

THE EXPRESSION, EXPERIENCE AND TRANSCENDENCE OF LOW SKILLS IN AOTEAROA NEW ZEALAND

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fossils: chrysolit
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in French was gr

WORKING PAPER 2

READING COMPONENTS, READING ENGAGEMENT
AND LITERACY PROFICIENCY IN AOTEAROA
NEW ZEALAND

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ABOUT THIS RESEARCH PROGRAMME

Over 1.3 million adult New Zealanders live with low literacy and/or numeracy (L+N) skills, with a strong over-representation of Māori and Pacific peoples. This has significant economic and social costs, including increased risk of unemployment and poverty, detrimental effects on physical and mental well-being, and decreased social and political attachment.

This programme applies a mixed-method approach to the following research aims: to build a detailed population-wide picture of those with low L+N skills; analyse their life-course pathways and effectiveness of interventions with respect to a range of economic and social outcomes; forecast future changes in population skill level; and develop an understanding of the barriers and enablers that build resilience to risk, along with pathway to transcend low skills.

For further information about our programme and other outputs, see www.workresearch.aut.ac.nz/low-skills

ABOUT THIS PAPER

This working paper develops multivariate models of how reading component processes are related to the higher order literacy proficiency assessed by the OECD's Programme for the International Assessment of Adult Competencies (PIAAC) and to adults' engagement with reading in everyday life.

DISCLAIMER

The views expressed are those of the authors and do not necessarily reflect the views of the organisations involved.

ABSTRACT

The Expression, Experience and Transcendence of Low Skills in Aotearoa New Zealand research project explores the life-course trajectories of adults living with low literacy and/or numeracy skills in Aotearoa New Zealand (NZ). The project defines low literacy in terms of the conceptual framework implemented in the OECD's Programme for the International Assessment of Adult Competencies (PIAAC). Like earlier international assessments of adult literacy, the PIAAC conceives literacy in terms of the broad skills and knowledge involved in evaluating and utilising texts to achieve a wide variety of goals in a range of contexts. This broad conception of literacy "extends well beyond the skills of decoding or comprehending texts" (OECD, 2013a, p. 1). For individuals with low levels of assessed literacy proficiency, however, the assessment provides little direct information about their basic component skills of reading - such as recognising printed words, understanding printed sentences or comprehending short passages.

To provide additional information about low-level readers, the PIAAC survey also assessed the basic component skills of reading of a small subsample of survey participants - primarily individuals with low assessed literacy proficiency. These reading components tests directly measured individuals' ability to recognise isolated printed vocabulary items, read simple sentences, and comprehend short passages. As expected, almost all NZ adults with literacy proficiency above the lowest levels were able to complete the reading components tasks without errors. Most also did them quite quickly which reflects a high degree of skill and fluency in their underlying reading processes. Most NZ adults with low literacy proficiency levels are also able to recognise most of the printed vocabulary items, understand many of the sentences and comprehend many of the short passages, although it typically takes them much longer to do so. For example, NZ adults at the lowest literacy level are able to recognize 86% of the printed vocabulary items correctly (compared to 99% for adults at the highest levels), though it takes them, on average, nearly twice as long to do so.

This working paper develops multivariate models of how reading component processes are related to the higher order literacy proficiency assessed by the PIAAC and to adults' engagement with reading in everyday life. Reading engagement and literacy proficiency mutually reinforce each other during adult literacy development, in part because the underlying reading components are closely associated with both reading engagement and literacy proficiency. The differences observed in those relationships suggest that the use of practice-centred instructional strategies and designs for intervention programs may be particularly helpful to those living with low literacy. By contextualising reading instruction within meaningful everyday reading practices of learners, teachers can increase levels of reading engagement that learners take away from programmes into their everyday lives. Over time, this increased reading engagement leads to increased literacy proficiency. The findings of this working paper suggest that practice-centred instruction may be particularly effective with learners from diverse ethnic and linguistic backgrounds.

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1 Introduction

This working paper focuses on the reading skills and practices of adults in Aotearoa New Zealand (NZ), both of which are important dimensions of low literacy. After reviewing some previous research on the topic, this working paper presents some new analyses of data from the recent Survey of Adult Skills (SAS) – the Programme for the International Assessment of Adult Competencies (PIAAC) - that suggest some promising new approaches to improving adult literacy in NZ.

As part of the PIAAC, the OECD conducted the SAS between 2012 and 2017 with a total of 38 countries participating in one of three data collection rounds, including New Zealand in the second round in 2014-15. The SAS is a household survey, sampled to be nationally representative of each country's adult population aged 16-65. In New Zealand, a sample of 6,177 people were surveyed. The survey was conducted in English and included an extensive background questionnaire covering education, employment, and the use of skills at work and in everyday life. The survey then assessed the literacy, numeracy and problem-solving skills of respondents.

Detailed information about the design and implementation and initial results of the SAS is available from OECD (2013a). Additional results for New Zealand and its international comparators are also available from OECD (2016a). The New Zealand government has published a series of detailed reports about the SAS findings for the country, including Ministry of Education and Ministry of Business, Innovation & Employment (MoE & MBIE) (2016), Jones and Satherley (2018) and Satherley (2018).

These publications include comparisons of literacy between New Zealand and other countries who participated in the SAS, as well as changes in literacy in New Zealand over time as measured in previous surveys and the SAS. The interested reader is referred to these publications to learn more about these findings. This working paper focuses specifically on low literacy in contemporary New Zealand as per the SAS.

The SAS conceptualised and assessed literacy within a framework developed by the PIAAC Expert Literacy Group (2009). This framework considers literacy as the ability to understand, evaluate, use and engage with written texts to get everyday things done. The SAS assesses only reading literacy; there is no writing component. Examples of abilities assessed include:

- understanding of written words and sentences;
- comprehension of text in charts and diagrams; and
- comprehension, interpretation and evaluation of complex texts.

The survey measures literacy proficiency on a continuous scale (0 – 500), comprising a range of abilities from being able to deal with simpler through more complex tasks. The continuous proficiency scales are often divided (for convenience) into levels to group people within similar ranges of ability. These levels help describe and communicate the kinds of tasks these groups of people can usually perform correctly. These levels do not, however, measure whether individuals meet certain performance standards in an absolute way nor, in the case of literacy proficiency, whether people are 'literate' or 'illiterate'.

Table 1 below displays the six levels and associate subranges of test scores used to describe the continuum of literacy abilities in the SAS:

Table 1. Six levels of test scores used to describe literacy abilities in the SAS

Literacy Level (proficiency range)	Type of Tasks Adults Can Usually Perform
Below Level 1 (0-175)	At this level, people can read brief texts on familiar topics and locate information in a longer piece of text if it is identical to what they are looking for. They should be able to understand most signs and follow short basic instructions.
Level 1 (176-225)	At this level, people can read relatively short texts and diagrams to locate a single piece of information that is identical to what they are looking for. There will be little competing irrelevant information.
Level 2 (226-275)	At this level, people can navigate within digital texts to identify information. They can compare and contrast different pieces of information and make some inferences.
Level 3 (276-325)	At this level, people can understand dense and lengthy texts to find relevant information among irrelevant or competing information.
Level 4 (326-375)	At this level, people can perform multi-step operations to interpret and integrate information from complex texts. They can also apply background knowledge and interpret subtle arguments.
Level 5 (376-500)	At this level, people can use multiple dense texts to evaluate the reliability of different sources to evaluate evidence and arguments, find key information and synthesise familiar and contrasting ideas.

Note: Table adapted from MBIE (2016).

It is important to note that these levels, useful for discussing literacy abilities, do not describe benchmarks or thresholds for participation in society and the economy. For the purposes of this working paper, adults are said to have low literacy proficiency¹ when they score 225 or below, that is at Level 1 or Below Level 1.

