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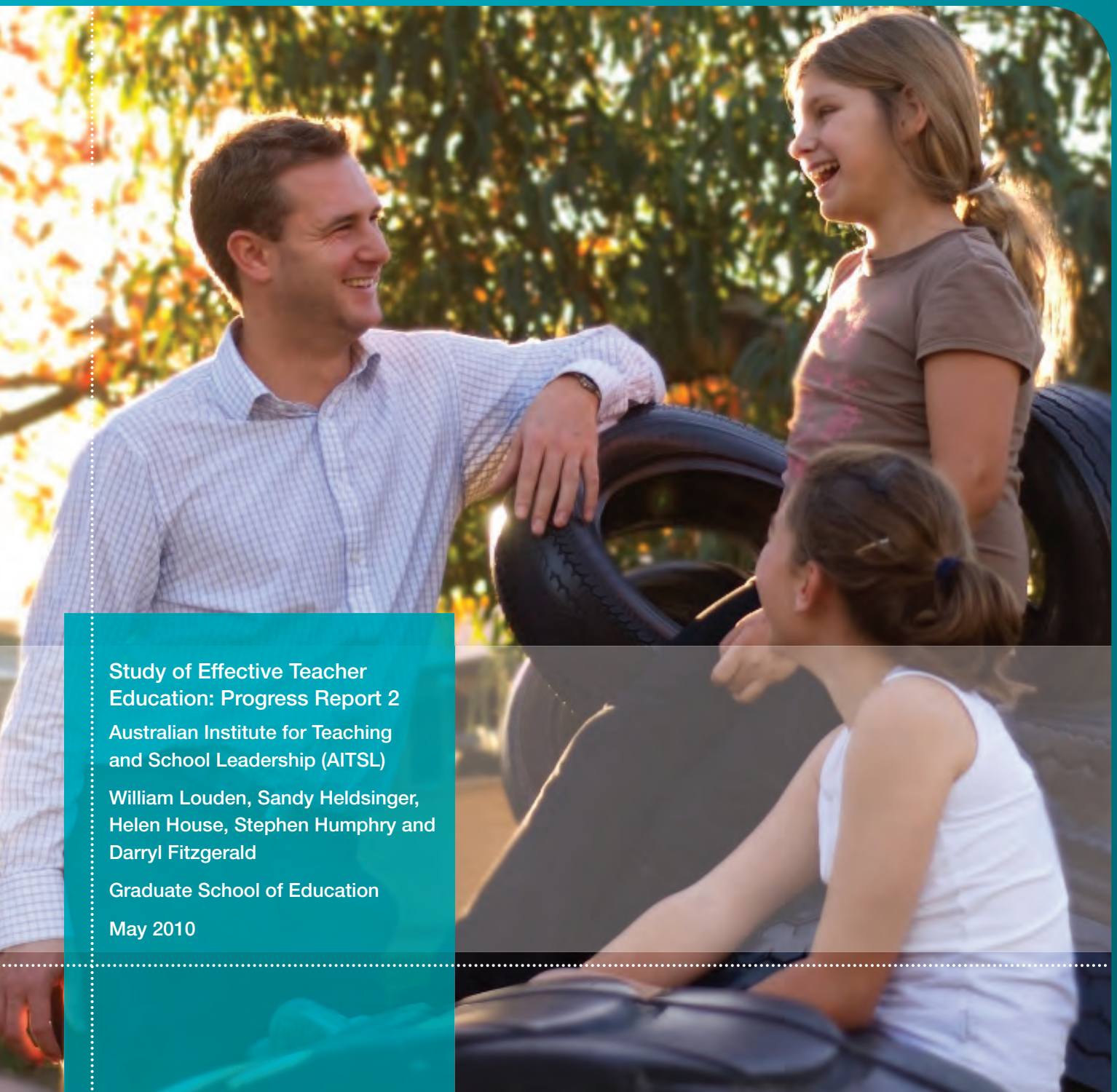
Learning from Teacher Education: The Impact of Teacher Education on Knowledge of Literacy and Mathematics Teaching



Study of Effective Teacher Education: Progress Report 2

Australian Institute for Teaching and School Leadership (AITSL)

William Louden, Sandy Heldsinger, Helen House, Stephen Humphry and Darryl Fitzgerald

Graduate School of Education

May 2010

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Acknowledgments

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This study was commissioned by Teaching Australia in April 2008 to provide evidence about the characteristics of effective teacher education programs. The study was undertaken by Professor William Louden, Dr Sandy Heldsinger, Mrs Helen House, Dr Stephen Humphry and Mr Darryl Fitzpatrick from the Graduate School of Education at the University of Western Australia. The research team also wish to thank the many 'research friends' who assisted and supported the research team providing literature searches, preparing, piloting and analysing the Teacher Learning Inventories.

Colleagues at Teaching Australia and more recently the Australian Institute for Teaching and School Leadership (AITSL) have provided both sound advice and strong support for the research team during the course of the project. Dr Graeme Hall has supported the research team, fielding the many queries and coordinating the project. We thank them all for their collegiality.

Bill Louden
May 2010

Learning from Teacher Education: The Impact of Teacher Education on Knowledge of Literacy and Mathematics Teaching

1. Executive Summary

Project goals

Teaching Australia commissioned a research team from The University of Western Australia to undertake this study in 2008. The goal of the study was to provide an empirical investigation of the effectiveness of teacher education. The project plan was to recruit a substantial group of teacher education students in their final year of teacher education, and to follow them through to the end of their second year of teaching. The research team conceptualised this longitudinal study as a series of related sub-studies, attempting to link program characteristics and personal characteristics with effectiveness in literacy and mathematics teaching, taking account of the impact of school context on teaching effectiveness.

Methods and Instrumentation

Study 1 provides an empirical classification of Australian teacher education programs. This was considered important for two reasons: to provide a check on the representativeness of the teacher education student sample; and to allow an analysis, in the context of the longitudinal study, of the impact of teacher education program characteristics on later teaching effectiveness. A review of the 38 Australian universities offering teacher education identified 530 separate programs. The classification frame (described in Section 2 of this report) distinguishes between degree program type, university sector, university type, field of education, undergraduate or postgraduate level, enrolment type, attendance mode, practicum type and program length.

Study 2 explores the background characteristics of teacher education students recruited to the study and Study 3 explores their knowledge of teaching. Study 2 and Study 3 drew on four separate forms of a new survey instrument, the Teacher Learning Inventory (TLI).

The Teacher Learning Inventories created for this project were designed to measure three traits:

- personal characteristics – including conscientiousness and teamwork – that have been shown to be associated with occupational success;
- perceptions of preparation for teaching in the two substantive areas, early years literacy and middle years mathematics teaching; and
- knowledge of literacy or mathematics teaching, as measured by capacity to analyse videos and written texts of students' reading, writing and mathematics.

The psychometric properties of the four new instruments developed for this study have been explored in detail. Analysis of these instruments using the Rasch Measurement Model (Rasch, 1960) shows that the instruments measure the three traits with satisfactory levels of internal consistency. Beyond this study, the sections of the TLIs designed to measure substantive knowledge of literacy or mathematics teaching may prove to be very useful to teacher educators interested in the effects of their programs.

A description of method, data analysis and results of Study 2 appear in Section 3 of this report. Details of the instrument design and marking keys for Study 3 appear in Section 4. Section 5 describes the results of an analysis of the relationship between the three components measured by the TLI: personal characteristics (Study 2); perceptions of teacher education (Study 2); and knowledge of teaching (Study 3).

Participants

More than 3,000 students in 15 universities were approached to participate in this study during 2008 and 2009. Of these, 766 agreed to participate and completed the ethical approval for the project. Subsequently, a total of 590 students actually completed one or other of the forms of the TLI (literacy, 409; mathematics, 181).

Participation in this study was inclusive, but not strictly representative. Students were drawn from four States and one Territory; from inner metropolitan, outer metropolitan and regional locations; from public and private providers; from undergraduate and postgraduate programs; and from programs leading to initial teacher education qualifications in early childhood, primary and secondary education.

Compared with the national demographic spread in initial teacher education, there were proportionally more students from post-Dawkins new universities, older Group of 8 research-intensive universities and private universities, and proportionally fewer students from technology universities and the 'gumtree' universities founded in the early 1960s to mid 1970s. Somewhat fewer regional students were included than the national proportion, and postgraduate initial teacher education students were over represented.

Results

For literacy, the results showed statistically significant differences on the three traits among four key program types (four-year Bachelor of Education; Double degree; Graduate Diploma[1]; Master of Teaching). Of these differences, the largest effect size was recorded for knowledge of teaching in the Master of Teaching programs.

- Among the Master of Teaching students who participated in this study, knowledge of literacy teaching as measured by the TLI was substantially greater than that of students in other kinds of programs.
- Although the effect sizes were small, there were statistically significant differences in favour of female students.
- Age was not statistically significant for any of the traits on the literacy TLIs.
- There was a notable difference in knowledge of literacy teaching between those who had entered the course on the basis of a completed degree, rather than through alternate entry, TAFE, on the basis of year 12 school performance or an incomplete degree.

The results for students completing the mathematics forms of the TLI were somewhat similar. Although between groups variance was statistically significant only in the case of knowledge of

[1] Master of Teaching: A two year graduate entry. Typically a two year degree post graduate program leading to registration as a teacher.

mathematics teaching, there was a large effect size associated with enrolment in a Master of Teaching program. There were no significant differences among groups according to gender or age of entry.

The results of this study have reinforced the importance of recruiting well-qualified entrants to the teaching profession. The measured personality trait was moderately related to perceptions of preparation for teaching – that is, people with higher scores on conscientiousness and teamwork reported that they were better prepared for teaching – but such people did not demonstrate greater knowledge of teaching through the TLI tasks examining ability to analyse student work. In contrast, students who entered teaching on the basis of a completed degree, or who entered the more demanding postgraduate option of a Master of Teaching rather than a Graduate Diploma, were more likely to be able to analyse student work and thus scored well on the teachers' knowledge trait.

Attrition

Studies 2 and 3 encountered unanticipated and very high levels of attrition. A total of 3,113 students from 15 universities were approached to participate in the study in 2008 and 2009. Of these, 362 completed the research ethics form in 2008 and 185 completed a version of the TLI. A change of strategy, involving the use of whole class groups and the return of analysed data to teacher educators added a further 417 in 2009 increasing the number completing a version of the TLI to 590. These numbers were sufficient to allow the analysis of results reported in Sections 3, 4 and 5 of this report.

Attempts to secure participation in the follow-up phase in the first year of teaching revealed that relatively few new graduates were willing or able to continue participation in the study in the year beyond completion of their teaching qualification. Of the 185 who completed TLIs in 2008, only 49 primary graduates and 24 secondary mathematics graduates identified their location the following year as working in a school. Of these 73 new graduates, 18 were working as supply or relief teachers, without their own classes – yielding a total of 55 of the 185 able to complete a second TLI during their first year of teaching. In consultation with Teaching Australia, it was therefore decided not to continue with the planned Studies 4 and 5.

2. Study 1: Characteristics of Teacher Education Programs

Teacher education is a major component of Australian higher education. More than 15,000 domestic students – almost one in every ten who complete any course– complete an initial teacher education course each year (DEEWR, 2010). There are, however, long-standing uncertainties about the quality of teacher education and the impact of teacher education on the first few years of professional practice. Some of the concerns arise from research on new graduates' perceptions of their professional preparation. Studies in the 1990s revealed that fewer than half of new teachers were positive about the quality of pre-service preparation (Batten, Griffin & Ainley, 1991) and that only "38% of respondents thought their teacher training adequately prepared them for teaching" (Dinham and Scott, 1996, p. 47). Similarly, studies in the last decade indicate that fewer than half of teachers rated themselves 'well' or 'very well' prepared for their first year of teaching by their pre-service course (Tasmanian Educational Leaders Institute, 2002, p. 134) and that only 69% of new primary school teachers thought that they had been prepared adequately to teach literacy (Louden & Rohl, 2006, p. 69). Such poor reviews of teacher education are frequently attributed to "transition shock" (Corcoran, 1981). That is, rather than ascribe their difficulties in the first year of teaching to the complexity of the role, new graduates conclude that they have received poor or impractical preparation.

Without research that disaggregates the complexity of the task of learning to teach from the quality of support provided to new graduates in their first years of school teaching, teacher educators are left with what Grossman (1990, xi) has called "the folk wisdom of ineffectiveness". Like their colleagues internationally, Australian teacher educators have learned to expect that external critiques will conclude that "teacher education is at best, ineffectual and, at worst, harmful and insidiously ideological" (Borko, Liston & Whitcomb, 2006, p. 199). Consequently, Australian teacher educators were not surprised that the House of Representatives Report *Top of the Class* (2007) noted that recent surveys of beginning teachers "presented a mixed picture of the effectiveness of teacher education programs". More challenging was the Inquiry's conclusion that "there is simply not a sufficiently rich body of research evidence to enable it to come to any firm conclusions about the overall quality of teacher education in Australia" (p. 6). This is consistent with United States' literature referring to the limited knowledge base about effective approaches to teacher education, especially if particular kinds of evidence are required (Cochrane-Smith & Zeichner, 2005; Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; Evertson, Hawley & Zlotnick, 1985; Kennedy, 1999; Raths & McAninch, 1999; Wilson, Floden & Ferrini-Mundy, 2001; Wilson & Floden, 2003).

