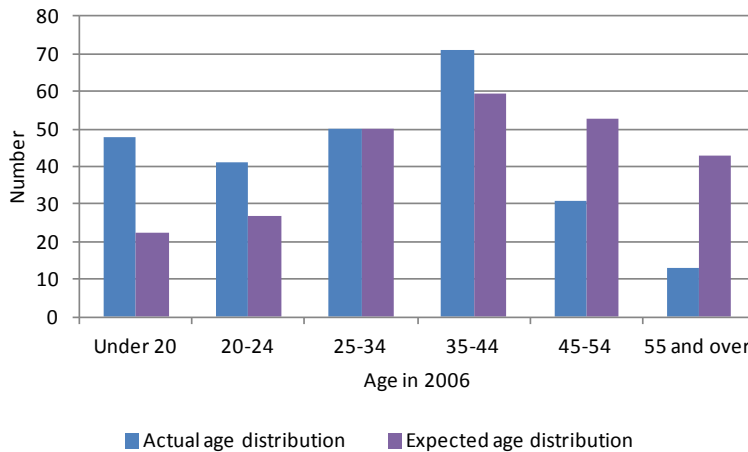
² In general, there is no discernable difference in the distribution of the results due to the year in which the assessment on the Tool was undertaken. This suggests that the effect of the elapsed time on the comparison may be minimal.

Tool and ALL, and compares this with their expected age distribution if they were representative of the age distribution of the ALL survey sample.

There are two major reasons for the younger age distribution. Younger people are more likely to have an NSN than older people, as they will have participated recently in school qualifications and tertiary education. A high proportion of assessments using the Assessment Tool have been undertaken with younger people. In 2011, 31 per cent of assessed learners were aged 16 to 19 and 51 per cent were aged under 25 (Lane, 2012).

Figure 1

Actual and expected age distribution of people assessed in both ALL and the Assessment Tool



The group who were assessed on the Assessment Tool had lower results on the ALL survey than for the general population in 2006. Table 1 compares the mean scale scores for under 25 year olds and people aged 25 years and over by whether people did or did not have an Assessment Tool result. In each case the differences for those who had an Assessment Tool result were statistically significant.³

Table 1

ALL survey mean scale scores for those with and without Assessment Tool results

	Under 25 years		25 years and over	
	No Assessment Tool results	With Assessment Tool results	No Assessment Tool results	With Assessment Tool results
Prose literacy	272	261	279	268
Document literacy	275	263	280	268
Numeracy	266	246	273	253

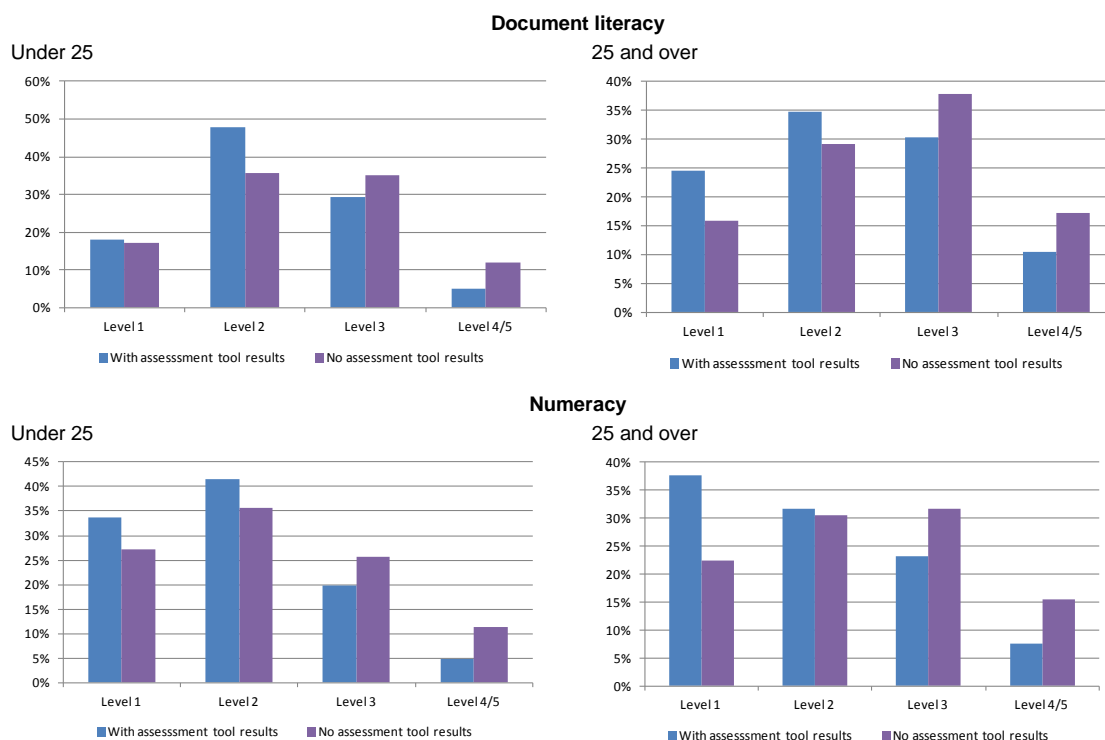
Figure 2 shows the distribution of ALL document literacy and numeracy levels for under 25 year olds and those 25 and over by whether or not they had an Assessment Tool result. For the under 25 year olds, those with Assessment Tool results were more likely to be at level 2 on ALL and less likely to be at level 3 and above. For those 25 and over, those with an Assessment Tool result were more likely to be on level 1 on ALL and less likely to be at level 4 and above.