Some of the key results about low literacy in New Zealand in SAS-related publications include:

- about one in eight (11.8%) of New Zealand adults (ages 16-65) have low literacy proficiency;²
- adults with less education are more likely to have low literacy proficiency;
- immigrants are more likely to have low literacy;
- adults who do not speak English as a native language are more likely to have low literacy proficiency;
- men and women do not have significantly different rates of low literacy proficiency; and
- Māori and Pasifika groups have higher rates of low literacy proficiency: 19% of Māori and 35% of Pasifika groups have low literacy proficiency.

¹ The term literacy “proficiency” is used in this working paper to refer to the specific SAS measure; other authors use “skills” or “competence” for the same construct.

² In addition, 1.9% of the adult population had literacy-related reasons their proficiency could not be assessed, e.g., did not speak English, had a learning disability/difference, etc.

1.1 Assessment of Reading Components

In order to provide more detailed information about the reading abilities of adults with low literacy proficiency, the OECD developed additional tests based on cognitive research about the processes underlying skilled reading (Sabatini & Bruce, 2009). For the SAS, literacy is defined as “understanding, evaluating, using and engaging with written texts to participate in society, to achieve one’s goals, and to develop one’s knowledge and potential...literacy... involves constructing meaning, and evaluating and using texts to achieve a range of possible goals in a variety of contexts...literacy extends well beyond the skills of decoding or comprehending texts to using them appropriately in context.” (OECD, 2013b, p. 21).

This assessment of reading components was intended to measure adults’ abilities to handle the fundamental aspects of understanding written texts – recognising and understanding printed words and building meaning from sentences and passages. The higher-level literacy proficiency observed in everyday reading activities is built upon a foundation of underlying, fluently operating, component skills (Curtis, 1980; Perfetti, 2003; Baer et al., 2009). These building blocks of reading include the ability to recognise words in printed form (“print vocabulary”), the ability to process meaning at the sentence level (“sentence processing”) and the ability to comprehend text passages (“passage comprehension”).

Previous research on these reading components in other PIAAC-participating countries (Grotlüschen et al., 2016) found that most adults with low literacy proficiency have basic knowledge of print vocabulary i.e., they are able to identify the printed word corresponding to a concrete object from a set of four alternatives. Most adults with low proficiency are also able to understand the meaning of sentences of short to medium length, read short passages relatively fluently, and correctly perform comprehension tasks (Grotlüschen et al., 2016). Because this prior research indicated that countries differ considerably, in terms of both the percentage of adults with low literacy proficiency and the basic reading skills that those low proficiency adults possess, it is important to look at these reading components as part of understanding the nature of low literacy in NZ (Grotlüschen et al., 2016; OECD, 2016b).

1.2 Plan for the Working Paper

The remainder of this working paper is organised as follows. Section 2 introduces Practice Engagement Theory (PET), a framework that is useful for understanding the role of reading components in adult literacy development. Section 3 describes the PIAAC’s reading components test in detail, the ways in which respondents were routed to the reading components test (or not), and the characteristics of respondents who took the reading components test. Section 4 examines adults’ performance on the reading components, paying particular attention to how performance varies across the PIAAC’s assessed levels of literacy proficiency. As expected, there is a close relationship between performance in the reading components and literacy proficiency level. Because the PET research reviewed in Section 2 consistently finds a close relationship between literacy proficiency and engagement in everyday reading activities, there is reason to expect a positive relationship between reading components performance and an index of reading engagement. Section 5 explores this relationship through multivariate models of literacy proficiency and reading engagement, paying particular attention to the question of whether reading components are directly associated with reading engagement when the effects of literacy proficiency and other variables are held constant. The affirmative answer found to this question has important implications for both theory and practice in adult education. Section 6 concludes the working paper with a discussion

of these findings and their implications for programmes, policy, and future research in adult education and for improving the literacy proficiency and wellbeing of those living in NZ with the challenges of low literacy.

1.3 Practice Engagement Theory

The development of effective reading components is part of the pathway leading to higher levels of reading proficiency (Strucker et al., 2009). As reading proficiency increases, the underlying components become more fluent and automatised (LaBerge & Samuels, 1974). There is a gradual shifting of attention and cognitive capacity away from the words on the page, towards the comprehension and use of written texts for higher purposes. In this conceptualisation of reading, both the accuracy and fluency of the underlying reading components are important determinants of literacy proficiency and development. As reading components develop, engagement with reading activities in everyday life should become easier and more frequent. PET offers a framework for understanding the relationships between changing levels of literacy proficiency and reading engagement.

PET (Reder 1994, 2009b, 2019; Sheehan-Holt & Smith, 2000; Reder et al., 2020) provides an account of how proficiency, in this case literacy proficiency, develops during adulthood. PET models reflect how engagement in reading activities in everyday life (whether at work or outside of work contexts) affects literacy proficiency development over the adult lifespan. Initially based on cross-cultural and cross-situational qualitative research about literacy practices and proficiencies, PET posits that individuals' literacy proficiencies develop as a by-product of their engagement in everyday reading and writing practices and, reciprocally, that literacy proficiencies affect levels of engagement in reading and writing practices (Reder, 1994). Quantitative modelling of PET became possible as large-scale national and international surveys started to measure literacy proficiencies, along with the use of those proficiencies in everyday activities (Smith, 1996, 2009; Sheehan-Holt & Smith, 2000). These cross-sectional analyses have been supplemented by Desjardins (2019), who examined synthetic cohorts of national populations aligned across repeated surveys and found that increased engagement in literacy practices is associated with increases in population levels of literacy proficiency over time.

PET has been more rigorously tested with data from several longitudinal panel studies of individual literacy development. The Longitudinal Study of Adult Learning (LSAL) followed a random sample of adults, with a low level of education in a metropolitan area in the United States, over eight years with repeated measurements of both literacy proficiency and engagement in reading and writing practices (Reder, 2009a, 2019a). A second longitudinal study, the German National Educational Panel Study (NEPS), was analysed by Wicht et al. (2020). A third panel study examined for evidence of PET was a longitudinal repetition of the PIAAC survey in Germany (PIAAC-L), analysed by Reder et al. (2020). Analyses of each panel study found that engagement in reading practices predicted growth of individuals' literacy proficiency over time, even though the three panel studies involved different measures of literacy proficiency and different measures of engagement in reading practices. Despite these differences in measures, the three studies found positive effects of individuals' reading engagement on their literacy proficiency growth over time. The PIAAC-L study analysed by Reder et al. (2020) utilised the same measures of literacy proficiency and reading analysed in this working paper. This research on PET highlights the importance of considering reading engagement along with reading components in understanding literacy development among adults with low levels of literacy. As will be seen, increased reading engagement has both theoretical and practical importance for improving the proficiency of low literacy adults in New Zealand.

2 The PIAAC Reading Components Tests

As discussed in Section 1, the reading components tests in New Zealand were part of the second round of the Survey of Adult Skills (SAS) conducted in 2014-15. In New Zealand, the SAS used a nationally representative sample of size 6,177 from the adult population aged 16-65. All SAS data analysed in this working paper was accessed with the assistance of the New Zealand Ministry of Education.

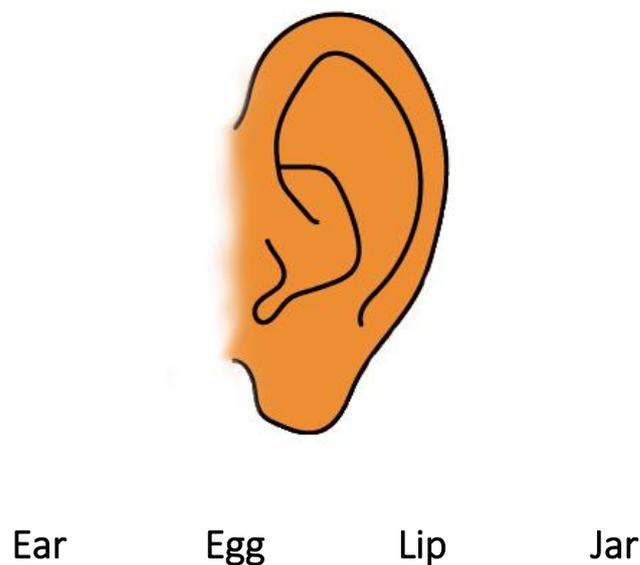
The PIAAC reading components tests were based on a framework developed by Sabatini and Bruce (2009), built on a solid base of research on the cognitive components underlying skilled reading. Additional information and discussion about these reading component tests is available in OECD (2013a) and Grotlüschen et al. (2016). Three tests comprise the PIAAC reading components: printed vocabulary recognition (34 items), sentence processing (22 items), and passage comprehension (44 items).