In the absence of convincing evidence about the effects of teacher education on professional practice, this study was designed to disaggregate the impact of three sets of forces:

- characteristics of teacher education programs;
- characteristics of teacher education students on entry (such as their developed academic ability and personal dispositions); and
- characteristics of the schools in which new graduates begin teaching (such as the quality of mentoring and the complexity of the school environment).

Study 1 takes up the first of these issues, seeking to identify and classify the characteristics of teacher education programs.

2.1 Features of teacher education programs

Exploration of the first of these questions began with a review of the program characteristics represented in the 530 teacher education programs the research team identified in the 38 Australian universities offering teacher education.

2.1.1 Classification of Program Types and the Studies Sampling Frame

A survey of the teacher education programs for initial teacher education in Australia was conducted for all universities listed by the Department of Education, Employment and Workplace Relations as initial teacher education providers (DEEWR, 2008). The survey method involved accessing and analysing teacher education program descriptions detailed by providers at their online (web site) descriptions, listings and handbooks. The university online program descriptions were surveyed twice, initially in June 2008 and then again in December 2009. Table 1 details the program type classification schema used. Only the programs that state they meet teacher accreditation by a State Teacher Regulation body at program completion are included in the two surveys.

Table 1 Teacher education program classification schema

Classification	***Characteristics***
Program Type	Single Degree, Double Degree, Graduate Entry, Graduate Diploma
Sector	Public, Private
University Type	Group of Eight, 'Gumtree', Post-Dawkins, Technology, Private
Location	Inner metro, Outer Metro, Regional
Field/Target Level	Early childhood, primary, middle, secondary, special education
Program Level	Undergraduate, Postgraduate
Enrolment Type	Fulltime, Part-time, Full & Part-time
Attendance Mode	Internal (on campus), External (Online), Multimode
Practicum Type	Distributed, Internship, Embedded
Program Length	1, 1.5, 2, 2.5, 3, 4, 4.5, 5 years

Based on this classification, a national sampling frame was developed in 2008. Thirteen universities agreed to participate in the first phase of the data collection in 2008. Table 2 below provides a mapping of the classification characteristics against program type. Because the anonymity of institutions has been guaranteed to participants, universities are identified by an alphabetic code in Table 2.

Table 3 provides a more detailed description of the 13 universities that agreed to participate in 2008. It shows the potential total number of students in each university, the opportunity that the university was able to provide for the project's research staff to discuss the project with students, and the number of students who completed the research ethics agreement that was the gateway to individual student participation. Students agreeing to participate in the literacy section of the study were all in primary teacher education programs; students agreeing to participate in the mathematics section of the study were all in secondary teacher education programs.

The project plan called for 1,000 participants. Despite recruiting 13 universities to the study in 2008, and despite the universities providing the research team with access to almost 2,300 students, the total number of students who agreed to participate in 2008 was 349 (see Table 4). This sample size was judged too small to make the longitudinal study viable. For this reason, after consultation with Teaching Australia, it was decided that in 2009 the research team should approach all of the universities who had participated in 2008 and a few others who had heard about the study and expressed interest. Two additional universities participated in 2009, and 7 were not able to participate a second time. The additional participants recruited in 2009 appear in Table 5.

Table 2 National sampling frame 2008

	Sector		Location			Enrolment Type			*Attendance Mode			Practicum Type		
	Public	Private	Inner Metro	Outer Metro	Regional	Fulltime	Part-time	Both	On campus	Online	Multimode	Distributed	Internship	Embedded
Single Degree	AABDG HIJKLM	C	ACH	ADHJ	ALM	HIJ		ABCDKM	ABCGHI JK	M	DM	AABIJKGHM	AABCGHI	
Double Degree	GIM	C	CJ					JCM	C GJ		M	JMGIC		
Graduate Entry														
Graduate Diploma	ABEFGH JK	C	ACE	AJK		BJ		ACEGHK	AEFJ KCH		G	ABJEGKH		

Lecturers in 2008 sample indicated poor attendance at lectures and tutorials for 'on campus' category as students were accessing their lectures online. Students moving from 'on campus' to 'multimode'.

Table 3 National sampling frame 2009

	Sector		Location			Enrolment Type			Attendance Mode			Practicum Type		
	Public	Private	Inner Metro	Outer Metro	Regional	Fulltime	Part-time	Both	On campus	Online	Multimode	Distributed	Internship	Embedded
Single Degree	AAJK	C	A	JA	J	J		AA	AACJK			AAJK	AACJK	
Double Degree	JK	C		K	J							JK	C	
Graduate Entry	EN		EN			N		E	EN			EN	E	
Graduate Diploma	AEJKEOL	C	AEEN	JKA	LO				AEJKEOL					

Table 4 Participants agreeing to complete the surveys by program type 2008

University	*Program Type*	*Focus*	*Cohort*	*Participants*
A	B.Ed	Literacy	150	39
A	Grad Dip	Literacy	120	22
A	B.Ed	Literacy	150	24
A	Grad Dip	Mathematics	30	8
A	B.Ed	Literacy	40	4
B	All programs	Literacy and mathematics	70	10
C	All programs	Literacy and mathematics	160	15
D	B.Ed	Literacy	60	18
E	Grad Dip	Mathematics	34	16
F	Grad Dip	Mathematics	30	13
G	All programs	Literacy and mathematics	630	31
H	B.Ed/Grad Dip	Literacy	180	35
H	B.Ed	Mathematics	4	4
I	All programs	Literacy	230	1
J	B.Ed/Grad Dip	Literacy	190	39
J	Science/mathematics	Mathematics	30	11
K	Secondary science/ mathematics	Mathematics	30	14
L	B.Ed	Literacy	61	43
M	Primary program	Literacy	90	2
TOTAL			2289	349

Table 5 Participants completing the surveys by program type 2009

University	*Program Type*	*Focus*	*Cohort*	*Participants*
A	B.Ed	Literacy	70	63
A	B.Ed	Literacy	50+	39
A	Grad Dip	Mathematics	30	16
C	B.Ed/Grad Dip	Literacy	150	99
C	B.Ed/Grad Dip	Mathematics	4	4
E	Grad Dip	Mathematics	15	14
E	M.Ed	Literacy	25	20
E	Grad Dip	Mathematics	30	22
J	B.Ed	Literacy	80	37
J	Grad Dip	Literacy	80	1
J	B.Ed, Double Degree, Grad Dip(Secondary)	Mathematics	40	31
K	B.Ed/Grad Dip	Literacy	30	2
K	B.Ed/Grad Dip	Mathematics	28	17
L	Grad Dip	Literacy	40	20
N	Grad Dip	Mathematics	20+	9
N	MTeach	Literacy	96	1
O	Grad Dip	Literacy	40	22
TOTAL			824	417

The striking improvement in success rate from 2008 to 2009 was achieved by changing the approach to academic staff. Instead of seeking access to their students solely for the purpose of initial recruitment, the researchers sought agreement from universities to make the completion of the Teacher Learning Inventory (TLI) a class activity (subject to completion of the research ethics agreement). This alternative approach was possible because the teacher educators' experience of the 2008 data collection had demonstrated the value of the instrument in monitoring their own students' knowledge of literacy and mathematics teaching. In return for this higher level of access,

the research team provided program-level summaries of the TLI results to academic staff in each institution. With the two additional 2009 universities included, the final national sampling frame represents the variety of teacher education contexts in Australia, including location, mode of delivery, practicum arrangements, public or private provider status, and size.

Together, the 2008 and 2009 data collection sought participation from 3,113 students in 15 institutions. A total of 766 students completed the research ethics agreement for the study. These students generated a total of 600 students who completed the TLI forms that are analysed in the discussion of Study 2 and Study 3.

2.1.2 Sampling Frame and DEEWR Teacher Education Statistics

The combined sampling frame for 2008 and 2009 study participants is compared to the DEEWR 2009 statistics published on their website and downloaded in December 2009. Comparison of the study participants and DEEWR statistics and the classification scheme was undertaken using the following variables:

- Location of teacher education institution, both by State and also by the classification schema location attributes (Inner metro, Outer metro, Regional)
- Field of education as defined by DEEWR and equivalent program classification target level (Early Childhood, Primary, Secondary, Special Needs)
- University type (Group of Eight, 'Gumtree', Post-Dawkins, Technology, Private)
- Program level (Undergraduate, Postgraduate)

Figure 1 below details the comparison of study participant numbers with DEEWR 2008 Teacher Education student numbers. In 2008, participants were located in the four States, and while the distribution of participants skewed towards W.A., the distribution is a fair reflection of the overall distribution. Unfortunately, in 2009, the steps taken to increase the number of participants limited the 2009 cohort to just three States, and further skewed participation towards W.A. The large number of participants W.A. relative to the national distribution of education students is a result of the change in recruitment strategy detailed above in Section 2.1.2.

Figure 2 below shows the distribution of participants and distribution of teacher education student numbers provide by DEEWR versus their field of teacher education. Both the 2008 and 2009 study participants distributions is a reasonable reflection of the overall DEEWR distribution of student numbers per field of education. The DEEWR category of "Teacher Education" does not fit the classification scheme used in the study. The actual fields of teacher education or educational target level represented by this category are unknown.

Figure 1 Comparison of teacher education numbers and study participant numbers in 2008 and 2009

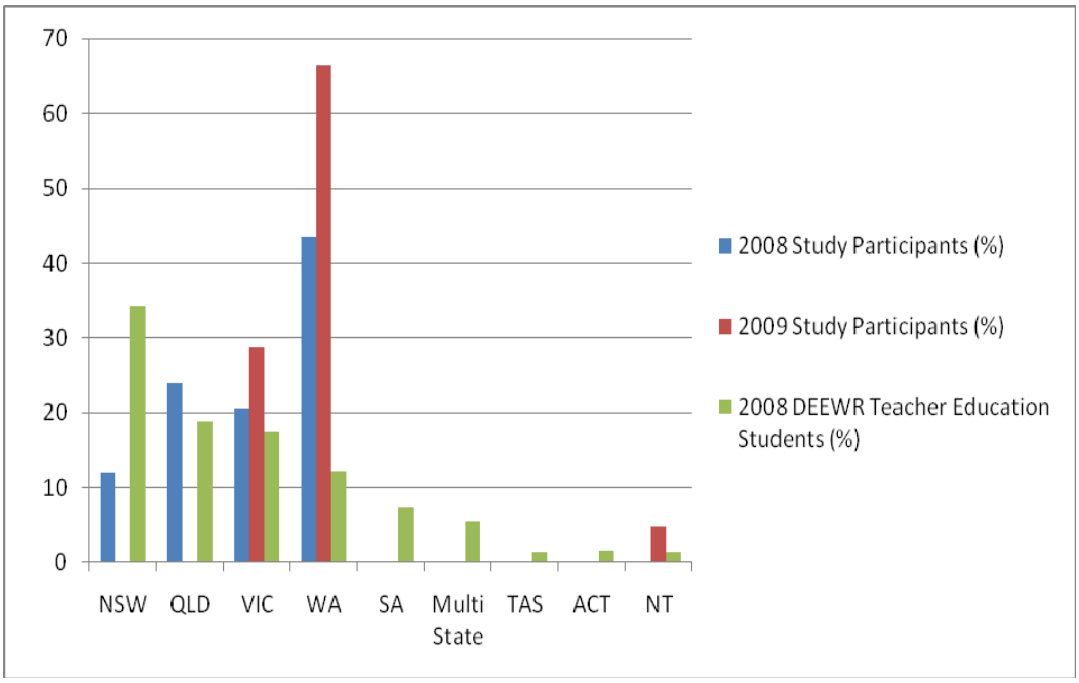


Figure 2 Comparison of teacher education numbers and study participant numbers in 2008 and 2009 by Field of Education

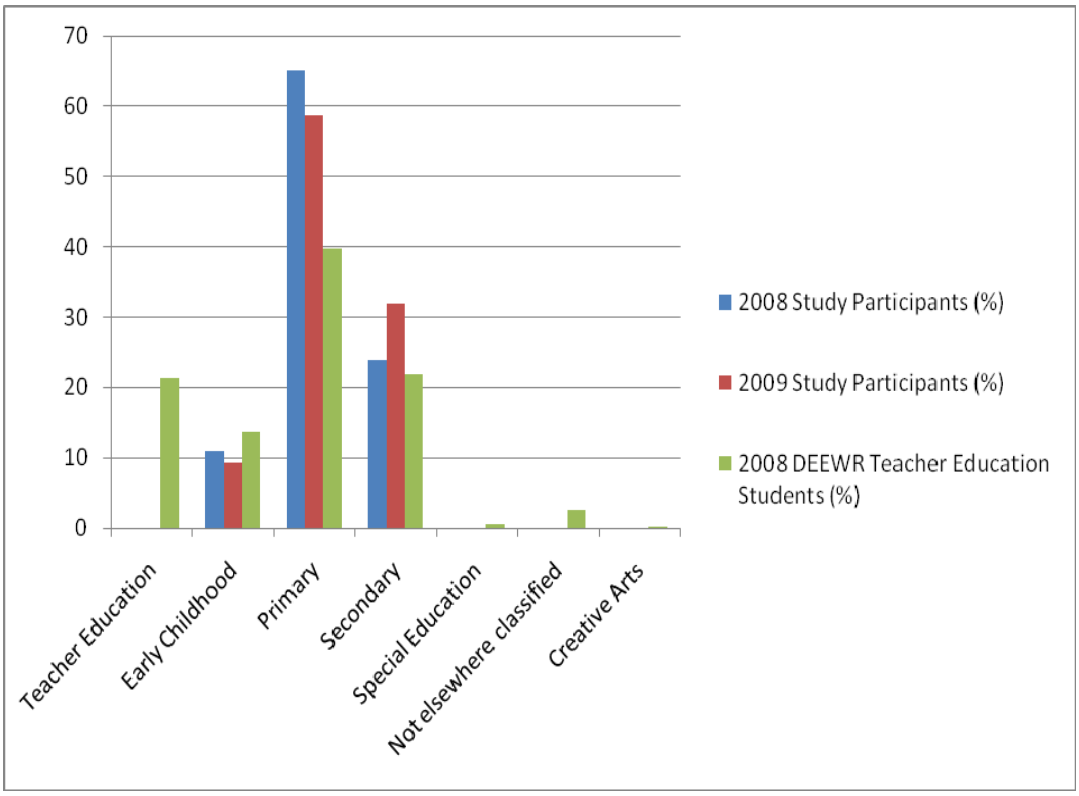


Figure 3 details the comparison of participants by university establishment type when compared with the distribution of student numbers from the DEEWR data. The graph shows over representation of “Group of Eight” and “Private” universities in both 2008 and 2009; under representation of the group that Marginson and Considine (2000) have called “Gumtrees”(those

founded between the early 1960s and the mid-1970s), with no participants in 2009; and the remaining categories are closer to the DEEWR student numbers. Again, as with the by State distribution, this departure in the sampled distribution demonstrates the difficulty in recruiting participants.