These results are consistent with the use of the Assessment Tool in lower-level tertiary education and adult education contexts. It would be expected that these learners would have literacy and numeracy skills that are on average lower than those of the general population.

³ Using an analysis of variance, the difference in the means of those who were and were not assessed was found to be statistically significant to beyond the 99% probability level.

The Assessment Tool was specifically designed to measure and differentiate literacy and numeracy skills in the lower range. This analysis shows that the comparison group is well distributed across the range of skill levels of interest for understanding the Assessment Tool.⁴ The results also suggest that people aged 25 and over who have an Assessment Tool result may represent a broader range of skill levels than those aged under 25.

Figure 2
Distribution of ALL survey levels for those with and without Assessment Tool results



Correlation of scale scores

The first step in the analysis was to compare the scale scores between ALL and the Assessment Tool results. This tests the extent to which the two are correlated. A high correlation would suggest that they are measuring a similar concept, a low correlation would suggest that they are measuring different concepts. The correlation analysis was undertaken separately for people aged under and over 25.

Table 2
Correlation of ALL survey scores with Assessment Tool scores

	Under 25 years		25 years and older	
	Pearson coefficient	Cronbach's Alpha	Pearson coefficient	Cronbach's Alpha
Prose	0.59	0.74	0.77	0.86
Document	0.60	0.75	0.78	0.88
Numeracy	0.78	0.88	0.72	0.84

⁴ It is also possible to compare the assessment results of the comparison group with all people who have had an assessment using the Assessment Tool. However, the latter is a selective and arbitrary population of people. The distribution of skills reflects the diverse range of contexts in which the Tool has been used rather than a particular part of the population. Undertaking this analysis would not add any useful information.

Table 2 shows the correlations of the ALL prose and document scores with the Assessment Tool reading scale score, and the ALL numeracy score with the Assessment Tool numeracy score. The Pearson coefficient measures the extent of linear relationship between the two scales. That is, given a result on one scale, how well could you predict a result on the other? Cronbach's Alpha looks at the internal consistency of the measures and provides an estimate of whether they are likely to be measuring a similar concept for those learners who were administered both assessments. High scores on both measures would suggest that the scales are related and measuring similar concepts.