2.1 Sample Items³

Printed vocabulary

The printed vocabulary items included a picture of a common object and four alternative words. The respondent is asked to match the object to one of the four alternative words, as illustrated in Figure 1.

Figure 1. Sample Printed Vocabulary Item



³ Sample items are sourced from OECD (n.d.).

Sentence processing

The sentence processing items ask the respondent to assess whether a sentence makes sense in terms of its properties of the real world or the internal logic of the sentence. The respondent reads the sentence and circles “YES” if the sentence makes sense or “NO” if the sentence does not make sense, as illustrated in Figure 2.

Figure 2. Sample Sentence Processing Item.

Sentence	Response	
	YES	NO
Three girls ate the song.	YES	NO
The man drove the green car.	YES	NO
The lightest balloon floated in the bright sky.	YES	NO
A comfortable pillow is soft and rocky.	YES	NO
A person who is twenty years old is older than a person who is thirty years old.	YES	NO

Passage comprehension

For passage comprehension items, respondents read a passage in which at certain marked points they select the word that makes sense from the two alternatives provided, as shown in Figure 3.

Figure 3. Sample Passage Comprehension Item.

To the editor: Yesterday, it was announced that the cost of riding the bus will increase. The price will go up by twenty percent starting next wife / month. As someone who rides the bus every day, I am upset by this foot / increase. I understand that the cost of gasoline / student has risen. I also understand that riders have to pay a fair price / snake for bus service. I am willing to pay a little more because I rely on the bus to get to object / work. But an increase / uncle of twenty percent is too much.

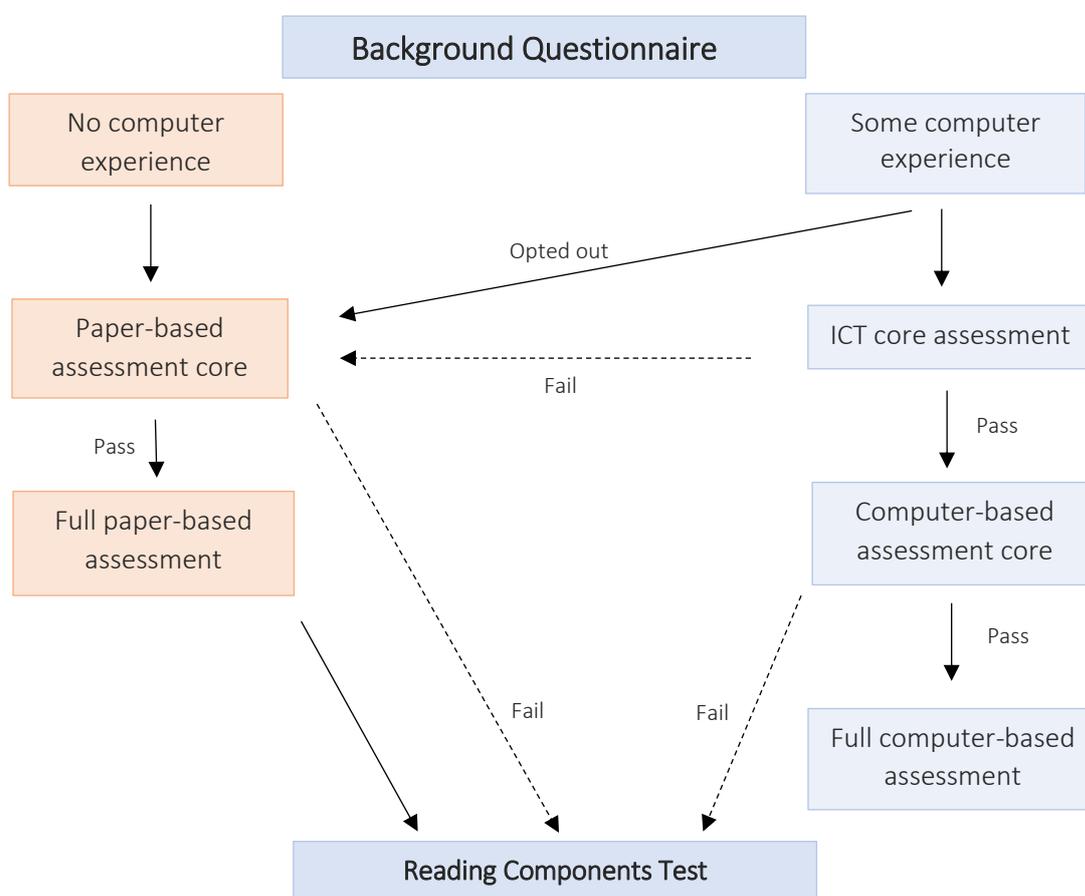
This increase is especially difficult to accept when you see the city's plans to build a new sports stadium. The government will spend millions on this project even though we already have a science / stadium. If we delay the stadium, some of that money can be used to offset the increase in bus fares / views. Then, in a few years, we can decide if we really do need a new sports cloth / arena. Please let the city council know you care about this issue by attending the next public meeting / frames.

Routing of PIAAC Respondents to Reading Components

Although nearly all PIAAC respondents received the literacy assessment, only a small fraction also received the reading components test. The reading components test was part of the paper-based assessment (PBA) but not part of the computer-based assessment (CBA) in the PIAAC. All respondents who took the PBA received the reading components test. Although some respondents at all literacy levels took the reading components test, the purpose for testing the reading components only on paper was to reach mostly respondents at low literacy levels and not burden too many respondents at higher literacy levels with a test that was very easy for them.

The complex design of the PIAAC assessment involved different pathways that respondents might traverse to reach the paper-based reading components. Figure 4 illustrates the various pathways leading to the PBA and reading components test.

Figure 4. Routing to Reading Components



Note: Figure 4 is adapted from Perry and Gauly (2019).

As can be seen in the figure, there are four pathways that led to the PBA/reading components test:

- **no computer experience:** adults who responded that they had no prior computer experience and were routed directly to the PBA core;
- **some computer experience, but opted out of CBA:** adults who responded that they did have prior computer experience, but chose to opt out of the CBA in favour of taking the remainder of the survey in the PBA core;

- **some computer experience, but failed CBA core:** adults who responded that they did have prior computer experience, tried but then failed the CBA core (i.e., did not have the requisite keyboarding, mouse and basic computer navigation skills) were re-routed to the PBA core; and
- **passed CBA core, but then failed literacy/numeracy core:** adults who passed the CBA core, demonstrating that they had basic computer navigation skills, but then failed the literacy/numeracy core screener, and were routed directly to reading components.

Table 2 shows the number of respondents reaching the reading components test through these four pathways along with the percentage each group represents of the entire reading components subsample and of the entire PIAAC sample in New Zealand.

Table 2. Respondent Routing to Reading Components Test

Reason for Being Routed to Reading Components Test	Number	% of RC Subsample	% of Full Sample*
No Computer Experience	149	25.4	2.5
Some Computer Experience, but Opted out of CBA	211	36.0	3.5
Some Computer Experience, but Failed CBA core	221	37.7	3.6
Uncategorised	5	0.9	0.1
Total Taking Reading Components	586	100.0	9.6

Note: Full sample used here has size of 6074 and excludes 103 sampled individuals who could not be assessed because of literacy-related non-response.