University location, using the attributes of inner metropolitan, outer metropolitan and regional was used to compare study participants location and the location of teacher education students reported by DEEWR. Figure 4 details the distributions based upon the above attributes. Regional students in both 2008 and 2009 study participants are fewer than that in the DEEWR data. This reflects the difficulty in recruiting students in the large number of regional campuses. The DEEWR data indicates that more than 30% of all teacher education students are located in regional campuses frequently enrolled for distance or mixed-mode education.

Figure 3 Comparison of teacher education student numbers and study participant numbers in 2008 and 2009 by university type

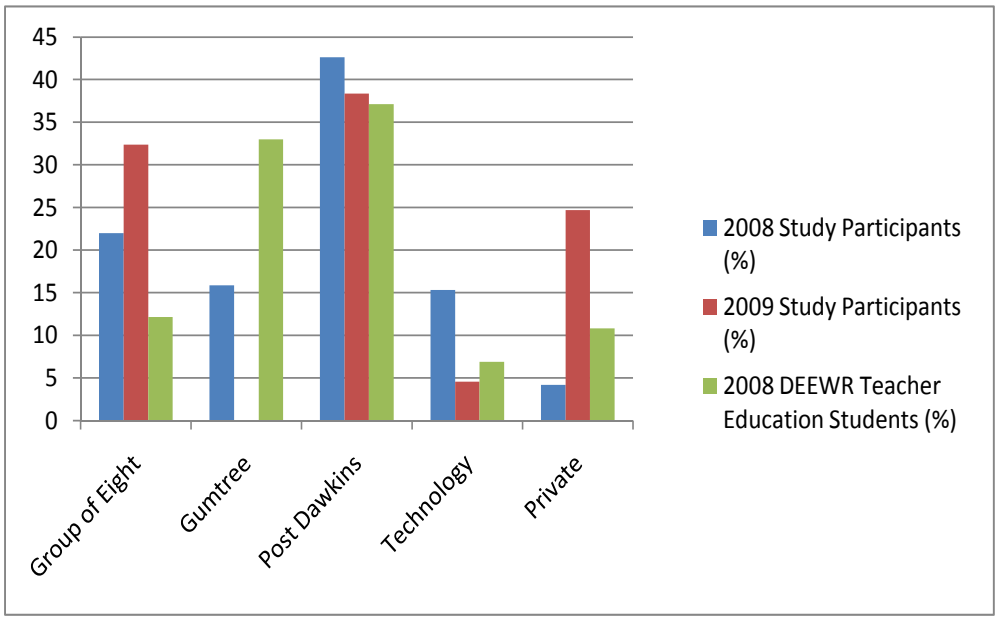
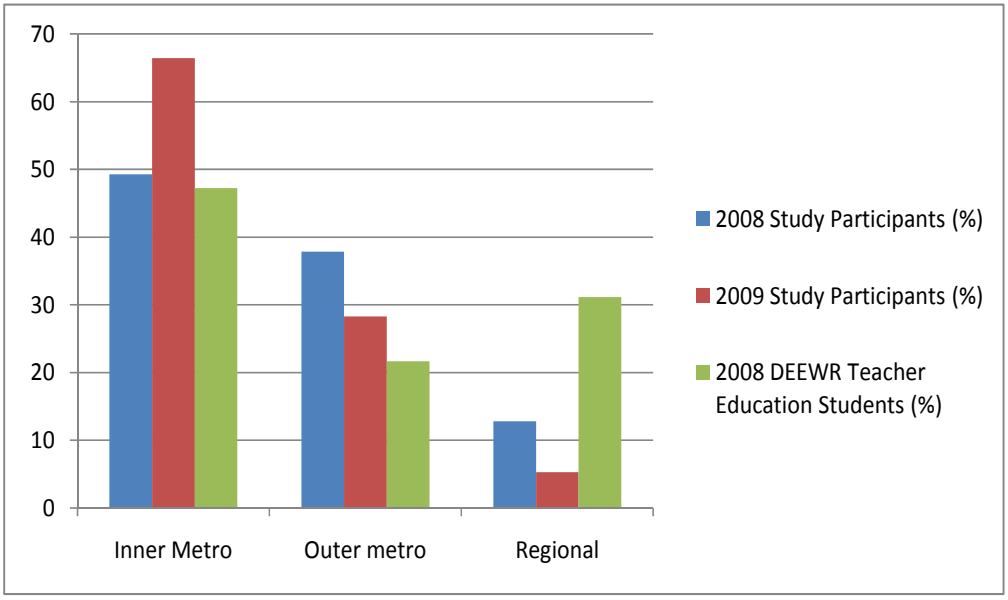
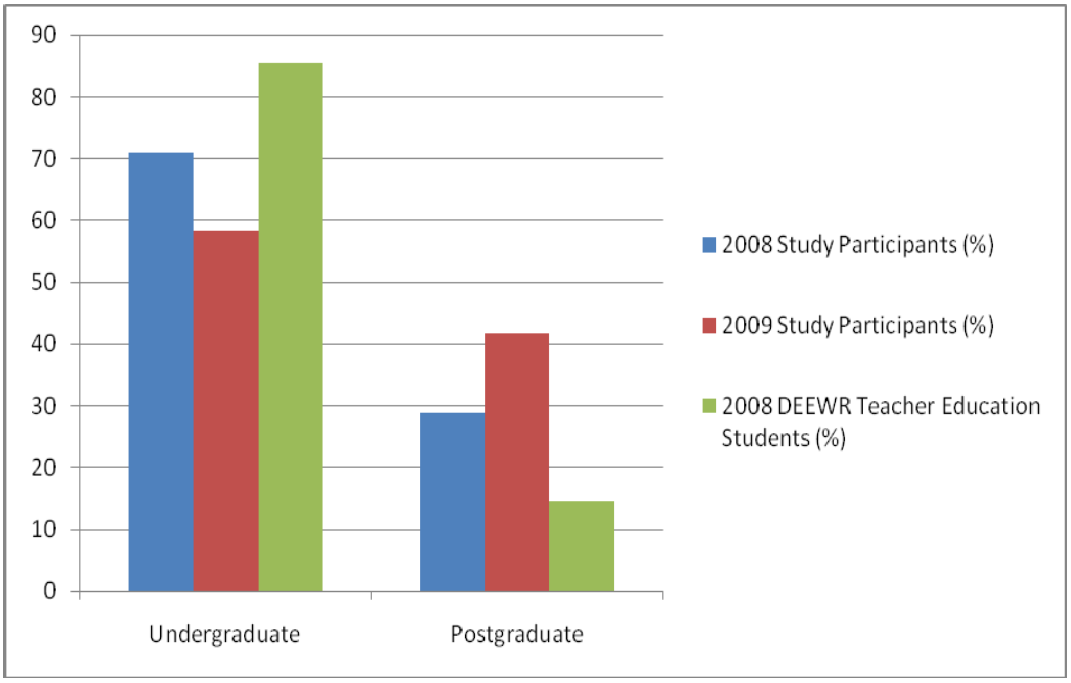


Figure 4 Comparison of teacher education student numbers and study participant numbers in 2008 and 2009 by university location



A comparison of study participants and DEEWR teacher education data based upon program level (i.e. undergraduate or postgraduate program) is given in Figure 5 below. Nationally there are only 15% of teacher education students studying at the postgraduate level. Study participants postgraduate students were 29% in 2008 and 42% in 2009. Postgraduate students are over represented in the study, particularly in the 2009 group. Again, this is a reflection of the change in participant recruitment strategy and perhaps an indication that postgraduate students are often more willing to take part in a study of this type making significant demands on their time.

Figure 5 Comparison of teacher education student numbers and study participant numbers in 2008 and 2009 by program level



In summary, this study was inclusive, but not strictly representative. Teacher education students from 13 of Australia's initial teacher education providers participated in 2008 and students from an additional two institutions participated in 2009. These students were drawn from four States and one Territory. Their institutions were located in inner metropolitan, outer metropolitan and regional locations, and represented the full range of public and private providers of teacher education. Students were enrolled in programs leading to initial teacher education qualifications in the three main school sectors; early childhood, primary and secondary education.

Despite this broad representation of students, difficulties in recruitment led the project team to accept a distribution of students that was not entirely representative of the national demographic spread. Among university types, there were proportionally more students from post-Dawkins new universities, older Group of 8 research intensive universities and private universities, and proportionally fewer from technology universities and the 'gumtree' universities founded in the early 1960s to mid 1970s. Somewhat fewer regional students were included than the national proportion, and postgraduate initial teacher education students were also over represented.

3. Study 2: Background Characteristics of Students

Study 2 was designed to explore whether or not there were differences between programs in terms of student characteristics such as developed academic ability and personal dispositions. These issues were explored through the Teacher Learning Inventory (TLI). Two of the three components of the TLI were analysed for Study 2:

1. Personal characteristics
2. Perceptions of preparation for teaching

3.1 Method and Data Analysis

The Rasch Measurement Model (Rasch, 1960) is used to examine the operational qualities of an instrument. In other words, analyses based on the Rasch Model are used to help establish the validity and reliability of the construct being assessed. In the context of the Teacher Learning Inventory, the Rasch Model was used to establish the validity and reliability of three constructs, 'personal characteristics', 'perceptions of preparation for teaching' and 'knowledge of teaching'.

The Rasch Model is applied to assessments in a wide range of disciplines, including health studies, education, psychology, marketing, economics and social sciences in order to examine the psychometric properties of these assessments. For many assessments in these disciplines the responses to the items are scored 0 or 1 (for two ordered categories); or 0, 1, 2 (for three ordered categories); and so on, to indicate increasing levels of a response (and thus increasing amounts of the property being measured) on some variable such as health status or academic achievement. These responses are then added across items to give each person a total score. This total score summarises the responses to all the items, and a person with a higher total score than another one is deemed to show more of the variable assessed. Summing the scores of the items to give a single score for a person implies that the items measure a single variable, often referred to as a unidimensional variable, at the particular level of scale at which the items have been developed.

The Rasch model, where the total score summarizes a person's standing on a variable, arises from a fundamental requirement, that the comparison of two people is independent of which items may be used to make such a comparison, within the set of items assessing the same variable. Thus the Rasch Model is taken as a standard for the structure of the responses which they should satisfy, rather than merely a statistical description of the responses.

If data do not fit the Rasch Model, then taking the total score as the basis for estimating a person's level of ability is not justified according to the measurement criteria articulated by Rasch. Data never fit the model perfectly, and it is important to consider the fit of data to the model with respect to the uses to be made of the total scores. However, if the data do fit the model adequately for the purpose for which the instrument is designed, then the Rasch analysis also linearises the scores into measurements.

The linearised value is the location of the person on the unidimensional measurement continuum - the value is called a parameter in the model and there can be only one number per person in a unidimensional framework. Estimates of this parameter can then be used in analysis of variance and regression analyses, in place of the raw total scores which are not linear. Locations are also estimated for each item and both item and people locations (estimates) are located on the same

measurement continuum. The model allows a specific interpretation of the relation between items and persons on the continuum in terms of the probability of success on an item; or more generally, the probability that a person will respond in a given category.

Analysing the data according to the Rasch Model provides information about the internal consistency and validity of the data as well as their internal reliability. As part of the analysis, a Person Separation Index is obtained for each set of items that measure a single trait, such as *preparation as a teacher*. The Person Separation Index varies between 0 and 1. A value of 0 indicates very poor internal consistency, whereas a value of 1 indicates very high internal consistency. Typically, values of 0.8 or higher are considered to indicate that the subtest measures the relevant trait in an internally reliable fashion.