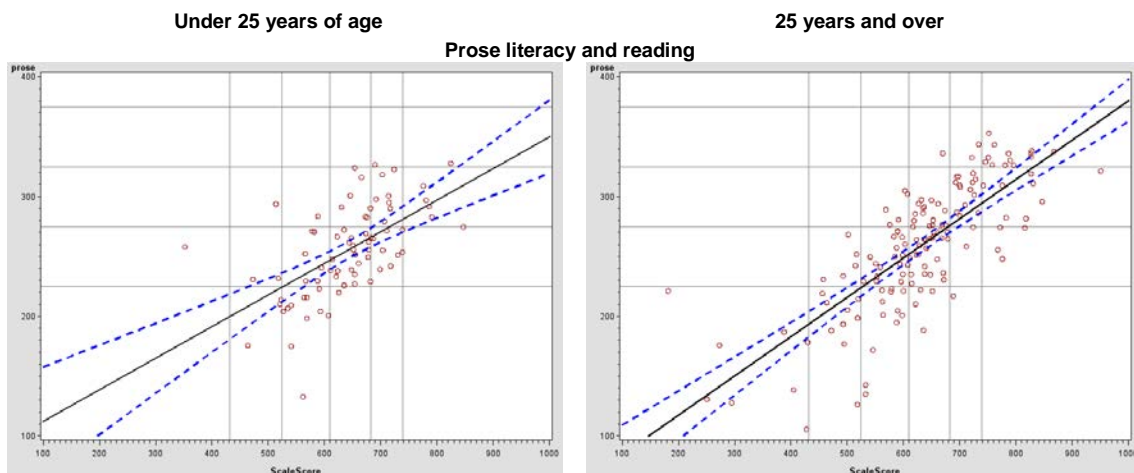
Overall, the results show that there is high degree of correlation between ALL and the Assessment Tool. It is likely that they are both measuring similar concepts.

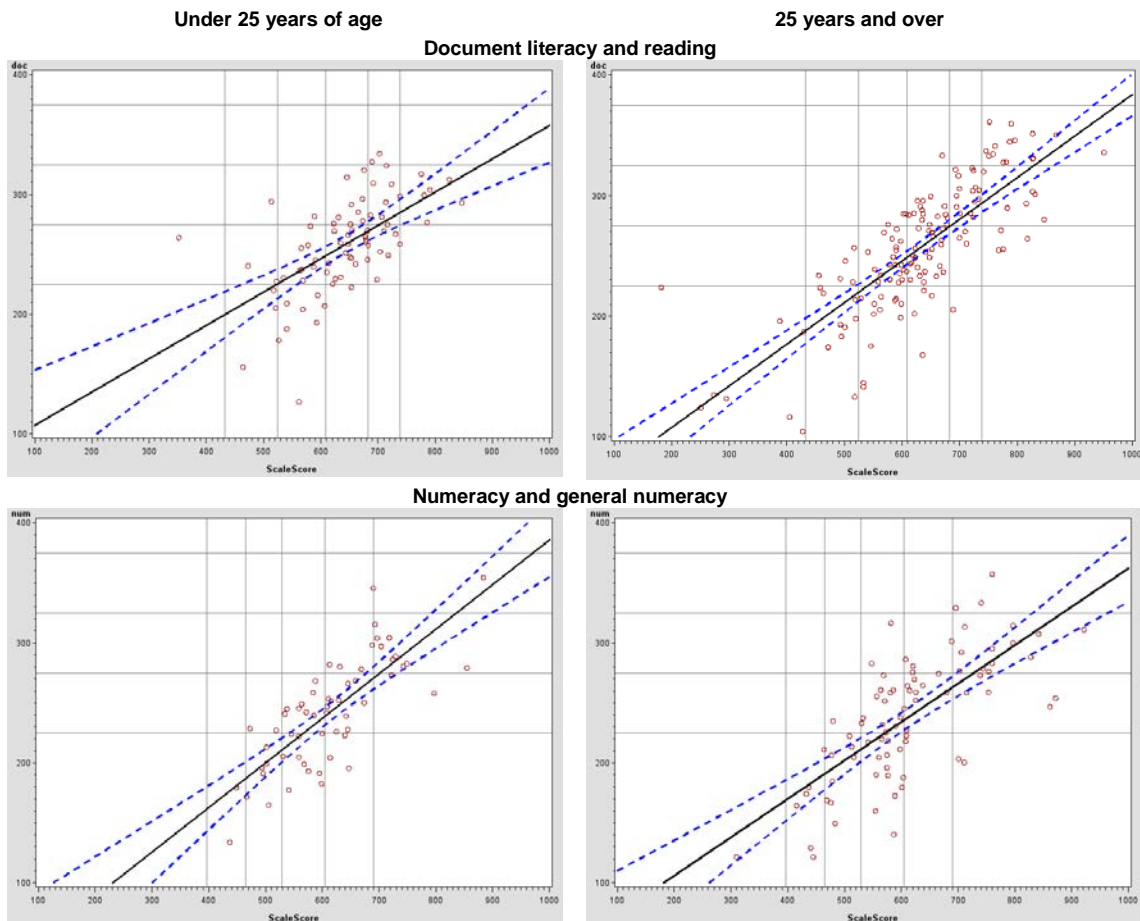
The distribution of the results is plotted in the graphs below. The horizontal lines show the cut-points between the five ALL levels. The vertical lines show the cut-points between the six Assessment Tool steps. The line of best fit is also shown in each case. This has been calculated using a linear regression. The dotted lines show the 95 per cent confidence intervals for the mean.