Overall, 586 individuals (only 9.6 % of New Zealand’s PIAAC respondents) took the reading components tests. Among all countries participating in the PIAAC, this was the 3rd lowest percentage taking the reading components tests. For New Zealand’s neighbour, Australia, the corresponding percentage was 22% (Grotlüschen et al., 2016). A major reason why relatively few New Zealand adults took the reading components tests was their much lower rate of having no previous computer experience: 2.5% compared to the average of the other PIAAC-participating countries: 14.7% (OECD, 2016b). Part of the difference in computer experience is that New Zealand and other PIAAC Round Two countries were surveyed in 2014, two years after Australia, and other Round One countries were surveyed in 2012.

2.2 Characteristics of Adults Taking Reading Components Test

Table 3 displays some of the characteristics of individuals taking the reading components test, individuals not taking the reading components test, and of the total population (aged 16-65). The point estimates and standard errors shown take the PIAAC’s complex sampling design and the multiply imputed measurement error (present in the literacy proficiency measure) into account. For the descriptive statistics in the lower part of the table, z-scores are given for the comparison of characteristics between those taking and not taking the reading components test.

The reading engagement index shown in the table was derived from individuals' reports of how often they engage in each of a set of reading tasks in the workplace (if they are employed) and in home and community settings. The index measure is scaled, with a mean set to 2.0 and a standard deviation to 1.0, to represent both the breadth of reading tasks in which individuals engage and the frequency of those task engagements. More information about this derived reading engagement index is provided in the appendix.

Table 3. Descriptive Statistics – Population Estimates, Ages 16-65

Descriptive Statistic	Adults Taking Reading Components Test	Adults Not Taking Reading Components Test	Z	Total
% Below Level 1	14.3 (1.8)	1.4 (0.2)		2.5 (0.3)
% Level 1	21.8 (2.2)	8.1 (0.5)		9.4 (0.5)
% Level 2	34.1 (2.9)	30.1 (0.8)		30.5 (0.8)
% Levels 3-5	29.8 (2.7)	60.4 (1.0)		57.6 (1.0)
Mean Literacy	241.9 (3.0)	284.5 (0.8)	-14.72***	280.7 (0.8)
Mean Reading Engagement	1.25 (0.06)	2.07 (0.01)	-13.51***	2.00 (0.01)
% Female	43.8 (1.9)	52.3 (0.2)	-4.06***	51.5 (0.1)
Mean Age (Years)	46.4 (0.6)	39.4 (0.1)	9.87***	40.0 (< 0.1)
% Native English Speakers	71.2 (2.0)	83.2 (0.5)	-6.68***	82.2 (0.4)
% New Zealand Born	68.2 (2.0)	71.4 (0.6)	-1.62	71.2 (5.3)
Mean Years Education	11.9 (0.1)	13.9 (0.4)	-17.72***	13.7 (< 0.1)
% Māori	19.7 (1.6)	13.0 (0.2)	4.32***	13.6 (< 0.1)
% Pasifika	15.8 (1.7)	5.4 (0.2)	7.62***	6.4 (0.2)
% NZ European	56.9 (2.6)	74.1 (0.4)	-6.85***	72.6 (0.4)
% Other Ethnicity ⁴	13.4 (1.5)	13.2 (0.3)	0.11	13.2 (0.2)
N	586	5488		6074

Note: standard errors are in parentheses and levels of statistical significance are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The full sample here excludes 103 sampled individuals who could not be assessed because of literacy-related non-response.

⁴ Respondents reported as part of the Background Questionnaire interview one or more ethnic identities. The most frequent identities reported were New Zealand European, Māori, and Pasifika. Additional identities reported are grouped in this working paper as "Other Ethnicity", including Asian and MELAA (Middle-Eastern, Latin American and African) ethnicities.

Overall, the intended routing of respondents to the reading components test successfully concentrated individuals with low levels of literacy proficiency. This can be seen comparing the distribution of literacy levels in the upper part of the table. Although less than half (36.1%) of adults taking the reading components test scored at Below Level 1 or Level 1, almost four times the percentage (9.5%) of the adults who did not take the reading components test. There were relatively far fewer adults (29.8%) taking the reading components test that had higher literacy proficiencies (Levels 3-5) than adults who did not take the reading components test (60.4%). The broad distribution of literacy levels among adults taking the reading components test will be useful later in understanding how reading component performance is related to literacy proficiency.

Table 3 shows that the mean literacy proficiency was much lower among those taking the reading components test than among those not taking it. The mean reading engagement index was also considerably lower among those taking the reading components test than among those not taking it. In addition to having lower literacy proficiencies, individuals taking the reading components test were generally less engaged in reading activities in their everyday lives.

Adults taking the reading components test included a statistically significant lower percentage of women, were significantly older, had significantly fewer native speakers of English, and averaged two years less education than adults who did not take the reading components test. There were significantly higher percentages of individuals reporting Māori and Pasifika identities and significantly fewer NZ European identities among those taking the reading components test. There were not statistically significant differences between the reading component groups in rates of being “Other Ethnicity” or being New Zealand-born.

3 Reading Components Performance in New Zealand

3.1 Performance on Reading Components Tests

Performance on the reading components tests is measured in terms of accuracy and speed. The population-weighted averages for the percentage of items answered correctly are 96% for printed vocabulary, 89% for sentence processing and 92% for the passage comprehension items. The total completion times for the three tests averaged 2.6, 2.9 and 6.2 minutes, respectively.

Printed Vocabulary

Since individuals assessed at a wide range of literacy proficiencies took the reading components tests, it is important to disaggregate these performance measures by literacy level. Table 4 displays the printed vocabulary recognition results disaggregated by literacy levels. Columns (1) and (2) show the population-weighted mean percent items correct and time taken to complete the 34-item test, respectively. These data are graphed in the top-left panel of Figure 5. Although accuracy increases regularly with increasing literacy level, it is still quite high (86%) among individuals assessed at the lowest literacy level. Adults at Level 1 are correctly identifying 95% of the printed vocabulary items. The speed of vocabulary processing also increases substantially across increasing levels of literacy i.e., the total time taken to complete the items decreases). Higher levels of literacy are characterised not only by more accurate performance but faster, more fluid performance of the vocabulary tasks.