3.2 Personal characteristics

Two kinds of personal information were sought from participants: demographic data and personal dispositions. The demographic data concerned age, gender, educational background and teacher education entry qualifications. The disposition data collection was designed to explore the possibility that success in teaching might be explained in part by some pre-existing personal characteristics of people entering the teaching profession. To the extent that teaching follows patterns established in selection for other occupations, it may be that success in teaching can be explained in part by personality traits such as extraversion, intellectual openness, conscientiousness, agreeableness, and emotional stability (McCrae & Costa, 1996). The traits, known as the Big Five or the Five Factor Model, have shown relatively high levels of stability during adulthood in longitudinal studies (Conley, 1984; Costa & McCrae, 1988). A meta-analysis of research on the Big Five personality traits has also shown that two of these traits – conscientiousness and emotional stability – are strong predictors of job performance (Barrick, Mount & Judge, 2001).

Items were developed that focus on conscientiousness and emotional stability as they relate to specific facets of teacher effectiveness: for example, items were developed that focus on interpersonal relationships and teamwork in teaching. Items were also developed that focus on locus of control as it relates specifically to effective teaching. Locus of control refers to an individual's beliefs about whether she or he has the capacity to change things perceived to cause good and bad effects: for example, whether they have the capacity to influence whether teaching is rewarding or whether good behaviour management occurs in the classroom.

The personal disposition items appearing in the 'About You' section of the TLI were constructed as polar opposites, with participants offered an eight-point scale between two plausible alternatives (see Table 6). For example, an item designed to explore whether participants tend to take personal responsibility for developing and maintaining relationships or tend to attribute successful relationships to external factors took the following form:

Table 6 S107 It's important to work hard to form relationships

It's important to work hard to form and keep strong relationships with students and colleagues.	o	o	o	o	o	o	o	o	I think personal relationships evolve in a certain way irrespective of whether people think they "work" at them.

Table 7 lists the aspects of personal characteristics that the TLI aimed to measure. The complete set of items appears in Appendices 1, 3, 5 and 7.

Table 7 Personal characteristics

Item	Aspect
S101	Work hard to overcome new challenges
S102	Think about teaching outside normal hours
S103	I am dedicated to teaching
S104	Work hard to be an effective member of team
S105	Strive to be the best teacher possible
S106	I put effort into lesson preparation
S107	It's important to work hard to form relationships
S108	I make sure I complete my teaching-related tasks
S109	The onus is on me to get what I need to get the job
S110	I find a way to work out challenges done
S111	Individual's influence on factors that make teaching rewarding
S112	Behaviour management is entirely in my hands
S113	I am confident I can handle a serious behavioural issue
S114	I would address any formal complaints against me
S115	If I experience difficulty I tough it out
S116	I can deal with disruptive students
S117	I'd seek advice from a teacher who intervenes in my class
S118	It wouldn't rattle me if my colleagues did not respect me
S119	I am confident in teaching a new topic at short notice

The Person Separation Index is 0.859, indicating good internal consistency with respect to measurement of the personality trait. The trait is a combination of *conscientiousness* and *emotional stability,* with a particular focus on its relevance to effective teaching. Items and their locations are shown in Table 8. The table shows the items in order. For example, it was relatively easy for teachers to agree that they work hard to be an effective member of a team. On the other hand, it was relatively difficult for a teacher to agree she or he can handle a serious behavioural issue. It was moderately difficult for a teacher to agree that she or he is dedicated to teaching.

Table 8 Item Locations in location order

Item	Location	Aspect
S104	-0.429	Work hard to be an effective member of team
S105	-0.423	Strive to be the best teacher possible
S112	-0.277	Behaviour management is entirely in my hands
S101	-0.274	Work hard to overcome new challenges
S111	-0.239	Individual's influence on factors that make teaching rewarding
S114	-0.236	I would address any formal complaints against me
S107	-0.162	It's important to work hard to form relationships
S106	-0.158	I put effort into lesson preparation
S103	-0.087	I am dedicated to teaching
S110	0.087	I find a way to work out challenges done
S109	-0.045	The onus is on me to get what I need to get the job
S102	0.013	Think about teaching outside normal hours
S119	0.089	I am confident in teaching a new topic at short notice
S116	0.198	I can deal with disruptive students
S115	0.213	If I experience difficulty I tough it out
S117	0.241	I'd seek advice from a teacher who intervenes in my class
S108	0.490	I make sure I complete my teaching-related tasks
S118	0.548	It wouldn't rattle me if my colleagues did not respect me
S113	0.652	I am confident I can handle a serious behavioural issue

3.3 Perceptions of preparation for teaching

The TLI was also designed to explore participants' perceptions of their preparation for teaching. In the section 'About your preparation for teaching', the questions follow the same format as those in the 'About you' section, but offer a series of literacy or mathematics specific prompts concerning literacy or mathematics teaching.

3.3.1 Literacy

Contemporary Australian research on teachers' perceptions of their preparation for literacy teaching suggests that new graduates may be more confident with some aspects of the preparation for literacy teaching than others. Typically, they report being well prepared on issues that can easily be covered in lectures and workshops such as lesson planning and relatively less well prepared on issues that require extensive practical classroom experience such as assessment and managing students' behaviour (Tasmanian Educational Leaders Institute, 2002, p. 101). With regard to literacy teaching, new primary school teachers have reported being better prepared to teach reading and writing than spelling, phonics and grammar (Louden et al, 2005, p. 47). To explore the specifics of preparation in more detail, the 'Preparation for teaching' section of the TLI included ten items concerning participants' perceptions of preparation for literacy teaching (see Appendices 1, 3, 5 and 7). These items follow the same format as the 'About you' section of the TLI. Item 208, for example, invited participants to locate themselves on a eight-point scale in response to an item concerning the breadth of their repertoire of skills (Table 9 and Table 10).

Table 9 S208 Broad repertoire of skills to teach reading

I have abroad repertoire of skills I can draw on to teach reading.	o	o	o	o	o	o	o	o	I know very few ways of teaching reading.

The items chosen for this section reflect some of the likely areas of literacy teacher preparation including reading, writing and assessment. Some items reflect broad conceptions of reading teaching ('roles of the reader') and others reflect specific aspects of reading or writing (decoding, phonological awareness and grammar).

Table 10 Perceptions of preparation for literacy teaching

Item	Aspect
S201	Ability to plan a teaching program for students who cannot read
S202	Teaching students to decode unfamiliar words
S203	Knowledge of grammar
S204	Wide range of strategies for teaching students to comprehend texts
S205	Understanding of phonological awareness
S206	Ability to plan individual learning based on own assessment of students
S207	Analyse students' writing and determine what needs to be taught next
S208	Broad repertoire of skills to teach reading
S209	Knowledge of the different reading practices
S210	Integrating knowledge of phonological awareness into teaching program

The Person Separation Index from the Rasch analysis of the items was 0.895, indicating a very high level of internal consistency. The items are shown in order of their location in Table 11. For example, teachers found it relatively easy to agree they were able to plan individual learning based on their own assessments of students. On the other hand, teachers found it relatively difficult to agree they had knowledge of the different reading practices specified in the TLI.

Table 11 Item Locations in location order

Item	Location	Aspect
S206	-0.301	Ability to plan individual learning based on own assessment of students
S205	-0.278	Understanding of phonological awareness
S208	-0.190	Broad repertoire of skills to teach reading
S202	-0.188	Teaching students to decode unfamiliar words
S210	-0.043	Integrating knowledge of phonological awareness into teaching program
S207	-0.035	Analyse students' writing and determine what needs to be taught next
S203	0.074	Knowledge of grammar
S204	0.144	Wide range of strategies for teaching students to comprehend texts
S201	0.379	Ability to plan a teaching program for students who cannot read
S209	0.438	Knowledge of the different reading practices

3.3.2 Mathematics

Following the pattern established in the literacy TLI section on perceptions of preparation, this section of the TLI reflected some of the likely areas of teacher preparation for mathematics teaching. The items chosen are summarised in Table 12, and are included in Appendices 5 and 7.

Table 12 Perceptions of preparation for mathematics teaching

S201	Ability to sequence lessons to develop students' understandings of whole number, fractions and decimals
S202	Ability to teach students how to generalize number pattern rules
S203	Confidence in demonstrating multiple solutions
S204	Ability to provide opportunities for students to estimate and measure quantities
S205	Ability to sequence lessons to develop students' understandings of area formulae
S206	Confidence in helping students solve perimeter, area and volume problems
S207	Confidence in providing students with opportunities to draw inferences from data
S208	Ability to explain the applicability of the calculations of *mean, mode* and *median* to real life data.
S209	Confidence to conduct chance experiments with students
S210	Confidence in devising assessment tasks
S211	Ability to describe mathematical concepts to different ability groups
S212	Confidence in planning individual learning strategies based on my assessment of students

The Person Separation Index obtained from the Rasch analysis of the items was 0.904, indicating excellent internal consistency. The items are shown in order of their location in Table 13. For example, teachers found it relatively easy to agree they were able to devise assessment tasks and to provide opportunities for students to estimate and measure quantities. On the other hand, teachers found it relatively difficult to agree they had the ability to sequence lessons to develop students' understandings for the purposes specified in item S201, indicating they found this a relatively more challenging task.

Table 13 Item locations in location order

Item	Location	Aspect
S210	-0.463	Confidence in devising assessment tasks
S204	-0.238	Ability to provide opportunities for students to estimate and measure quantities
S206	-0.156	Confidence in helping students solve perimeter, area and volume problems
S208	-0.15	Ability to explain the applicability of the calculations of *mean, mode* and *median* to real life data.
S207	-0.148	Confidence in providing students with opportunities to draw inferences from data
S209	-0.022	Confidence to conduct chance experiments with students
S205	0.049	Ability to sequence lessons to develop students' understandings of area formulae
S211	0.14	Ability to describe mathematical concepts to different ability groups
S212	0.141	Confidence in planning individual learning strategies based on my assessment of students
S203	0.196	Confidence in demonstrating multiple solutions
S202	0.258	Ability to teach students how to generalize number pattern rules
S201	0.393	Ability to sequence lessons to develop students' understandings of whole number, fractions and decimals

4. Study 3: Knowledge of Teaching

This component of the TLI was designed to explore the level of knowledge participants have developed in either literacy or mathematics teaching. Rather than assessing participants' knowledge of educational theory or teaching methods, the research team developed a series of tasks designed to measure participants' capacity to analyse students' performances and to identify and recommend strategies to improve those students' performances.

The decision to measure knowledge through diagnostic skills reflects research that shows that skilful assessment is one of the most powerful influences on student growth. (Barber & Moushart, 2007; Louden, et al, 2008; Rowe, 2006; Hattie, 2003; Black & Williams, 1998). Whilst this field has received considerable attention in the literature of late, the importance of teachers understanding students' skills and using that as the springboard for future teaching has been considered for some time. John Dewey wrote, in 1897:

> Education must begin with an insight into the child's capacities, interests and habits. It must be controlled at every point by reference to the same considerations. These powers, interests and habits must be continually interpreted – we must know what they mean. (cited in Heritage and Bailey, 2006, p.145)

4.1 Literacy – construction of knowledge items

The literacy TLI included both a reading and a writing analysis task (see Appendices 1 and 3). The reading performance provided for analysis consisted of three parts: a two minute video of a child reading to his teacher, an image of the front cover of the book the child was reading, and the text that the child was asked to read. The text was annotated showing the teacher's observations of the child's errors whilst reading. Three questions were posed:

Q1. What are the student's relative strengths and weaknesses in reading?
Q2. A student in a Year 1 class is making poor progress in learning to read. Identify the kinds of information you would collect about his/her literacy skills to better understand why he/she is making poor progress.
Q3. Identify three ways you could integrate the teaching of reading into a school day.

The writing performance provided for analysis was taken from a read and retell activity. Participants were provided with a brief summary of the task, the image of the book used for the task, the student's plan and the student's written performance. Three questions were posed:

Q1. Identify as least three relative strengths and weaknesses in this written performance.
Q2. What information can you deduce from this performance about the student's knowledge of the relationship between letters, sounds and meaning?
Q3. List the strategies you would use to help this student progress in their writing.

The findings of the National Reading Panel in the USA (2000) and Australian National Inquiry into the Teaching of Literacy (2005) were used to inform the development of the marking keys. In response

to the reading question, 'What are the student's relative strengths and weaknesses in reading?' an answer that referred specifically to the student's knowledge of phonics was scored more highly than an answer that provides a more general description of the student's decoding ability. Table 14 below shows an extract of the marking key for Reading Question 1.

Table 14 Extract of Marking Key for RQ1

Item	Question	Mark range	Answer provided
RQ1	What are the student's relative strengths and weaknesses in reading?	3 marks	he has the ability to sound out unfamiliar words successfully; fair letter-sound relationship knowledge; appears to have a fair sight word bank. Weaknesses: cannty [sic] identify phonemes such as /ow/; reads quite slowly.
		2 marks	rereads to correct; sounds out familiar words; stops for punctuation
		1 mark	he has some strategies of how to read stories – sounding out, using pictures

Similarly, in marking of Question 2 in the writing section, 'What information can you deduce from this performance about the student's knowledge of the relationship between letters, sounds and meaning?' explicit reference the relationship between letters, sounds and meaning was scored more highly (Table 15).