For document and prose literacy, the difference between the two age groups is that there is a wider dispersion of observations in the under 25 age group than in the 25 and over age group. Most of the dispersion for under 25 year olds is among those who had higher ALL results (level 3) and higher Assessment Tool results (step 4 or 5). This may reflect the Tool being less accurate for these individuals or they were less engaged in the assessment process. Another explanation would be that ALL had over estimated their skills. This is less likely, as there has been considerable research using the ALL data that has confirmed it is generally robust and well correlated with a range of social and economic indicators.

In the 25 years and over age group, there is a suggestion of a small group who have improved their results. These show up as a band of observations below the regression line, representing learners who have higher Assessment Tool results than would be predicted by their ALL results. Some educators have expressed concern that there could be a group of lower to medium skilled learners who are measured well below their ability on the Tool due to poor engagement. However, there are very few observations where people who have Assessment Tool results that are a lot lower than their ALL results would predict, particularly at the middle to lower end.

Figure 3
Comparison of ALL Survey and Assessment Tool scale scores





For numeracy the relationship appears to be somewhat tighter for people aged under 25 than for those aged 25 and over. This is consistent with the correlation statistics reported in Table 2. The dispersion of results suggests there are some learners who have improved their skills since the ALL study (below the line in the 25 years and over plot) and a some who had numeracy at level 3 and above on ALL who were not as well measured on the Assessment Tool.

The results of this analysis confirm that it would be best to focus on people aged 25 and over for the analysis of the relationship between reading and literacy. However, this may not be for the reason initially proposed of changes in literacy proficiency over time. For numeracy, there is no evidence to suggest a need to restrict the population by age group.

Matching of steps to levels

The next question of interest is whether steps on the Assessment Tool can be mapped to specific levels in the ALL survey. Further investigation of the data showed that the match between steps and levels was clearest if the sample was restricted to people who reported they spoke English as their main home language in the ALL survey. It is likely that the literacy and numeracy levels of those who spoke other languages at home increased during time between the survey and the assessments, reducing the value of the comparison.

Reading and document literacy

Figure 4 shows the match between the Assessment Tool steps for reading and ALL document literacy levels for people aged 25 and over, who spoke English at home at the time of the ALL survey. Figure 5 shows the match from ALL document literacy levels to Assessment Tool steps.

Figure 4

Match of Reading Assessment Steps to ALL Document Literacy Levels (25 and over, home language English, n=125)