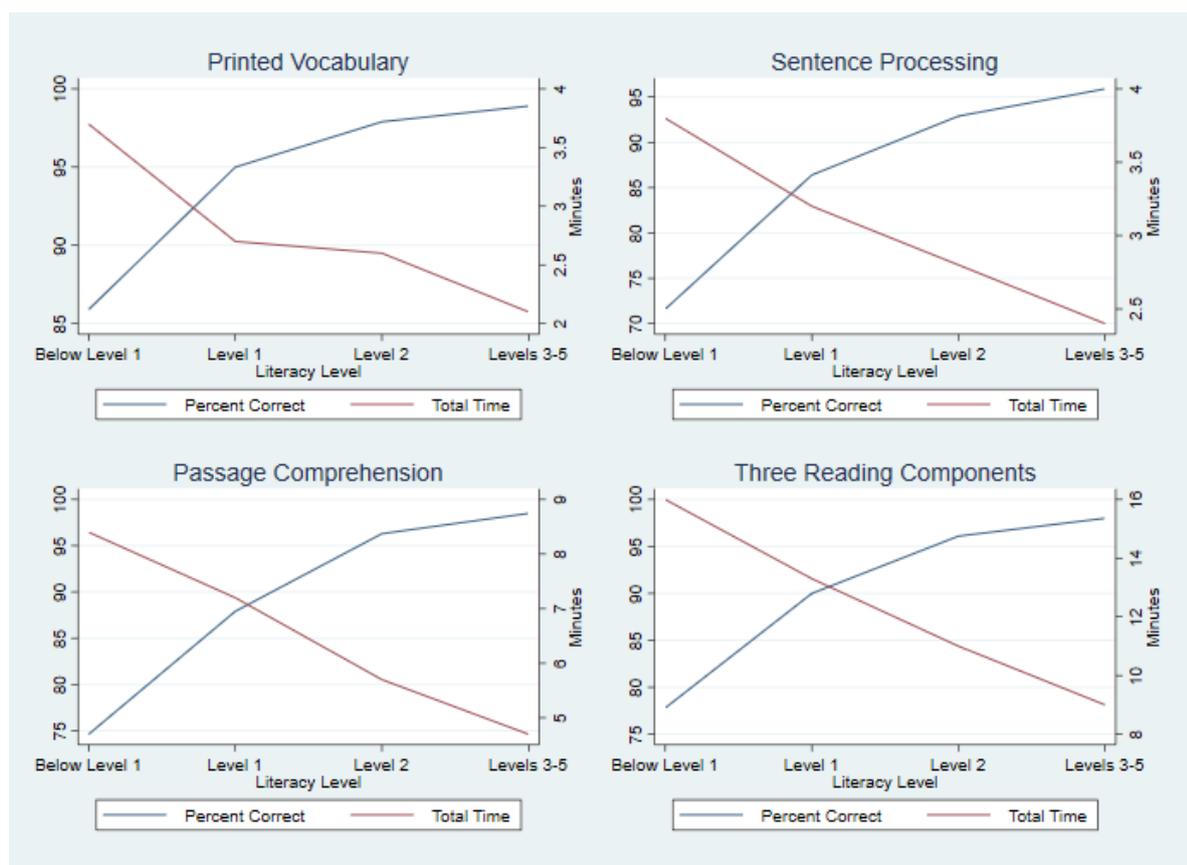
Table 4. Printed Vocabulary Recognition

Literacy Level	% Correct (1)	Total Time (mins) (2)	% Getting 90%+ correct (3)	Total Time (mins) (4)
Below Level 1	85.9 (2.8)	3.7 (0.4)	61.9 (7.2)	2.9 (0.4)
Level 1	95.0 (2.1)	2.7 (0.3)	86.1 (4.3)	2.7 (0.3)
Level 2	97.9 (0.7)	2.6 (0.2)	90.9 (2.6)	2.4 (0.2)
Levels 3-5	98.9 (0.4)	2.1 (0.4)	94.6 (2.0)	2.0 (0.1)

Note: standard errors are in parentheses.

The majority of individuals at each literacy level correctly recognised 90% or more of the printed vocabulary items. Column (3) of the table displays the percent of adults in the population at each literacy level who correctly recognised at least 90% of the vocabulary items. Not surprisingly, this percentage rises steadily with literacy levels. About 62% of adults at the lowest literacy level correctly recognise 90% or more of the items, compared to 86% of adults who are assessed at Level 3 or above. The average time these highly accurate readers take to complete the vocabulary test decreases regularly with increasing levels of literacy, as shown in Column (4) of the table.

Figure 5. Accuracy and Speed of Reading Components



Sentence Processing

The sentence processing test shows a similar pattern of results in both Table 5 and Figure 5.

Table 5. Sentence Processing

Literacy Level	% Correct (1)	Total Time (mins) (2)	% Getting 90%+ correct (3)	Total Time (mins) (4)
Below Level 1	71.6 (3.9)	3.8 (0.3)	30.8 (6.6)	3.1 (0.4)
Level 1	86.4 (2.2)	3.2 (0.3)	58.5 (6.0)	3.1 (0.2)
Level 2	92.9 (0.9)	2.8 (0.1)	81.8 (3.7)	2.7 (0.1)
Levels 3-5	95.9 (0.7)	2.4 (0.1)	89.5 (2.6)	2.3 (0.1)

Note: standard errors are in parentheses.

As with vocabulary recognition, accuracy in sentence processing rises steadily and processing time decreases steadily across increasing literacy levels. The sentence processing tasks, however, are evidently more difficult than the vocabulary recognition tasks. Adults at the lowest literacy level answer only 72% of the sentence processing items correctly compared to 85% of the vocabulary items.⁵ While 62% of adults

⁵ Recall that vocabulary items have four response alternatives whereas sentence and passage items have only two response alternatives, so the chance of correctly guessing an item when uncertain about it is much higher in the sentence and passage tests

at the lowest literacy level are able to answer 90% or more of the vocabulary items correctly, only half as many (31%) are able to answer 90% or more of the sentence processing items correctly.⁶

Passage Comprehension

A similar pattern of results can be seen for passage comprehension in both Table 6 and Figure 5. As with vocabulary recognition and sentence processing, accuracy in passage comprehension rises steadily and its processing time decreases steadily across increasing literacy levels. As we saw for the sentence processing tasks, the passage comprehension tasks may be somewhat more difficult than the vocabulary recognition tasks. Adults at the lowest literacy level answer only 75% of the passage comprehension items correctly compared to 85% of the vocabulary items. Compared to the 62% of adults at the lowest literacy level who are able to answer 90% or more of the vocabulary items correctly, nearly as many (57%) are able to answer 90% or more of the passage comprehension items correctly.

Table 6. Passage Comprehension

Literacy Level	% Correct (1)	Total Time (mins) (2)	% Getting 90%+ correct (3)	Total Time (mins) (4)
Below Level 1	74.6 (5.1)	8.4 (0.7)	57.0 (7.4)	8.6 (0.8)
Level 1	87.9 (3.0)	7.2 (0.5)	79.4 (5.1)	7.4 (0.5)
Level 2	96.3 (1.1)	5.7 (0.3)	94.2 (2.1)	5.7 (0.2)
Levels 3-5	98.5 (0.6)	4.7 (0.2)	96.3 (1.9)	4.7 (0.2)

Note: standard errors are in parentheses.

Reading Components Combined

The similar systematic variation of accuracy and processing speed across literacy levels observed for each of the three reading components suggests that performance on the three tests could be meaningfully combined and reported in terms of overall accuracy and processing time measures. There are 100 items across the three tests (34 vocabulary, 22 sentence and 44 passage items). Table 7 and Figure 5 each show the overall accuracy and total processing time for the 100 items together.

Table 7. Vocabulary Recognition, Sentence Processing and Passage Comprehension (combined)

Literacy Level	% Correct (1)	Total Time (mins) (2)	% Getting 90%+ correct (3)	Total Time (mins) (4)
Below Level 1	77.8 (3.8)	16.0 (1.2)	47.9 (8.3)	14.4 (1.4)
Level 1	90.0 (2.2)	13.3 (0.9)	75.3 (5.2)	13.2 (0.9)
Level 2	96.1 (0.7)	11.0 (0.4)	90.7 (2.9)	10.9 (0.4)
Levels 3-5	98.0 (0.4)	9.0 (0.4)	95.9 (1.9)	8.8 (0.3)

Note: standard errors are in parentheses.

than in the vocabulary test. These differences underline the greater difficulty level of the sentence and passage tasks evident in percentages of items correctly answered.

⁶ It is not meaningful to compare total processing times across the vocabulary, sentence and passage tests because of the different number of items comprising each test and the inherent differences in the nature of the test items.

Not surprisingly, the combined measures show the same pattern of variation across literacy levels observed for each of the three components. Adults at the lowest level of literacy correctly answered 78% of the items, a percentage that climbed steadily over literacy levels with those at Level 3 and above correctly answering 98% of the items. Nearly half (48%) of those at the lowest level answered 90% or more of the items correctly. Those at higher levels of literacy also processed the items much more quickly, taking on average a total of nine minutes to complete the items, compared to an average of 16 minutes for those at the lowest level.