Table 15 Extract of Marking Key for WQ2

Item	Question	Mark range	Answer provided
RQ1	What information can you deduce from this performance about the student's knowledge of the relationship between letters, sounds and meaning?	3 marks	This student is using the main sounds in a word to create meaning: 'ber' for bear, 'freis' for furious. He has knowledge of letter sounds, though he appears to be having difficulty with the vowel sounds: 'bot' and 'bat' for but. The student has yet to learn the writing rules that change letter sounds ('cam': a_e makes a long a; shrp must contain a vowel), letter patterns ('ee': 'slep'; 'ea': 'ber'). However the student has nade [sic] meaning in his/her writing by using letters he hears in the spoken word and making his own words.
		2 marks	'B' capital 'B' for Bear; 'ch' for 'tr' is tried several times- not hearing of understanding the 'tr' sound; no magic 'e' to make long vowel sound; 'aw' 'ow' vowels sounds misspelled.
		1 mark	The student is confused with the sound 't' and 'ch'

4.2 Literacy – quality of the instrument

The fit of the knowledge items to the Rasch Model was good. The Person Separation Index (an index of reliability) was 0.73 and the Standard Deviation was 1.232. In the context of this assessment (18 total score points) the Separation Index is satisfactory.

The analyses provide the opportunity to examine whether the ordering of the categories in the marking key is as required. That is, that the score points indicate increasing levels of quality. Graphical evidence for this is provided by a Category Probability Curve which shows the probability (Y axis) of receiving a score in each of the successive categories 0, 1, 2, and 3 for a particular item across the entire range of person total scores (X axis). Figure 6 and Figure 7 show the Category Probability Curve for Reading Question 1 and Writing Question 1 and it can be seen that the thresholds between each successive pair of categories (0 and 1, 1 and 2, etc) are ordered as required. This indicates that the marking key adequately captures qualitative differences between responses. The thresholds are ordered for all questions. If they were not, then both the fit of items and their reliability would be affected negatively.

Figure 6 Category Probability Curve RQ1

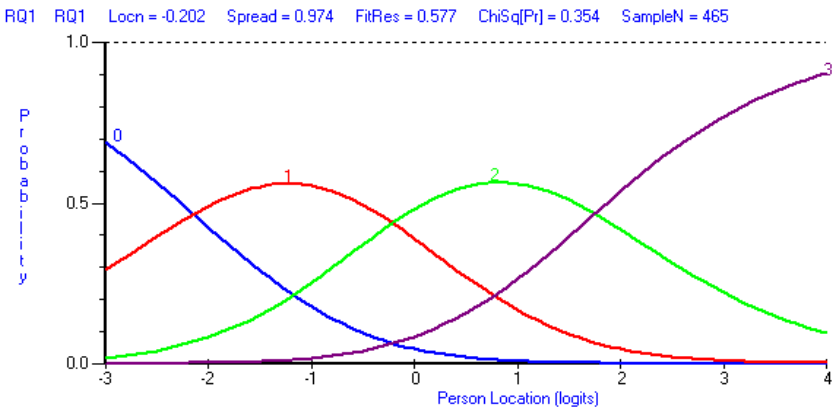


Figure 7 Category Probability Curve WQ1

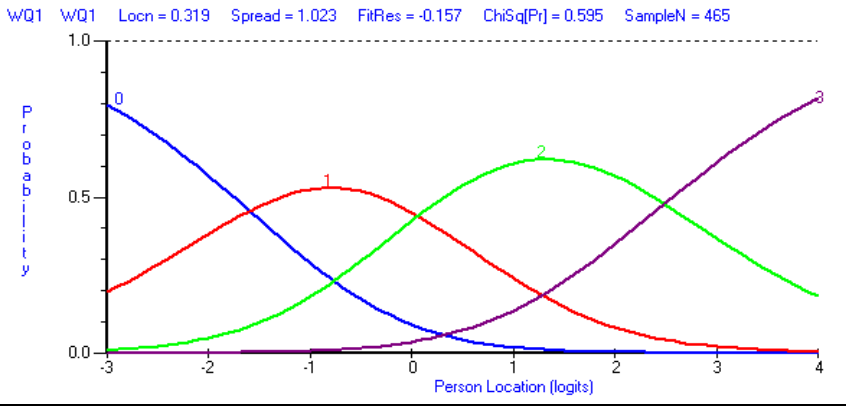


Figure 8 displays the Item Characteristic Curve (ICC) for Reading Question 1. An ICC provides the theoretical curve of the score values (Y axis) on a specific item across the range of total scores of

persons on all items (X axis) and the actual scores obtained. As such they provide a check that an item – in this case, Reading Question 1 is working consistently with all other items (that is, it fits the Rasch Model). The four dots (●) shown near the theoretical (smooth) curve in each ICC are the observed means of the total scores for students divided into four adjacent class intervals. If the data fit the model, then the means scores for each class interval (the ●) should be close to the theoretical curve. Figure 8 and Figure 9 show that the first reading question and the first writing question fit the Rasch Model well and provide good measurement of student teachers' ability to analyse work samples. This was the case of all items in the Knowledge component of the Literacy TLI.

Figure 8 Category Probability Curve RQ1

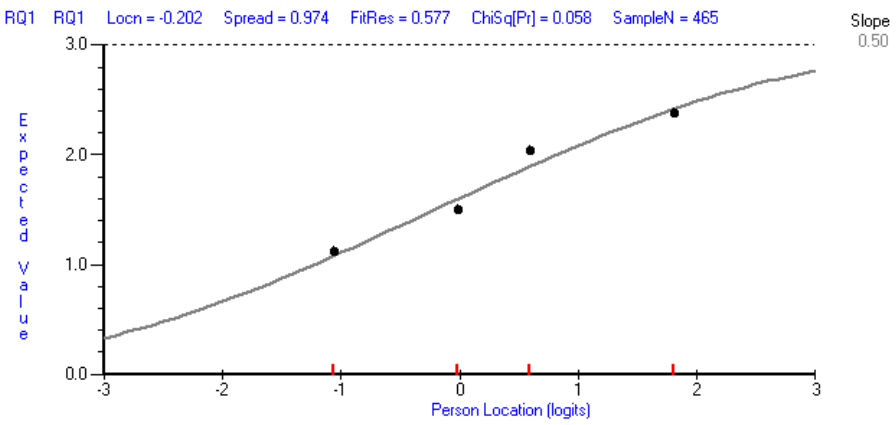
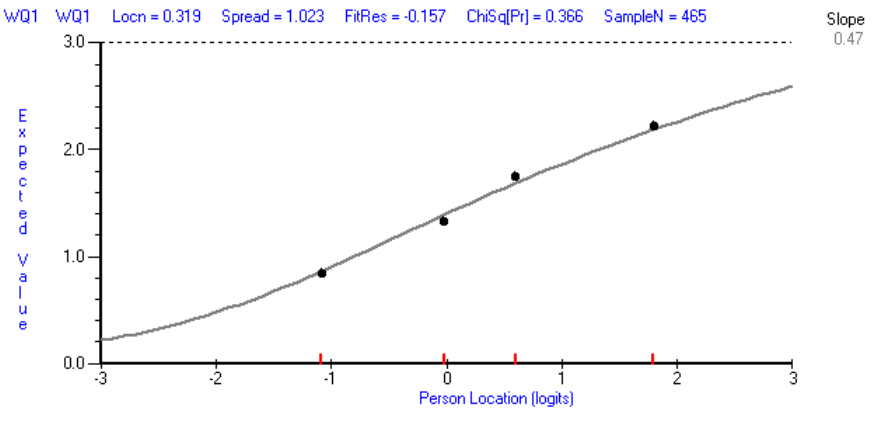


Figure 9 Category Probability Curve WQ1



The Rasch analysis provides a range of information about the relative difficulties between items (see Table 16 and Table 17). The easiest score obtained was the first score point for the third reading question which asked participants to identify three ways they could integrate the teaching of reading into a school day. The student who wrote 'get the children to read the day and date every day, use big books and group reading' was awarded a score of 1.

The most difficult score was the third score point for the second writing question which asked students, 'What information can you deduce from this performance about the student's knowledge

of the relationship between letters, sounds and meaning?' Only 2% of students scored a 3 on this question. The student who wrote the following was awarded a score of 3:

> This student is using the main sounds in a word to create meaning: 'ber' for bear, 'freis' for furious. He has knowledge of letter sounds, though he appears to be having difficulty with the vowel sounds: 'bot' and 'bat' for but. The student has yet to learn the writing rules that change letter sounds ('cam': a_e makes a long a; shrp must contain a vowel), letter patterns ('ee': 'slep'; 'ea': 'ber'). However the student has [m]ade meaning in his/her writing by using letters he hears in the spoken word and making his own words.

Table 16 Item Locations

Seq	Item	Type	Location	SE	Residual	DF	ChiSq	DF	Prob
30	RQ1	Poly	-0.202	0.069	0.577	380.72	7.759	7	0.354336
32	RQ3	Poly	0.011	0.081	1.078	312.47	8.456	7	0.294107
31	RQ2	Poly	0.124	0.063	0.340	377.43	3.134	7	0.872338
35	WQ1	Poly	0.319	0.071	-0.157	369.21	5.534	7	0.595090
37	WQ3	Poly	0.637	0.068	-0.377	349.47	6.749	7	0.455487
36	WQ2	Poly	1.752	0.081	-0.156	343.72	8.864	7	0.262553

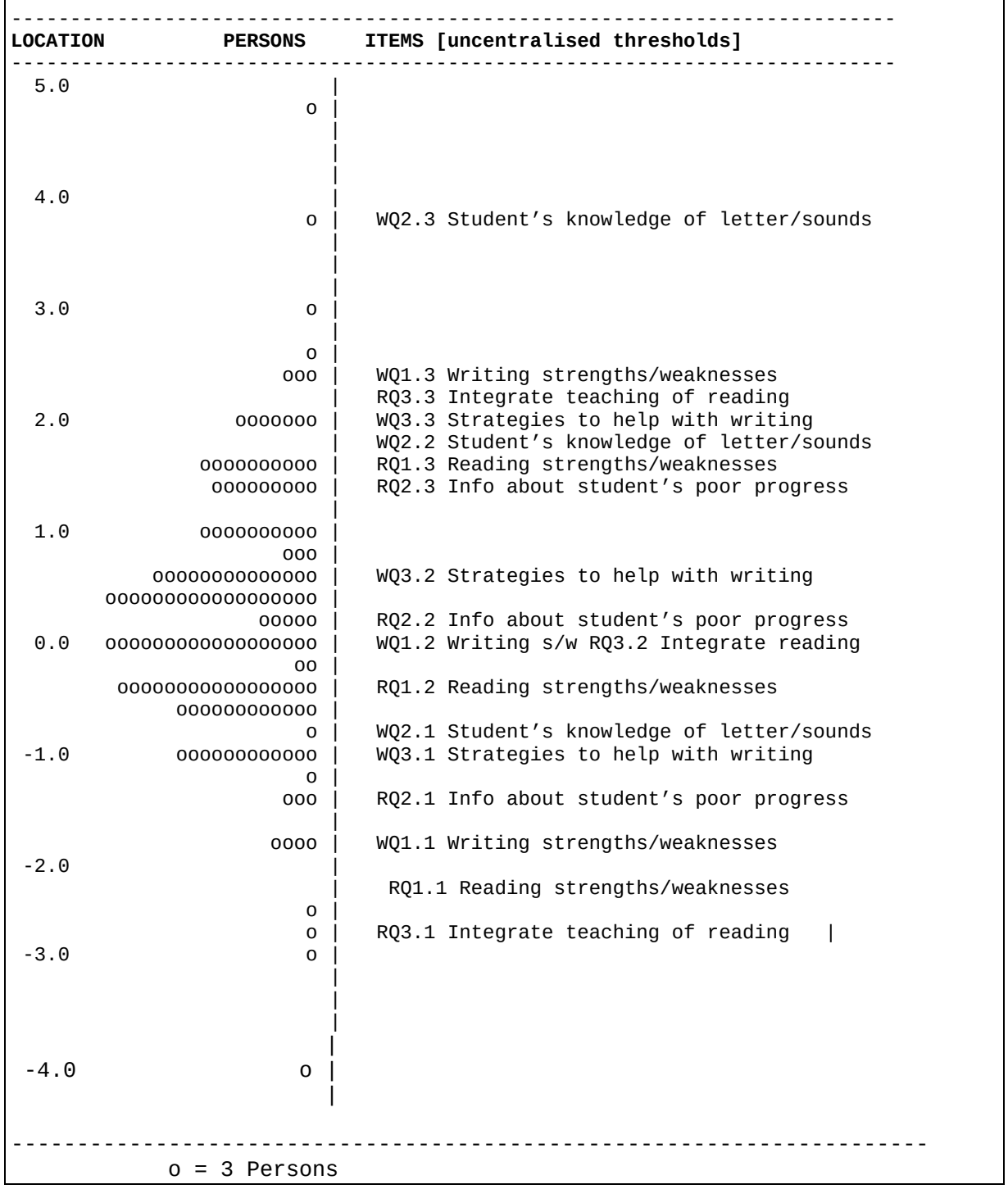
On average the reading items were easier than the writing items. Although the item locations are dependent on how the questions are asked, it was noted in the development of the marking keys that when discussing writing most students focused on the conventions of writing (spelling and punctuation) and only the occasional student discussed the textual features of narrative writing such as characters, setting, narrative structure, sentence structure and use of descriptive language. The qualitative feedback from the markers was that participants were more able to analyse and discuss the teaching of reading than to analyse and discuss the teaching of writing.