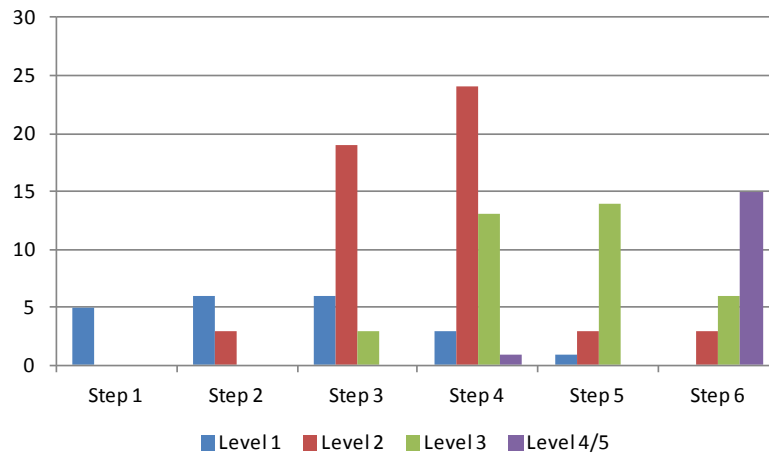
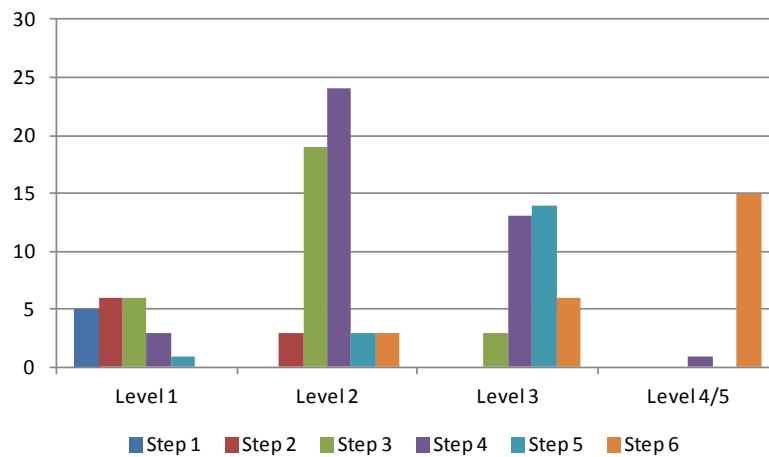


Figure 5

Match of ALL Document Literacy Levels to Reading Assessment Steps (25 and over, home language English, n=125)



The results show that people who were assessed at Steps 1 and 2 on the Assessment Tool were nearly all assessed at Level 1 on ALL. Those who were assessed at Step 3 were spread between Levels 1 and 2, with most of them in Level 2. Similarly those assessed at Step 4 were spread between Levels 2 and 3, with more in Level 2. Most people assessed at Steps 5 and 6 were assessed at levels 3 and above on ALL.

Table 3 shows a map of the relationship between reading assessment steps and ALL document literacy levels. The symbols for the Steps are taken from the Learning Progressions.

Figure 7

Match of ALL Numeracy Levels to General Numeracy Assessment Steps (25 and over, home language English, n=72)

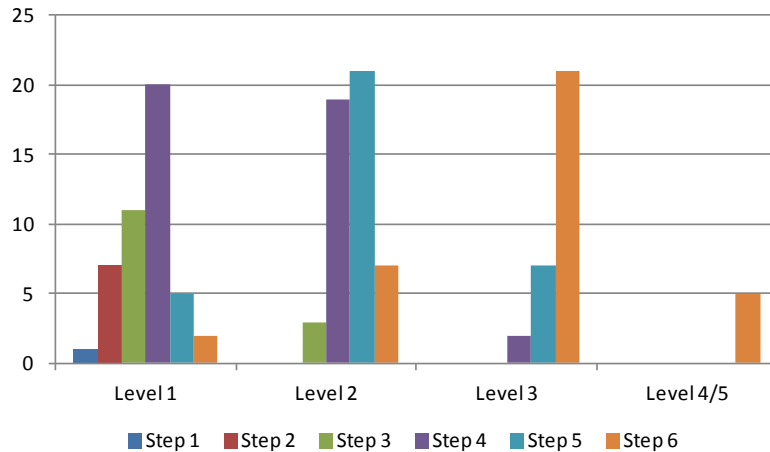


Table 4 shows a mapping of the relationship between numeracy assessment steps and ALL numeracy levels.

Table 4

Mapping of General Numeracy Assessment Steps to ALL Numeracy Levels

Level 4/5						
Level 3						
Level 2						
Level 1						
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
	General numeracy assessment					