3.2 Conclusions from the Reading Components Tests

As found in many other PIAAC-participating countries, adults at the lowest level of measured literacy proficiency (Below Level 1) are in general far from illiterate. They can accurately recognise common printed words, understand most simple written sentences and comprehend most short passages. NZ adults measured at the lowest level of literacy proficiency (Below Level 1) exhibit similar levels of performance on reading components tasks to Below Level 1 adults from other OECD countries. NZ adults average 86%, 72% and 75% correct on the Vocabulary, Sentence and Passage tasks, respectively; the corresponding averages for OECD countries in Round One of SAS are 90%, 73% and 68%.⁷

These findings are important because they add nuance to the common (mis)understandings of low literacy and challenge common stereotypes about adults who have low literacy proficiency. This does not imply, of course, that all adults Below Level 1 can perform these tasks easily. Some have much lower accuracy rates, and most take much longer to recognise words, process sentences and understand short passages. Their overall low levels of reading speed or fluency may require most of their attentional resources and make more difficult and less enjoyable to use reading in their everyday lives. The research reviewed above certainly suggests the possibility of those limitations.

There is little specific research connecting the accuracy and fluency of underlying reading components to the use of reading in everyday activities. The present results show a clear relationship between reading component performance and literacy proficiency. The Practice Engagement Theory research reviewed in Section 2 consistently finds positive relationships between literacy proficiency and engagement in reading activities, so there is good reason to expect positive relationships between reading components and reading engagement as well. Previous research has not examined this relationship directly, however, so it is not known whether there is a direct relationship between reading component performance and reading engagement when the effects of literacy proficiency are controlled. Such a connection would have important implications for the design and implementation of adult literacy programmes. This possibility is examined in the following section.

⁷ Although reading components results have been reported for Round 1 countries by OECD (2013b) and Grotlüschen et al. (2016), the results here for New Zealand are the first reported for either Round 2 or Round 3 countries.

4 The Usefulness of Reading Components for Understanding Low Literacy

This section examines how the reading components are related to both the literacy proficiency and reading engagement measures. Two important points to keep in mind as the analyses unfold are (1) because these measures were assessed together at a single point in time, it is difficult to disentangle what causes what; and (2) literacy proficiency and reading components were assessed in English whereas the reading engagement index was scaled from activities that might include reading materials in English and/or other languages.

Given the broad base of reading research that PIAAC developers drew upon in designing the reading component tests, there is good reason to expect that reading component performance would be positively associated with the PIAAC's assessed literacy proficiency. Furthermore, given the research reviewed above about relationships between literacy proficiency and use of reading skills in everyday life and work, there is good reason to expect positive relationships between performance on reading components and reading engagement. An unexamined question is whether reading components, as measures of the basic processes underlying skilled reading, directly explain variation in reading engagement after the effects of literacy proficiency are statistically controlled. As argued later in this paper, the answer to this question is important for both scientific and andragogical reasons and can help shape and improve the effectiveness of adult literacy programmes.

Linear regression models are used to explore the relationships among the reading components, literacy proficiency and reading engagement measures. In these models, the combined measures of reading components are used, the overall percentage correct and total time taken for the vocabulary, sentence and passage items. All models include a constant and a set of controls for age, gender, education, native language, country of birth and ethnicity. For each of two dependent variables (literacy proficiency and reading engagement), three models are compared: a baseline model containing the control variables and a constant; a second model that adds reading engagement (for literacy proficiency) or literacy proficiency (for reading engagement) to the baseline model; and a third model that adds the overall accuracy and speed variables for the reading components to the second model.

Table 8 displays six regression models, three for literacy proficiency and three for reading engagement. Models (1) and (4) are the baseline models for literacy proficiency and reading engagement, respectively. Models (2) and (5) are the PET models, adding reading engagement to the literacy proficiency model or literacy proficiency to the reading engagement model, respectively. Models (3) and (6) add the reading components measures to the PET models. The increasing variances accounted for by adding the PET variable to the baseline model and then the reading components variables to that model are clear in Table 7. For literacy proficiency, the three models account for 27%, 33% and 45% of the variance in literacy proficiency, respectively. For reading engagement, the three models account for 18%, 24% and 30% of the variance in reading engagement, respectively.

Table 8. Regression Models of Literacy Proficiency and Reading Engagement

Covariates	Literacy Proficiency			Reading Engagement		
	(1)	(2)	(3)	(4)	(5)	(6)
Literacy Proficiency					0.00601*** (0.00147)	0.00277* (0.00155)
Reading Engagement		12.88*** (3.004)	5.270* (2.935)			
Reading Comprehension % Correct			162.4*** (25.43)			2.615*** (0.479)
Reading Comprehension Time Taken			-2.615*** (0.501)			-0.0354*** (0.00868)
Age	2.147 (1.307)	1.843 (1.231)	2.310* (1.193)	0.0236 (0.0284)	0.0107 (0.0259)	0.0217 (0.0254)
Age-squared	-0.0282* (0.0155)	-0.0249* (0.0145)	-0.0278** (0.0141)	-0.000259 (0.000325)	-0.0000892 (0.000293)	-0.000193 (0.000288)
Female	3.794 (5.485)	5.878 (5.348)	-0.640 (5.376)	-0.162 (0.104)	-0.185* (0.101)	-0.250** (0.0980)
Education	9.695*** (1.284)	6.799*** (1.340)	5.675*** (1.342)	0.225*** (0.0246)	0.167*** (0.0304)	0.155*** (0.0291)
English is Native Language	30.90*** (9.097)	28.53*** (8.865)	17.63** (8.308)	0.184 (0.218)	-0.00235 (0.210)	-0.0770 (0.207)
NZ born	8.516 (11.62)	3.266 (11.13)	2.069 (10.24)	0.408* (0.208)	0.355* (0.211)	0.314 (0.191)
Maori	-18.74* (10.96)	-20.55* (10.78)	-11.71 (10.47)	0.140 (0.198)	0.254 (0.201)	0.306 (0.200)
Pasifika	-21.54 (13.77)	-28.64** (14.36)	-15.70 (14.00)	0.551** (0.256)	0.680** (0.275)	0.742*** (0.269)
Euro	-8.927 (11.64)	-11.86 (12.21)	-5.126 (11.80)	0.228 (0.217)	0.282 (0.233)	0.330 (0.222)
Other Ethnicity	-27.57* (15.62)	-32.72** (14.94)	5.374 (16.12)	0.400 (0.323)	0.565* (0.315)	1.025*** (0.304)
constant	79.15** (39.18)	112.2*** (37.89)	-2.379 (46.35)	-2.570*** (0.725)	-3.045*** (0.717)	-4.425*** (0.785)
N	546	546	546	546	546	546
r ²	0.270	0.327	0.451	0.179	0.243	0.304

Note: Standard errors are in parentheses. Levels of statistical significance are as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.1 Reading Components and Practice Engagement Theory

The results for models (2) and (5) are consistent with the expectations of PET. Reading engagement accounts for statistically significant variation in literacy proficiency when education and other variables are statistically controlled in (2), and literacy proficiency accounts for statistically significant variation in reading engagement when education and other variables are statistically controlled in (5). When the reading components variables are added to these models, both accuracy and fluency are statistically significant predictors, with higher accuracy and fluency (i.e., shorter times) associated with increased literacy proficiency in (3) and with increased reading engagement in (6).

Adding reading components to the models also lowers the effects of reading engagement on literacy proficiency and of literacy proficiency on reading engagement. This can be seen by the markedly lower coefficient for reading engagement in (3) than in (2) and by the markedly lower coefficient of literacy proficiency in (5) than in (4). These results suggest that the PET effects reflected in models (2) and (5) are partially mediated by the effects of underlying reading components on both literacy proficiency and reading engagement. This is an important addition to practice engagement theory.

It is noteworthy that reading engagement remains a statistically significant predictor of literacy proficiency in these models even with the accuracy and fluency of the underlying reading component processes statistically controlled (along with education and other variables). Although these findings do not necessarily establish a causal relationship between reading engagement and literacy proficiency, the findings are certainly consistent with the research reviewed above that has used stronger causal methods to demonstrate that engagement in reading practices leads to growth in literacy proficiency over time (and vice-versa).

A particularly important result in (6) is its affirmative answer to an important question posed earlier: reading components are positively associated with reading engagement even when effects of literacy proficiency, education and other variables are statistically controlled. The accuracy and fluency of the underlying reading component processes are positively associated with reading engagement when the effect of literacy proficiency is statistically controlled. The final section of this report attempts to clarify this relationship and its importance for both theory and programmes.