Table 17 Category Response Proportions

Label	0	1	2	3
RQ1	.05	.30	.46	.18
RQ2	.12	.36	.33	.20
RQ3	.05	.42	.45	.08
WQ1	.10	.35	.45	.10
WQ2	.28	.53	.17	.02
WQ3	.18	.41	.30	.11

Figure 10 below displays the locations of each of the categories or marks for each of the items relative to the student distribution. The o's on the left of the display represent student teacher locations. The labels on the right of the display are the locations of the categories for each item. It can be seen from this display that the location for first score point (category) for each item is lower on the scale than the second category and that in turn the second category is lower on the scale than the third category. This display provides verification that the marking coterie worked as intended and captured increasing qualities of performance.

Figure 10 **Item Map showing the relative locations for each of the categories (marks) of the knowledge items**



4.3 Mathematics– construction of knowledge items

Like the literacy knowledge TLI, the junior secondary mathematics TLI examined participants' ability to analyse a student's mathematics performance (see Appendices 5 and 7). Three extracts of students' work were used as the stimulus for the items. The first extract was from a task which required that the student add fractions. Diagrammatical representation of the fractions was provided. The second task asked the student to convert decimals to fractions and the third task assessed the student's understanding of area and perimeter. The tasks from the first mathematics TLI were presented as follows in Figure 11, Figure 12 and Figure 13.

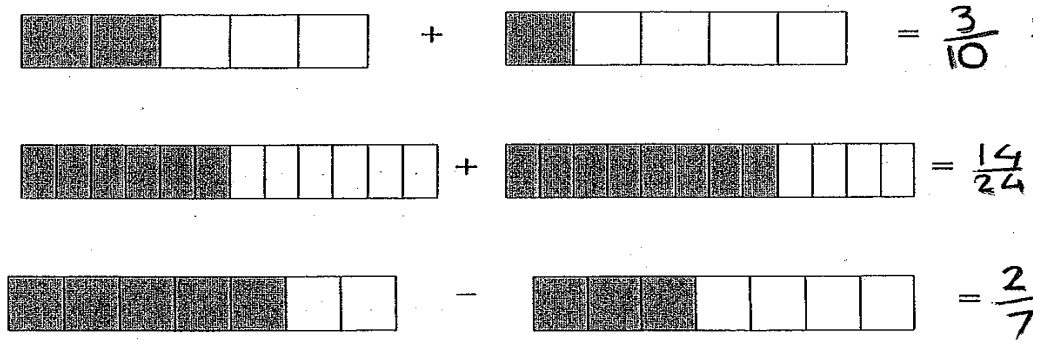
Figure 11 Extract from Mathematics TLI: Question 1

Question 1

The following task was used to assess students' understanding of *fractions*.
Look at the student's answers and then answer the questions below.

Student's Work

1. Write down the fraction sums or differences that are illustrated in these diagrams and give the answers



a. What misconceptions does this student have in addition and subtraction of fractions?

_____
_____
_____
_____

b. What strategies would you use to help the student improve her understanding of fractions?

_____
_____
_____
_____

c. If the student does not attain this concept, what problems could arise in future learning?

_____
_____
_____
_____

Figure 12 Extract from Mathematics TLI: Question 2

The following task was used to assess students' understanding of *fractions*.
Look at the student's answers and then answer the questions below.

Student's Work

2. Convert the following decimals to fractions in the simplest form

Decimal	Fraction
0.35	35/100
1.4	1.4/10
0.0087	87/100
0.120	120/100

a. What mathematical process is this student unable to perform?

_____
_____
_____
_____
_____

b. What does the student need to know to complete the task successfully?

_____
_____
_____
_____
_____

c. What strategies would you use to improve student understandings of this process?

_____
_____
_____
_____
_____

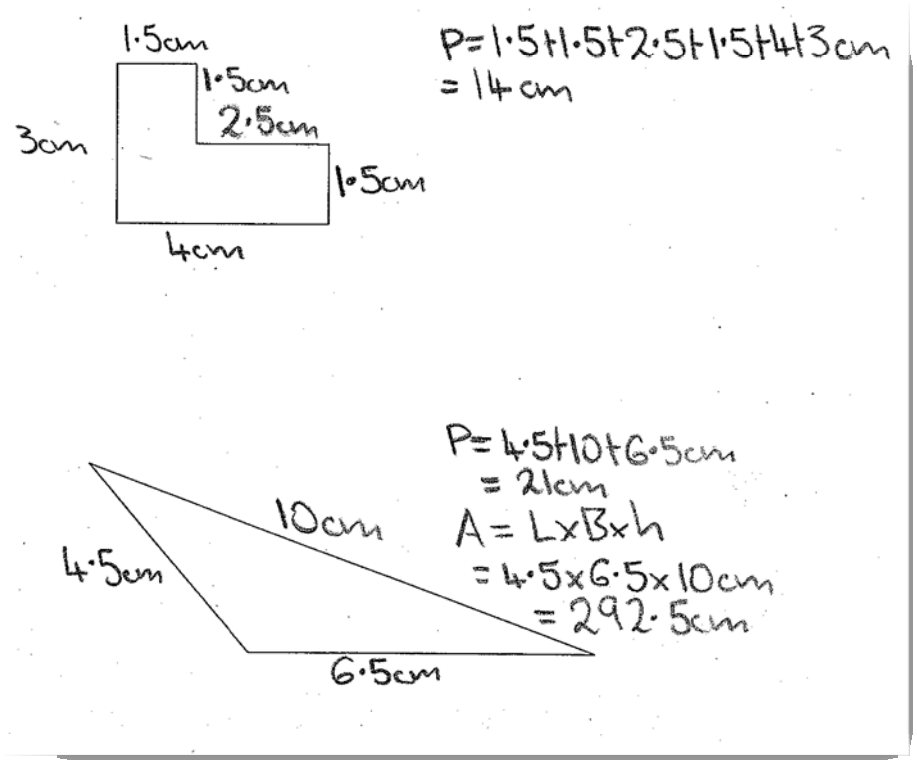
Figure 13 Extract from Mathematics TLI: Question 3

The following task was used in to assess students' understanding of *area* and *perimeter*.

Look at the student's answers and then answer the questions below.

Student's work

3. Measure the area and perimeter of the following shapes. Show all your working, including the dimensions you measure and use.



a. Identify the errors in the student's workings.

_____
_____
_____
_____

b. What misconception is demonstrated in the students' working?

_____
_____
_____
_____

c. What strategies would you use to improve this student's understanding of measurement?

_____
_____
_____
_____

Marking keys were developed with regard to recent research studies into effective mathematics teaching. Studies, summarised in Louden, Rohl and Hopkins (2008), identify the following characteristics of effective mathematics teachers. They:

- Use a range of different tasks
- Draw out and build upon student thinking
- Use activities that help students to consolidate what they have learned
- Are committed to using review and feedback in each teaching session
- Identify specific outcomes as a lesson focus
- Make connections between different representations of a concept, connecting real-world enactments, concrete models, language, icons and symbols.
- Provide clear explanations
- Attend to literacy aspects of mathematical texts
- Provide a challenging curriculum.

In response to the question, 'What strategies would you use to help the student improve his or her understanding of fractions?', for example, an answer that refers specifically to using a range of concrete examples and to providing a clear explanation of the concept was scored more highly than an answer that provides a more general description of the teaching required. Table 18 below shows an extract of the marking key for Question 1b (see Appendix 6 for a complete marking guide).

Table 18 Extract of Marking Key for Q1b

Item	Question	Mark range	Answer provided
Q1b	What strategies would you use to help this student improve his or her understanding of fractions?	3 marks	I will try in the first place to make the concept clear. I would probably take a pizza or a cake to the class, cut it into pieces & practically explain as to what whole means and what a part of the whole means. I would then explain that whole is always represented in the denominator and the part in the numerator. And then in a play way, make them understand how to add and subtract.
		2 marks	Explain each of them first. So count first one is 6/12. Second one is 8/12. When they have the same denominator, they just add numerator together. Lead student to think of each part separately.
		1 mark	Use everyday items such as fruit, cake etc to engage the student and set a point at which students can relate

Similarly, in marking of Question 1c, 'If the student does not attain this concept, what problems could arise in future learning?' explicit reference the relationship of mathematical skills was treated as a higher quality answer. (See Table 19.)

Table 19 Extract of Marking Key for Q1c

Item	Question	Mark range	Answer provided
Q1c	If the student does not attain this concept, what problems could arise in future learning?	2 marks	Problems with advanced algebra, or anything that includes decimal, probability, percentages etc.
		1 mark	They become demoralised due to difficulties in understanding more difficult fraction problems.

4.4 Mathematics – quality of the instrument

The fit of the knowledge items to the Rasch Model was good. The Person Separation Index (an index of reliability) was 0.65 and the Standard Deviation was 0.542.

Figure 14 and Figure 15 show the Category Probability Curve for Question 1a and Question 2a and it can be seen that the thresholds between each successive pair of categories (0 and 1, 1 and 2, etc) are ordered as required. This indicates that the marking key adequately captures qualitative differences between responses. The thresholds are ordered for all questions. If they were not, then both the fit of items and their reliability would be affected negatively.

Figure 14 Category Probability Curve Q1a

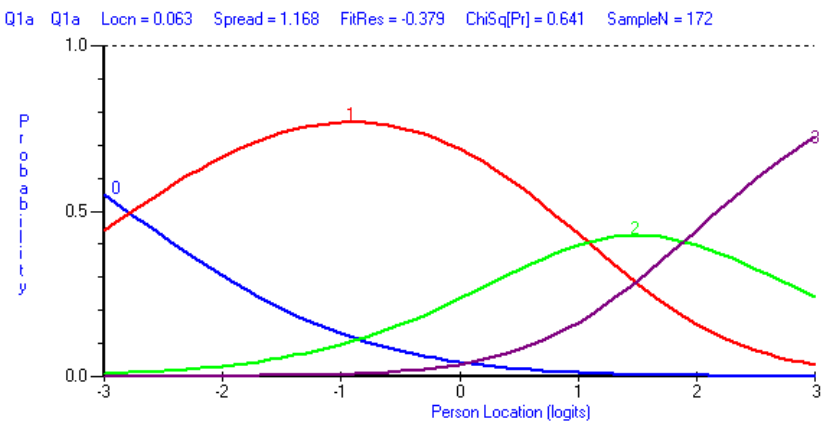


Figure 15 Category Probability Curve Q2a

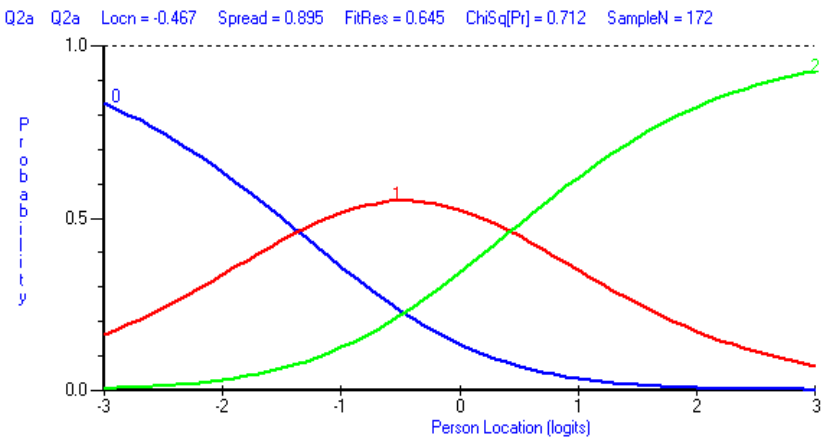


Figure 16 and Figure 17 show that question 1a and the question 2a fit the Rasch Model well and provides good measurement of student teachers' ability to analyse work samples. The means scores for each class interval (the ●) are close to the theoretical curves. This was the case for all items in the Knowledge component of the Mathematics TLI.