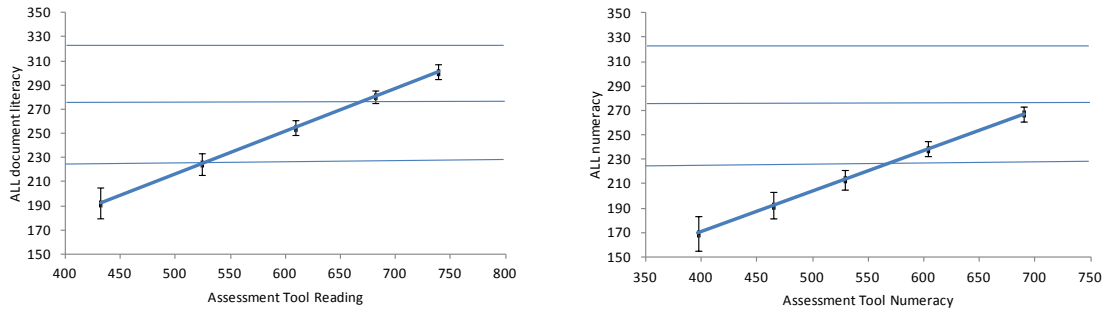
Converting scale scores

The final piece of analysis was to see if it was possible to develop a way of converting the Assessment Tool scale scores to ALL scale scores. This would provide a more precise method for comparing the results from the two instruments. Rather than trying to map results from Assessment Tool steps to ALL levels, if the scale scores could be converted, then groups of learners who had been assessed on the Assessment Tool could be assigned to an ALL level.

A linear regression model was used. It was restricted to people who spoke English at home at the time of the ALL survey, and were aged 25 and over in the case of document literacy. The model simply looked at the ALL literacy or numeracy score as a function of the Assessment

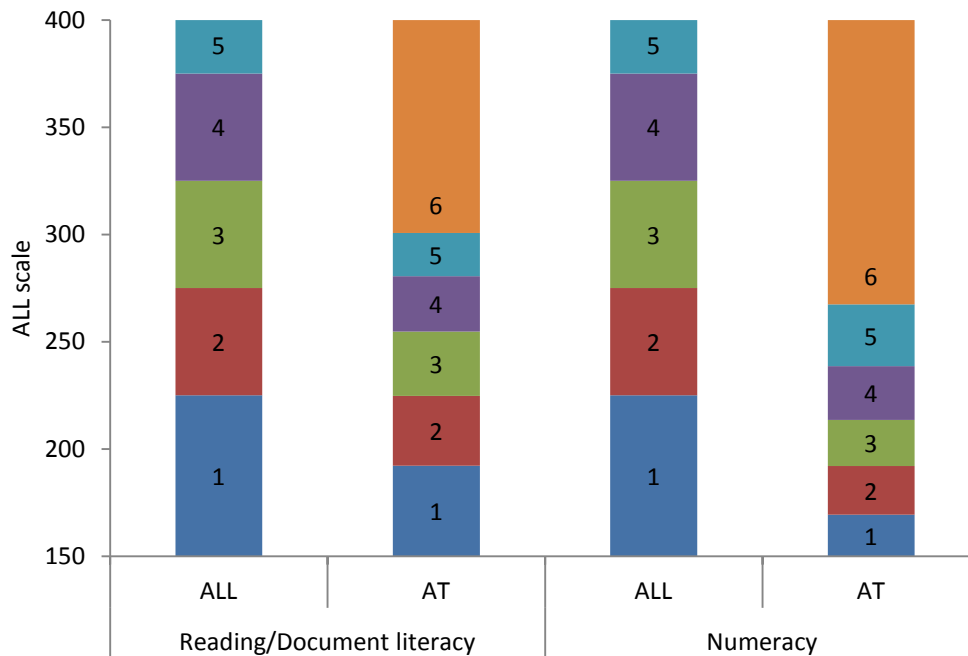
Tool scale score. The relationships are shown in Figure 8. The points on the line are the cut points for the Assessment Tool steps and the error bars are the 95 per cent confidence intervals for the mean, using the population weights in the ALL survey. The horizontal lines are the cut points for the ALL levels 1 to 4.

Figure 8
Conversion of ALL literacy or numeracy scores to Assessment Tool scale scores



Converting the Assessment Tool steps to ALL levels is shown graphically in Figure 9. The actual values are shown in Table 7 in the Appendix. And the conversion scales from the regression are presented below the table. The results are consistent with the mappings shown above in Table 3 and Table 4. The relationships between step and level cut points differ slightly in some places as a result of the regression forcing a linear relationship between the two scales.