4.2 Variation with Individual Background Characteristics

Years of education is a highly significant positive predictor of literacy proficiency and of reading engagement in all of the models. Age has significant effects in only model (3) of literacy proficiency, with a positive coefficient for age and a negative coefficient for age-squared. These coefficients are consistent with the inverted-U age profile found in previous research on the effects of age on adult literacy proficiency (Reder, 2009a; Paccagnella, 2016). Gender is not significant in models of literacy proficiency but is statistically significant in reading engagement models (5) and (6) that control for literacy proficiency and other variables; females have lower levels of reading engagement with other variables held constant.

English being the native language is a statistically significant, positive predictor of literacy proficiency in all models. In contrast, native language is not statistically significant in any of the models of reading engagement. It is not surprising that being a native speaker of English predicts higher literacy proficiency since PIAAC assesses proficiency in English. Since non-native speakers of English may read materials written

in languages other than English,⁸ it is reasonable that native language does not significantly affect overall reading engagement the way it affects assessed literacy proficiency in English. With native language controlled, being born in NZ is not a statistically significant predictor of literacy proficiency but is a significant predictor of reading engagement in some specifications.

With native language, country of birth and other variables controlled, none of the ethnicity flags is a statistically significant predictor of literacy proficiency in model (3) that includes reading components and reading engagement. In model (6) that includes both literacy proficiency and reading components, on the other hand, both Pasifika and Other Ethnicity are statistically significant, positive predictors of reading engagement. Although other specifications exhibit varying effects of ethnicity flags, there seems to be a clear overall pattern difference between ethnicity effects in literacy proficiency and reading engagement models. All statistically significant ethnicity effects on literacy proficiency are negative, whereas all statistically significant ethnicity effects on reading engagement are positive.⁹ It is argued below that this pattern suggests that literacy interventions targeting particular ethnic groups may be more effective if their designs and outcomes are specified in terms of reading engagement rather than literacy proficiency.

⁸ The background questionnaire items referred to how often individuals read certain types of materials but did not specify English language materials.

⁹ The small sizes of some ethnic subsamples taking the reading components limits the power of the statistical tests of these effects.

5 Summary and Discussion

5.1 Summary of Findings

Two principal sets of findings have emerged from looking at the reading components in NZ's PIAAC data. The first set of findings essentially replicates for NZ what previous research has found for reading components in other PIAAC countries (Grotlüschen et al., 2016). Most adults having low levels of literacy proficiency can nevertheless perform basic tasks drawing on the reading components – recognizing common printed vocabulary items, understanding short written sentences, and comprehending short passages. This richer picture of the reading abilities of adults having low levels of literacy proficiency indicates that prevailing public assumptions and stereotypes about their “illiteracy” may well be overstated, misleading and stigmatising.

The major differences observed in the performance of reading components tasks among adults at differing levels of literacy proficiency is the time required to complete basic tasks correctly rather than the overall level of task accuracy. The research-based cognitive theory framing the design of the tests of reading components (Sabatini and Bruce 2009; Strucker et al. 2009) holds that the increased speed and fluency reflects greater automaticity of underlying components, which in turn demand less attention and cognitive resources to process the words on the page. This greater automaticity of underlying component processes enables skilled readers to allocate more of their limited attention and cognitive effort to the higher-level written information processing involved in more complex reading tasks benchmarking the higher levels of PIAAC literacy proficiency.

The second set of findings offers a new perspective on the PIAAC reading components and further develops practice engagement theory. Multivariate models of literacy proficiency and reading engagement measures indicate that reading components explain variation in both literacy proficiency and reading engagement when education and other individual background characteristics are statistically controlled. In line with previous research on reading components in other PIAAC-participating countries (Grotlüschen et al., 2016), the accuracy and speed of the reading components in New Zealand explain variation in literacy proficiency after controlling for education and other variables. This is the first time, however, that the relationship between reading components and reading engagement has been examined in this way. Better reading components performance is associated with more reading engagement as well as with higher literacy proficiency when education and other background variables are controlled.

These models also indicated that the PET effects observed in the NZ data -- and perhaps in other research studies reviewed in Section 2 as well -- are partially mediated by the effects of underlying reading components on both literacy proficiency and reading engagement. This could be an important addition to practice engagement theory because it identifies measurable underlying mechanisms that contribute to the higher order reciprocal interactions between proficiencies and practices over time at the core of adult literacy development. The reading components mediation of both proficiency and engagement does not fully account for the practice engagement effects, however. The models indicate that even with the effects of reading components and other background variables controlled, there are direct effects of proficiency and engagement on one another.

An important aspect of the mediation findings is the relationship observed between reading components and reading engagement. Although causality cannot be readily identified from measurements of these variables at only a single point in time, it is reasonable to assume from cognitive research on reading that repeated engagement with reading tasks leads over time to increased accuracy and fluency of underlying reading components. In turn, increased accuracy and fluency of reading components enables more automatization of the underlying processes and increases attentional resources available to higher level reading processes, thereby fostering increased reading engagement.

Individual background characteristics seem to influence literacy proficiency and reading engagement differently in these multivariate models. There are statistically significant age effects present in literacy proficiency but not reading engagement models. There are statistically significant gender and country of birth effects present in reading engagement but not literacy proficiency models. The most striking differences, however, occur with native language and ethnicity. With other variables controlled, having a native language other than English has a significant negative effect on literacy proficiency but no significant effect on reading engagement. Ethnicities also have different effects on proficiency and engagement with other variables equated. Where specific ethnicity indicators have statistically significant effects on literacy proficiency, those effects are negative; where specific ethnicity indicators have statistically significant effects on reading engagement, those effects are positive. These findings suggest that adult literacy interventions targeting particular ethnic and language groups may be more effective if their designs and outcomes are specified in terms of reading engagement rather than literacy proficiency. This is considered in more detail below.

5.2 Limitations

These findings are subject to some methodological limitations. The positive relationships observed in the PIAAC between reading component performance and literacy proficiency as well as between reading components and reading engagement are based on essentially correlational analyses. The multivariate models do not in themselves establish causal relationships between reading components and literacy proficiency or between reading components and reading engagement. It seems clear from a large base of cognitive reading research, however, that the relationship between reading components and literacy proficiency is indeed causal. There is less research about the relationships between reading components and reading engagement, but the research supporting practice engagement theory reviewed above is consistent with such a causal relationship. The theoretical framework underlying the reading components assessment assumes that the attentional resources freed up by the automatization of underlying reading components enable adults to allocate more attention to applying written information to the performance of higher order tasks (Sabatini & Bruce 2009). The attentional resources that fluent reading components free up to support higher levels of literacy proficiency should also help adults to engage more often and in a wider variety of reading activities in everyday life. Further research is needed to clarify the nature of the underlying relationship between reading components and these higher order proficiency and practice engagement processes.

A second limitation is that the PIAAC assesses reading components and literacy proficiency only in English, so that the functional role played by reading and literacy in respondents' other languages is not directly considered. The multivariate models indicate that English being a native language is indeed an important predictor of literacy proficiency but not of reading engagement, suggesting that reading in second

languages may also play an important role in literacy development. Although more detailed information about the use of languages other than English is available in the PIAAC, the subsample sizes for respondents' varying linguistic contexts are too small for meaningful further analysis within the already small reading components subsample.¹⁰

A third limitation is the uncertain generalizability of the findings about reading components to the entire PIAAC population as opposed to the subpopulation that took the reading components assessment. Recall that a complex routing process, described in detail in Section 4, determined which respondents took the reading components tests. The non-randomness of that selection complicates the generalization and interpretation of some of the findings in ways that future research may need to consider.

5.3 Implications

The findings have some important implications for adult literacy programmes, policy and future research.