Figure 16 Category Probability Curve Q1a

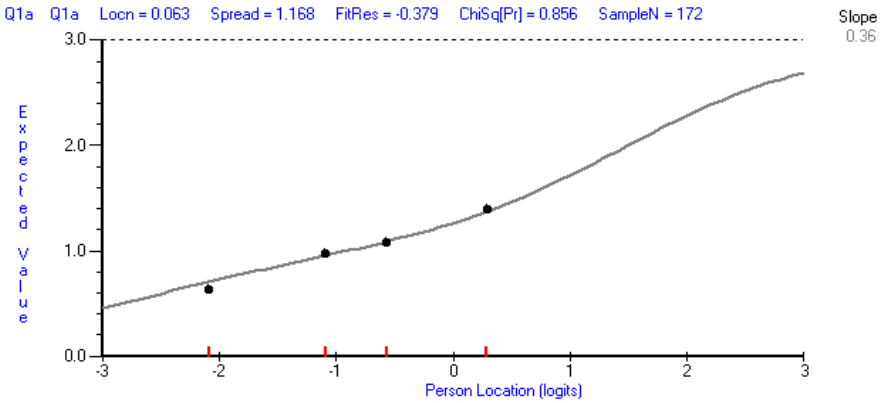
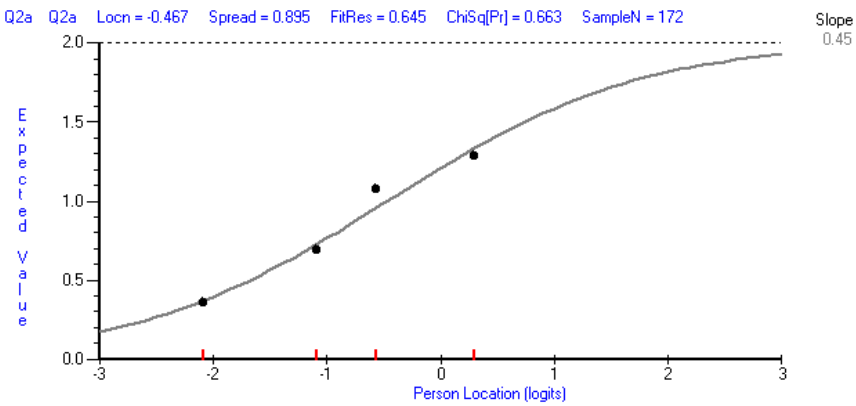


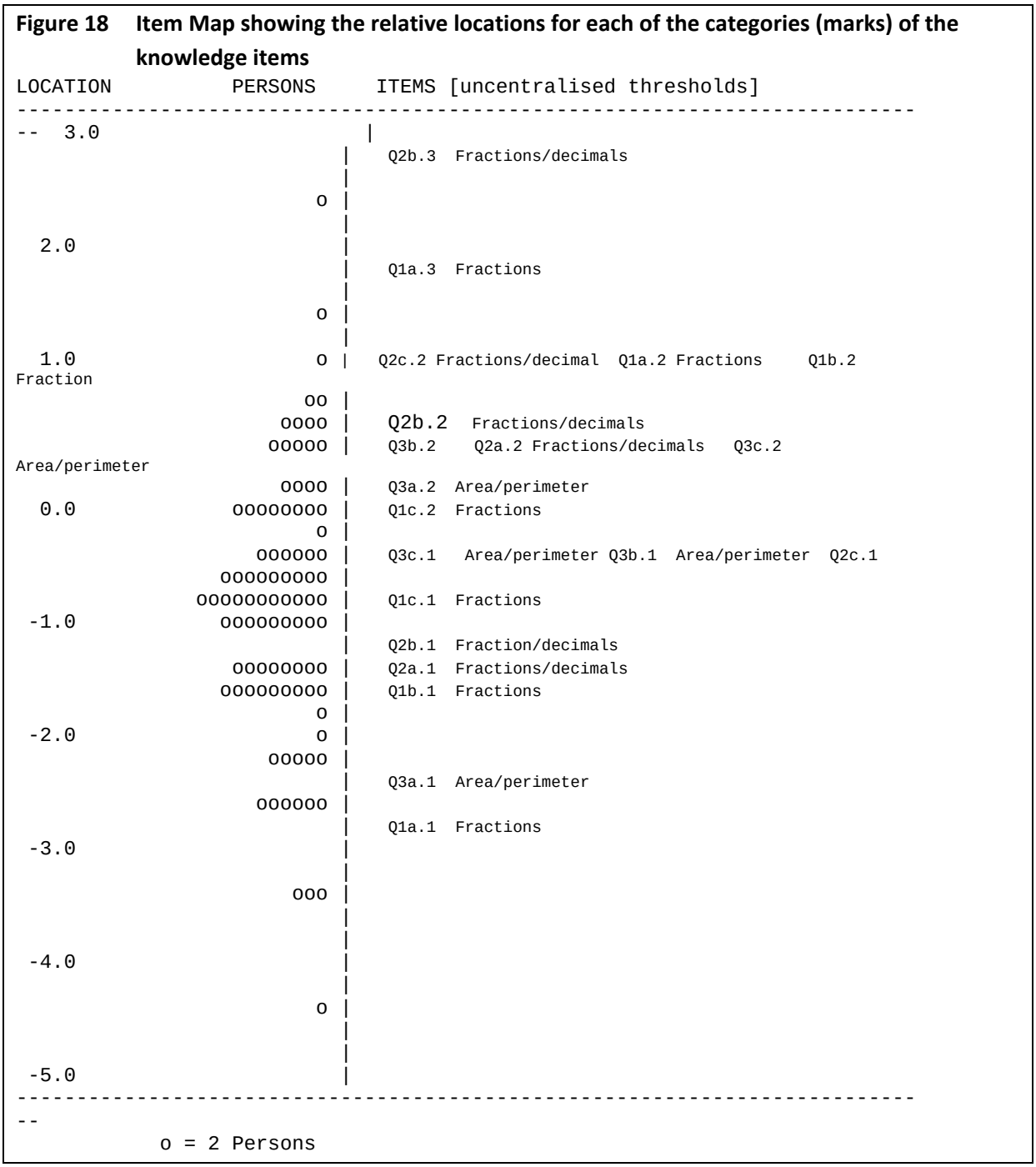
Figure 17 Category Probability Curve Q2a



In terms of the relative difficulties between items, the easiest score was the first score point on question 1a, which asked 'What misconception does this student have in addition and subtraction of fractions?' The student who answered 'does not deal with each side of the equation' was scored 1.

Figure 18 shows the item difficulties for each of the mathematics knowledge items. The most difficult score was the third score point for question 2b which asked in relation to converting decimals to fractions, 'What does the student need to know to complete the task successfully?' The students who explained that the question required an understanding of two processes, the process of converting decimals to factions and the process of simplifying fractions were scored 3.

Figure 18 Item Map showing the relative locations for each of the categories (marks) of the knowledge items



4.5 Summary: Instrumentation

In summary, the instruments developed in this study have characterised three traits of interest to teacher educators: personal characteristics concerning conscientiousness, teamwork and locus of control that have elsewhere been associated with occupational success; perceptions of preparation for early years literacy or middle years mathematics teaching; and knowledge of literacy or numeracy teaching.

Students who score higher on the personal characteristics scale are more likely to agree that they conscientiously complete tasks, seek external advice and deal with difficult behavioural issues. Students who score higher on the preparation for teaching scales are more likely to agree that they are well prepared for complex tasks such as planning a teaching program for students who cannot read. Finally, students who score well on the teachers' knowledge scales have greater capacity to analyse student work samples and propose detailed teaching strategies to assist students to improve performance. Lower performers on this scale tend to make general comments on the reading, writing and mathematics work samples, whereas higher performers are able to identify gaps in specific capacity such as aspects of phonemic awareness or to provide clear and concrete advice about the concepts of place value or fractions.

5. Results

This section brings together the results of Studies 1, 2 and 3. Among the many university teacher education program characteristics identified in Study 1, the analysis considers four program type subgroups:

- Undergraduate Bachelor of Education programs;
- Undergraduate double and combined degree programs;
- Postgraduate Master of Teaching programs; and
- Postgraduate Diploma of Education programs.

Study 2 collected demographic data in a series of categories including:

- Gender;
- Age (20- 24 years; 25-30 years; 31-40 years; 40+ years); and
- Basis of entry to the course (TAFE, school rank (ATAR), incomplete university degree, completed degree, alternate entry).

In addition, the TLI measured three separate traits:

- personality characteristics related to occupational performance measured by the AboutYou section of the TLI (Study 2);
- perceptions of preparation for teaching literacy (or mathematics) (Study 2); and
- knowledge of teaching in literacy (or mathematics) (Study 3).

In the tables that follow, the demographic categories are self explanatory: the three measured traits are labelled 'LitKnow' (knowledge of teaching in literacy); 'Prep' (perceptions of preparation for teaching literacy); and 'AboutYou' (personal characteristics related to occupational performance).

5.1 Literacy: Differences among subgroups on the measured traits

What differences were there among the demographic subgroups with respect to the three measured traits? In order to answer this question a simple statistical test called Analysis of Variance (ANOVA) was used to examine whether people in different subgroups (e.g. age groups) responded differently to the sections of the TLI that measured the traits (e.g. literacy knowledge). A statistically significant difference is one that has a small probability of occurring just by chance alone; that is, it probably is a real difference. A statistically significant difference does not necessarily have practical significance. To help judge whether differences are practically significant, effect sizes are obtained and reported. These provide an indication of how large the differences between the averages of the groups are relative to the variation among persons within the groups.

The one-way Analysis of Variance (ANOVA) (Table 20) showed the between groups variance is statistically significant in all cases ($\alpha = 0.01$). That is, the differences between the means of the three measured traits show significant differences between the subgroups, defined by the programs.

Table 20 ANOVA Summary for Program

		Sum of Squares	df	Mean Square	F	Sig.
LitKnow	Between Groups	62.317	4	15.579	17.089	.000
	Within Groups	343.685	377	.912		
	Total	406.002	381			
Prep	Between Groups	21.006	4	5.251	7.194	.000
	Within Groups	294.910	404	.730		
	Total	315.915	408			
AboutYou	Between Groups	4.355	4	1.089	4.312	.002
	Within Groups	102.259	405	.252		
	Total	106.614	409			

Table 20 reports the effect sizes for these statistically significant differences. Differences among groups on perceptions of preparation (Prep) are relatively small, with four-year Bachelor of Education and Master of Teaching students perceiving themselves somewhat better prepared than Double Degree or Graduate Diplomas students. For knowledge of literacy teaching (LitKnow), however, the mean for the Master of Teaching subgroup is substantially higher than the mean for other subgroups and the standardized difference between the means for the Master of Teaching and other programs combined is 1.53 standard deviations (i.e. expressed as Cohen's *d*). This is a moderate to large effect size. Among the Master of Teaching students who participated in this study, knowledge of literacy teaching, as measured by the TLI sections on teaching reading and writing, was substantially greater than that of students in other programs.

Table 21 TLI Means by Program

		N	Mean	Std. Deviation
LitKnow	Four Y B.Ed	283	0.19	0.91
	Double Degree	23	-0.25	1.29
	Master of Teaching	25	1.71	1.20
	Graduate Diploma	50	0.06	0.92
	Total	382	0.24	1.03
Prep	Four Y B.Ed	294	0.21	0.91
	Double Degree	24	-0.35	0.44
	Master of Teaching	26	0.15	0.80
	Graduate Diploma	64	-0.29	0.72
	Total	409	0.10	0.88
AboutYou	Four Y B.Ed	295	0.55	0.53
	Double Degree	24	0.41	0.40
	Master of Teaching	26	0.29	0.44
	Graduate Diploma	64	0.32	0.43
	Total	410	0.49	0.51

Table 22 reports differences among groups by gender. The standardized differences between the gender group means for the personality trait and preparation as a teacher are both approximately 0.41 (i.e. Cohen's *d*). This is a moderate effect size. Both differences between the means are statistically significant ($\alpha = 0.01$). The standardized difference for Literacy Knowledge is approximately 0.21. In this case, the effect sizes are quite small. That is, there are only small differences between the average locations of males versus females for the measured traits.

Table 22 Variable Means by Gender

		N	Mean	Std. Deviation
LitKnow	0	6	-0.56	0.79
	Male	48	-0.01	0.87
	Female	298	0.18	0.95
	Total	352	0.15	0.94
Prep	0	6	-0.23	0.48
	Male	50	-0.21	0.73
	Female	322	0.16	0.91
	Total	378	0.10	0.89
AboutYou	0	6	0.22	0.37
	Male	50	0.34	0.30
	Female	322	0.55	0.53
	Total	378	0.51	0.51

Differences between age groups are also relatively small for all of the variables (Table 23). The between groups variance is not, overall, significant for any of the variables at the $\alpha = 0.01$ level (Table 24).

Table 23 Variable Means by Age

		N	Mean	Std. Deviation
LitKnow	20 to 24 yrs	221	0.16	0.91
	25 to 30 yrs	52	0.24	1.17
	31 to 40 yrs	47	0.20	0.89
	40+	35	-0.20	0.75
	Total	355	0.14	0.94
Prep	20 to 24 yrs	235	0.09	0.81
	25 to 30 yrs	58	-0.08	0.69
	31 to 40 yrs	49	0.21	1.11
	40+	39	0.23	1.17
	Total	381	0.10	0.88
AboutYou	20 to 24 yrs	236	0.50	0.52
	25 to 30 yrs	58	0.38	0.36
	31 to 40 yrs	49	0.62	0.44
	40+	39	0.62	0.67
	Total	382	0.51	0.51

Table 24 ANOVA Summary for Age

		Sum of Squares	df	Mean Square	F	Sig.
LitKnow	Between Groups	4.721	3	1.574	1.789	.149
	Within Groups	308.761	351	.880		
	Total	313.482	354			
Prep	Between Groups	3.166	3	1.055	1.361	.254
	Within Groups	292.312	377	.775		
	Total	295.477	380			
AboutYou	Between Groups	2.074	3	.691	2.654	.048
	Within Groups	98.462	378	.260		
	Total	100.536	381			

The final demographic difference explored in this analysis (see Table 25) was the entry qualification of students: whether they entered on the basis of a TAFE qualification (TAFE), on the basis of completed Year 12 tertiary entrance rank (SchoolRank), an incomplete university degree (Incomplete Uni Degree) or a previously completed university degree (Completed Uni Degree). The differences among means were statistically significant at the $\alpha = 0.01$ for the Literacy Knowledge and personal characteristic trait. For Literacy Knowledge, the standardized difference between the mean of the

Completed University Degree group and the mean of other groups combined is 0.53. This is a moderate effect size, indicating a notable difference

For the personal characteristic trait (shown as AboutYou), there are only relatively small differences among the groups and no particular group clearly stands apart from other groups.