Figure 9
Graphic illustration of conversion of Assessment Tool scale to ALL survey scales



The results suggest that this is a reasonable approach for comparing the results of groups of learners between the Assessment Tool and the ALL survey. So using this method, we can take the Assessment Tool results for a group of learners and predict with reasonable certainty how their results would be distributed on the ALL scale. However, we would have much less certainty about predicting what result each individual learner might get on the ALL scale. The 95 per cent confidence intervals for individuals are very much wider than the difference

between the steps. For example, on numeracy the 95 per cent confidence interval for an individual score is plus or minus 65 scale points, compared with step differences of around 25 scale points on the ALL scale.

Conclusion

The ALL survey and the Assessment Tool have different purposes and starting points. The ALL survey was a population survey, intended to provide reliable information about the literacy and numeracy skills across the population and for international comparison. It started with general definitions of literacy and numeracy and then developed scales and levels to represent ranges of ability. The Assessment Tool is intended to provide reliable information on individuals to inform teaching and learning. It has not been referenced to a specific population. It measures reading and numeracy ability based on the Learning Progressions. These identify the specific elements of learning adults need to build upon to reach proficiency in literacy and numeracy.

In spite of the different purposes and approaches, both measures identify similar underlying constructs of literacy and numeracy. There are strong correlations between the measures in the scores for people who have been assessed on both. Interestingly, the comparisons show no evidence that there are any learners who had lower skills on ALL who have underperformed to a large extent on the Assessment Tool. This is an area of concern for some educators. On the contrary, there would appear to be a small group whose Assessment Tool scores are higher than would be predicted by their ALL results.

It is possible to develop an approximate mapping of the Assessment Tool steps to the ALL levels. This involves mapping the steps to overlapping ranges on the ALL scale, as there is not a precise correspondence between the steps and levels. Steps on the Assessment Tool are much better at differentiating the lower levels of literacy and numeracy, especially level 1 on ALL, than higher levels. This is consistent with the purpose of the Learning Progressions to inform foundation learning in literacy and numeracy.

The ability to clearly compare steps on the Assessment Tool and levels on the ALL survey is limited. For literacy and reading, it would be reasonable to equate Steps 1 and 2 on the Reading Progressions with ALL Level 1 and Steps 5 and 6 with ALL levels 3 and above. For numeracy, it would be reasonable to equate Steps 1 to 3 on the General Numeracy Progression with ALL Level 1.

A more promising approach is to convert the Assessment Tool scale scores for groups of learners to ALL scale scores. This allows an approximation of ALL levels to the Assessment Tool results. This approach is only valid in looking at results for groups of learners and not for individual learner results.

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APPENDIX

Table 5

Summarised descriptors of ALL levels and associated scale ranges

	Scale range	Descriptor summary
Level 1	up to 225	Read simple documents, accomplish literal information-matching with no distracting information, and perform simple one-step calculations.
Level 2	226-275	Search a document and filter out some simple distracting information, make low-level inferences, and execute one- or two-step calculations and estimations.
Level 3	276-325	Perform more complex information-filtering, sometimes requiring inferences and manipulate mathematical symbols, perhaps in several stages.
Level 4	326-375	Integrate information from a long passage, perform more complex inferences and complete multiple-step calculations requiring some reasoning.
Level 5	376 and over	Make high-level inferences or syntheses, use specialised knowledge, filter out multiple distracters, and understand and use abstract mathematical ideas with justification.

Source: (Satherley et al., 2008)

Table 6

Scale ranges for Assessment Tool steps

	Reading	General Numeracy
Step 1	Up to 431	Up to 396
Step 2	432-523	397-464
Step 3	524-608	465-528
Step 4	609-681	529-603
Step 5	682-738	604-689
Step 6	739 and over	690 and over

Note: the numeracy ranges were adjusted in mid-2012. These adjustments were not incorporated in Lane (2012).

Table 7

Conversion of Assessment Tool step to ALL scale scores

Assessment Tool Step	ALL survey scale scores	
	Reading to Document literacy	General Numeracy to Numeracy
Step 1	Up to 191	Up to 168
Step 2	192 - 224	169 - 191
Step 3	225 - 254	192 - 213
Step 4	255 - 280	214 - 238
Step 5	281 - 300	239 - 266
Step 6	301 and over	267 and over

$$\text{Document(ALL)} = 39.52 + 0.353 * \text{Reading(AT)}$$

$$\text{Numeracy(ALL)} = 36.51 + 0.335 * \text{Numeracy(AT)}$$