Implications for Programmes

One of the original goals for the reading components within the PIAAC was to provide richer information about the reading abilities of adults with low literacy proficiency. The PIAAC framework provides descriptions of the kinds of everyday tasks that adults can do who have proficiency scores at or Below Level 1. These descriptions often seem abstract and distant from programmes' profiles of and instructional stages for their adult literacy learners. The reading components may be easier for practitioners to align with the needs and experiences of their learners.

Ako Aotearoa, for example, is an umbrella organization offering support and training to tertiary educators and adult literacy instructors and programmes throughout NZ. They have been using adult literacy learner "Profiles, Steps 1 to 6" to describe learners and organise materials and trainings for teachers suited to each stage of the literacy development process (Ako Aotearoa, 2010). The Step 1 profile is organised around word recognition, vocabulary and text features. Step 2 is organised around understanding sentences and short texts. The reading component information is readily mapped onto these steps for adult educators and programmes.

Surveying the reading components results of numerous PIAAC Round One countries (not including NZ), Grotlüschen et al. (2016) noted "Understanding the relationships among components and general literacy proficiency can be helpful in creating policies and planning instructional programmes for adults seeking to enhance their literacy abilities." (p. 86). The findings in this working paper deepen our understanding of these relationships by linking reading components not only to literacy proficiency as has been done before but also to reading engagement as well.

For programme planning, this broadened conception of literacy development suggests an important strategy for programmatic innovation and design: practice-centred instruction. By contextualising reading instruction and exercises within meaningful everyday reading practices of learners, teachers can increase levels of reading engagement that learners take away from programmes into their everyday lives.

¹⁰ Multivariate analyses of relationships between literacy proficiency and reading engagement across respondents' varying linguistic contexts are more feasible using the entire PIAAC sample (i.e., not just within the reading components subsample). The author's preliminary look at these data suggests that reading in languages other than English is not a significant predictor of the overall reading engagement measure considered in this working paper.

According to PET, the reciprocal linkage between proficiency and practice engagement enables reading engagement to mediate relationships between experiences in adult life and literacy proficiency development. And there is considerable evidence that reading engagement is more malleable than literacy proficiency and may be an effective instructional target for adult literacy programmes.

In analysing the impact of adult basic education programmes on students' proficiency trajectories, Reder (2009b) and Sheehan-Holt and Smith (2000) found that programmes have a short-term impact on students' levels of practice engagement in the first year after programme exit, but no significant short-term effect on proficiency change. Over time, however, programmes have a substantial impact on proficiency change when assessed five years after programme exit, due to the long-term mediating effects of programme-generated change in practice engagement (Reder, 2019a). By increasing everyday levels of reading engagement in their students, adult programmes are likely to produce improved literacy proficiency as well over time.

Practice-centred instruction is readily adaptable to the varying cultural and linguistic contexts and backgrounds of adult students. Instructional materials and tasks can be aligned with those having meaningful contexts in the learners lives outside of the programme. Purcell-Gates et al. (2000) studied diverse adult basic skills classes in the United States and found the incorporation of meaningful literacy practices into classroom instruction to be one of two key features of effective classroom programmes. The results in Section 5 about multivariate modelling of reading engagement and literacy proficiency in New Zealand further support the idea of trying to align reading materials and activities with the varying contexts and interests of NZ's diverse adult learners. Learners from minority ethnic and linguistic groups show less disadvantage (with other variables held constant) in reading engagement than in literacy proficiency so it may be a better domain for programmatic alignment. By initially fostering increased levels of reading engagement through use of culturally relevant materials and activities, programmes may generate higher levels of literacy proficiency over longer time periods. The strong and consistent associations between accuracy and processing speed across the proficiency spectrum suggests that reading component-like indicators could be used by programmes as early indicators of learning progress within practice-based instruction. These are certainly ideas for programmes to consider exploring and evaluating.

Implications for Policy

These findings also have implications for policy in NZ. The goals for adult literacy programmes and interventions should be formulated in terms of both literacy proficiency *and* reading engagement outcomes. Given the increasing research-based evidence about practice engagement theory, programme evaluations should be based on shorter-term impacts on reading engagement and longer-term impacts on literacy proficiency.

Although the scope of this working paper does not include looking at how individual social and economic outcomes are related to low levels of literacy and reading components, a large body of PIAAC research establishes the importance of adult literacy for a broad range of economic and social outcomes (OECD, 2013a; Dinis da Costa et al., 2014; Hanushek et al., 2015; OECD, 2016; Perry & Gauly, 2019). Literacy proficiency has been linked to employment, earnings, health status, social trust, political efficacy and civic engagement. With educational attainment held constant, strong relationships are found between proficiency levels and economic and social outcomes. Many of these findings also apply to New Zealand, as the initial PIAAC report produced by the government indicates (MoE & MBIE, 2016).

The research reported in this working paper implies that reading engagement should be incorporated into such analyses. New Zealand's central policy focus on wellbeing, closely aligned with some of these

economic and social indicators, should make this line of inquiry and policy development especially important.

Implications for Future Research

The findings in this working paper suggest several lines of future research that would be particularly useful:

- Replicate the multivariate modelling of reading components, reading engagement and literacy proficiency in other PIAAC-participating countries.
- Examine the role of reading engagement and parallel measures of writing engagement, maths engagement, and digital engagement in multivariate models of economic and social outcomes measured in the PIAAC.
- Examine the role of proficiencies and practice engagement in life trajectory models of economic and social outcomes in data sets linked to the PIAAC in NZ's Integrated Data Infrastructure (IDI).
- Explore the role of reading and writing in non-English languages in literacy development in the overall NZ PIAAC population (rather than in the reading components subpopulation where subsample sizes are too small).
- Conduct longitudinal studies measuring literacy proficiency, reading engagement and reading components at multiple points in time.
- Develop better measures of practice engagement/skill use for future large-scale surveys.

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7 Appendix

7.1 The Reading Engagement Index (RE)

An index of reading engagement was derived for this working paper from responses to the PIAAC Background Questionnaire. Respondents were asked to report how often they performed eight specific reading tasks: Read:

- directions or instructions
- letters, memos or e-mails
- articles in newspapers or magazines
- articles in professional journals or publications
- books
- manuals or reference materials
- bills, invoices, bank statements or other financial statements
- diagrams, maps or schematics.

Respondents indicated, on a five-point Likert scale, how often they performed each task:

- Never
- Less than once a month
- Less than once a week but at least once a month
- At least once a week but not every day
- Every day.

All respondents were asked how often they performed each task outside of work, and, if they were currently working, how often they performed each task at work. To derive an overall reading engagement index, respondents' reports of how often they performed each task activities were combined over the separately reported at-work and outside-of-work contexts. For each task, the greater usage frequency reported between work and outside-of-work contexts becomes the frequency for that merged context item. For example, if an individual reported reading newspapers or magazines "every day" at work and "once a week" outside of work, then the merged frequency would be "every day". For individuals who were not employed at the time of the interview, the merged frequency was just the outside-of-work frequency.¹¹ The generalised partial credit model of item response theory¹² (Hamel et al. 2016; Masters 1982) was used to scale these merged frequency items into an overall index of breadth and frequency of reading engagement (RE). This index variable was scaled with a mean set to 2 and a standard deviation of 1.

¹¹ Data were merged across contexts for several reasons. First, the overall merged-context level of practice engagement was of theoretical interest in our analysis. Second, individuals who are working tend to substitute some reading behaviours between non-work and work contexts. Third, the merged context measures allow analysis of the entire adult population rather than just the currently employed subpopulation for which the separate work context engagement measures were available. Similar merged-context measures of practice engagement have been used in other PIAAC research (Reder et al. 2020; Reder 2019b).

¹² A partial credit model of item response theory estimates values of an underlying variable (e.g., overall reading engagement) from ordered responses (e.g., *Never*; *Less than once a month*; *Less than once a week but at least once a month*; *At least once a week but not every day*; *Every day*) to a set of individual items (e.g., how often individuals perform each of the queried reading tasks).

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