Table 25 Variables by Entry Point

		N	Mean	Std. Deviation
LitKnow	0	1	-0.23	.
	TAFE	61	-0.04	0.90
	School Rank	123	0.21	0.93
	Incomplete Uni Degree	23	0.23	1.16
	Completed Uni Degree	78	0.67	1.30
	Alternate Entry	91	0.13	0.87
	Total	377	0.24	1.04
Prep	0	1	-0.58	.
	TAFE	61	0.23	0.98
	School Rank	133	0.18	0.84
	Incomplete Uni Degree	24	0.06	1.13
	Completed Uni Degree	93	-0.11	0.83
	Alternate Entry	92	0.17	0.84
	Total	404	0.11	0.88
AboutYou	0	1	0.28	.
	TAFE	61	0.61	0.56
	School Rank	134	0.47	0.49
	Incomplete Uni Degree	24	0.44	0.51
	Completed Uni Degree	93	0.34	0.46
	Alternate Entry	92	0.61	0.52
	Total	405	0.49	0.51

5.2 Literacy: Correlations among the measured traits

Section 5.1 explored differences among demographic subgroups on the three measured traits for those who completed the literacy forms of the TLI. This section explores the possibility that there might be associations between two measured traits, such as literacy knowledge and teacher education preparation. To this end, correlation coefficients between each pair of measured traits are reported to provide an indication of whether the traits are correlated among the respondents.

Table 26 shows that there is a moderate correlation between the personal trait measure (AboutYou) and preparedness for teaching (r = 0.552). There is a small correlation between the measurements of teachers' preparedness and literacy knowledge (r = 0.215). There is no correlation between the measurements of personal traits and literacy knowledge.

Table 26 Correlations among TLI Variables

Correlations

		LitKnow	Prep	AboutYou	Score
LitKnow	Pearson Correlation	1	.151**	.007	.116
	Sig. (2-tailed)		.004	.891	.214
	N	357	357	357	117
Prep	Pearson Correlation	.151**	1	.552**	-.002
	Sig. (2-tailed)	.004		.000	.982
	N	357	383	383	131
AboutYou	Pearson Correlation	.007	.552**	1	-.240**
	Sig. (2-tailed)	.891	.000		.006
	N	357	383	384	132

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

5.3 Mathematics: Differences among subgroups on the measured traits

Section 5.2 reports on differences in the measured traits among the demographic subgroups. The one-way Analysis of Variance (ANOVA) (Table 27) indicates that the between groups variance is statistically significant only in the case of mathematics knowledge ($\alpha = 0.01$). To provide an indication of effect size, Table 28 shows that the standardized difference between the means for the Master of Teaching and other programs combined is 0.93 standard deviations (i.e. expressed as Cohen's *d*). This is a relatively large effect size.

Table 27 ANOVA Summary for Program

		Sum of Squares	df	Mean Square	F	Sig.
MathKnow	Between Groups	15.578	4	3.895	3.795	.006
	Within Groups	173.416	169	1.026		
	Total	188.994	173			
Prep	Between Groups	4.122	4	1.030	.992	.413
	Within Groups	181.780	175	1.039		
	Total	185.901	179			
AboutYou	Between Groups	1.248	4	.312	1.755	.140
	Within Groups	31.306	176	.178		
	Total	32.555	180			

Table 28 TLI Means by Program

		N	Mean	Std. Deviation
MathKnow	B.Ed	9	-1.14	1.15
	Double Degree	10	-0.64	1.04
	Master Teaching	9	0.15	0.58
	Grad Dip	141	-0.83	1.03
	Other	5	-1.90	0.88
	Total	174	-0.81	1.05
Prep	B.Ed	9	0.09	0.68
	Double Degree	10	0.26	0.64
	Master Teaching	10	0.47	0.22
	Grad Dip	146	0.65	1.08
	Other	5	0.52	1.11
	Total	180	0.59	1.02
AboutYou	B.Ed	9	0.34	0.39
	Double Degree	10	0.70	0.68
	Master Teaching	10	0.28	0.21
	Grad Dip	147	0.47	0.42
	Other	5	0.27	0.25
	Total	181	0.46	0.43

Table 22 reports the results by gender. Although the gender differences were not statistically significant for any of the variables at the $\alpha = 0.01$ level, the standardized difference between the means for preparation as a teacher is approximately 0.43 ($p = 0.043$).

Table 29 TLI Means by Gender

Descriptives

		N	Mean	Std. Deviation
MathKnow				
	Male	73	-0.85	0.99
	Female	93	-0.77	1.09
	Total	168	-0.80	1.04
Prep				
	Male	73	0.85	1.12
	Female	99	0.41	0.92
	Total	174	0.59	1.02
AboutYou				
	Male	74	0.47	0.41
	Female	99	0.46	0.43
	Total	175	0.46	0.42

Table 30 reports TLI means by age. There were no noticeable differences between the means of the different age groups and the between groups variance is not statistically significant for any of the variables at the $\alpha = 0.01$ level.

Table 30 TLI Means by Age

Descriptives

		N	Mean	Std. Deviation
MathKnow	20 - 24 yrs	59	-0.72	1.02
	25 - 30 yrs	44	-0.92	1.07
	31 - 40 yrs	34	-0.96	1.01
	40+ yrs	36	-0.71	1.12
	Total	173	-0.82	1.05
Prep	20 - 24 yrs	62	0.49	0.87
	25 - 30 yrs	46	0.51	1.00
	31 - 40 yrs	34	0.68	1.40
	40+ yrs	37	0.78	0.88
	Total	179	0.59	1.02
AboutYou	20 - 24 yrs	63	0.41	0.41
	25 - 30 yrs	46	0.43	0.47
	31 - 40 yrs	34	0.55	0.48
	40+ yrs	37	0.51	0.33
	Total	180	0.46	0.43

The final demographic difference explored among those completing the TLI mathematics forms is teacher education according to entry qualifications. The differences between the means were not statistically significant for any of the variables; i.e. the between groups variances were not statistically significant in a one-way ANOVA. Table 31 shows that the standardized difference between the alternative entry mean and the mean of other groups combined is -1.22. However, the number of respondents in the alternative entry group is only 5, which is very small.

Table 31 TLI Means by Entry Point

		N	Mean	Std. Deviation	Std. Error
MathKnow	TAFE	1	-0.95	.	.
	School Rank	11	-1.06	1.24	0.37
	Incomplete Uni Deg	7	-0.50	0.74	0.28
	Completed Uni Deg	150	-0.77	1.02	0.08
	Alternate Entry	5	-2.02	1.12	0.50
	Total	174	-0.81	1.05	0.08
Prep	TAFE	1	1.41	.	.
	School Rank	11	-0.13	0.34	0.10
	Incomplete Uni Deg	7	0.57	0.71	0.27
	Completed Uni Deg	156	0.63	1.05	0.08
	Alternate Entry	5	0.67	1.06	0.47
	Total	180	0.59	1.02	0.08
AboutYou	TAFE	1	0.75	.	.
	School Rank	11	0.38	0.39	0.12
	Incomplete Uni Deg	7	0.65	0.81	0.31
	Completed Uni Deg	157	0.46	0.41	0.03
	Alternate Entry	5	0.41	0.38	0.17
	Total	181	0.46	0.43	0.03

5.4 Mathematics: Correlations among the measured traits

Section 5.3 explored differences among the demographic subgroups in the three measured traits for those completing the literacy forms of the TLI. This section provides a parallel analysis for those who completed the mathematics forms of the TLI. In order to explore whether there are associations between two measured traits, such as knowledge of mathematics teaching and teacher education preparation, correlation coefficients between each pair of measured traits are reported.

Table 32 Correlations among Inventory Variables

Correlations

		MathKnow	Prep	AboutYou	Score
MathKnow	Pearson Correlation	1	.243**	.086	.277
	Sig. (2-tailed)		.001	.257	.063
	N	174	173	174	46
Prep	Pearson Correlation	.243**	1	.556**	-.053
	Sig. (2-tailed)	.001		.000	.718
	N	173	180	180	49
AboutYou	Pearson Correlation	.086	.556**	1	-.157
	Sig. (2-tailed)	.257	.000		.283
	N	174	180	181	49

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

Table 32 shows that there is a moderate correlation between the personal trait measure (AboutYou) and perceptions of preparedness for mathematics teaching (r = 0.556). There is a small, though statistically significant, positive correlation between teachers' perceptions of preparedness and their measured knowledge of mathematics teaching (r = 0.243). That is, teachers who report being more prepared tend to perform better on the knowledge section of the TLI, although the association is not strong. There is no correlation between the measurements of personality traits and literacy knowledge.

6. Discussion and conclusions

The long-term goal of this study was to investigate the relative impact of personal characteristics, teacher education and school context on the formation of teachers, and the impact of these teachers on growth in student achievement scores. Through this long evidential chain, it was hoped to be able to draw some conclusions about the input, process and output characteristics of effective teacher education.

The foreshortening of the study, forced by participant attrition rates, leaves some of these questions unanswered. The value of approaches such as this has, however, been demonstrated by a broadly similar study currently under way in New York State (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009). The New York study has shown that teacher education programs vary in effectiveness as measured by student test score gains. As was anticipated in this study, differences seem to be related to both program effects (such as the depth of focus on the work of the classroom), and selection effects (such as the academic background of students recruited to the program).

Although the long-term study cannot be completed, the phases which have been completed have shed some light on the relative impact of personal and program characteristics on the knowledge of literacy and mathematics teaching of a large number of final year teacher education students.

With respect to literacy, the results showed statistically significant differences on the three traits among the four key program types (four-year Bachelor of Education; Double degree; Graduate Diploma; Master of Teaching). Of these differences, the largest effect size (1.53 standard deviations) was recorded for knowledge of literacy teaching among students enrolled in Master of Teaching programs. Among the Master of Teaching students who participated in this study, knowledge of literacy teaching as measured by the TLI was substantially greater than that of students in other kinds of programs. There was a notable difference in knowledge of literacy teaching between those who had entered the course on the basis of a completed degree (0.53 standards deviations), rather than through alternate entry, TAFE, on the basis of year 12 school performance or an incomplete degree.

Other demographic differences had little or no effect on the three traits measured by the literacy TLIs. There were statistically significant differences in favour of female students but the effect size was smaller (0.41 standard deviations). Age was not statistically significant for any of the traits on the literacy TLIs.

The results for students completing the mathematics forms of the TLI were somewhat similar. Although between groups variance was statistically significant only in the case of knowledge of mathematics teaching, there was a large effect size associated with enrolment in a Master of Teaching program (0.93 standard deviations). There were no significant differences among groups according to gender or age of entry.

Analysis of correlations among the traits measured by the TLIs produced similar results in literacy and mathematics. In both cases there were moderate correlations between the personal trait measure and perceptions of preparedness for teaching (literacy, $r = 0.552$; mathematics, $r = 0.556$), smaller correlations between knowledge of teaching and perceptions of preparedness (literacy, $r =$

0.215; mathematics, *r* = 0.243), and no significant relationship between measurement of the personality traits and literacy or mathematics knowledge.

In summary, the results of this study have reinforced the importance of recruiting well-qualified entrants to the teaching profession. The measured personality trait was moderately related to perceptions of preparation for teaching – that is, people with higher scores on conscientiousness and teamwork reported that they were better prepared for teaching – but such people did not demonstrate greater knowledge of teaching through the TLI tasks examining ability to analyse student work. In contrast, students who entered teaching on the basis of a completed degree, or who entered through the more demanding postgraduate option of the Master of Teaching rather than a Graduate Diploma, were more likely to be able to analyse student work and thus scored well on the teachers' knowledge traits.

But would those students with high levels of knowledge of teaching turned out to have been more effective teachers, in terms of their impact of students' growth in test scores? Given the inability to follow these students through their first two years of teaching, the best estimate of effectiveness comes from a parallel study completed for another education agency.

In the context of a program evaluation for the Catholic Education Office of Western Australia (Heldsinger, 2010), one of the authors of the present report explored the relationship between student growth and teachers' knowledge scores using TLI literacy instruments. What she found was that there was a strong relationship between teachers' ability to analyse student performance (as measured by the TLI) and students' growth in Year 5 (as measured by growth in achievement using WALNA reading tests) (2002, 2004). She found a small but statistically significant relationship between teachers' ability to analyse student performance and students' growth in Year 3. Heldsingers' results in the Catholic Education Office study, combined with the results of this study, suggest that the path towards creation of more effective teacher education will be characterised by recruiting academically successful students and working with them to improve their capacity to analyse students' performance. With these skills well developed, superior student growth scores may well follow, as they have for the teachers with the highest TLI teachers' knowledge scores in Heldsinger's study.

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