

Learning for Living

The Unitec Numeracy Cluster Evaluation Report

Joanna Higgins

VICTORIA UNIVERSITY OF WELLINGTON
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Victoria University of Wellington

P O Box 600

Wellington 6001

New Zealand

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1. Introduction

Background to the Learning for Living Adult Numeracy Initiative

Over the last two decades many countries have launched large scale initiatives aimed at strengthening key competencies as governments acknowledge that sustainable economic development, social welfare, cohesion, and justice, as well as personal well-being are closely linked to knowledge and skills (Gal et al., 2005; Ministry of Education, 2005). In New Zealand the government's focus on ensuring that all people can participate in "our knowledge society" is outlined in its Tertiary Education Strategy (TES). Raising foundation skills was one of the six goals in the first TES (Ministry of Education, 2002). The government released the second TES in December 2006. This strategy, which sets out the government's expectations and priorities for New Zealand's tertiary education system from 2007 to 2012, identifies "raising the literacy and numeracy levels for the workforce" as one of four priority outcomes (Ministry of Education, 2006, p.5). The priority given to this outcome recognises that the prevalence of low numeracy levels, along with low literacy and language levels, needs to be addressed if New Zealand is to develop a high-performing economy.

The construct 'numeracy' does not have a universally accepted definition, nor agreement about how it differs from 'mathematics'. (Gal et al., 2005, p.143)

While internationally there are many different interpretations of numeracy, in New Zealand there appears to be a consensus that numeracy is a continuum of the knowledge and skills that adults draw on to meet the varied mathematical demands of their lives. The definition developed for the Ministry of Education's Literacy and Numeracy Strategy states "To be numerate is to have the ability and inclination to use mathematics effectively – at home, at work and in the community" (Ministry of Education, 2001a, p.i). This broad definition positions numeracy as an adult construct and also acknowledges the impact of disposition on numerate behaviour. The Literacy and Numeracy Strategy provides alignment and consistency for a range of policies, programmes, and projects all focused on improving literacy and numeracy achievement from early childhood through the school years. The Adult Literacy Strategy adds to this strategy and extends the focus on raising literacy and numeracy achievement into the adult sector (Ministry of Education, 2001b).

In early 2004, the government released the Learning for Living Strategy, which builds on TES (2002-2007), the New Zealand Adult Literacy Strategy and the Adult English as a Second or Other Language Strategy. The overall goal of the Learning for Living Strategy is to ensure that

foundation learning results in real gains for learners and, over time, results in significantly improved literacy, numeracy and language levels in the population. There are two phases to the Learning for Living work programme. Phase One consists of research and development projects aimed at encouraging expertise in the sector. The second phase will involve the introduction of a funding mechanism aimed at supporting access to quality foundation learning in appropriate contexts for priority learners.

The Adult Numeracy Initiative

The Learning for Living Professional Development Initiative, focused on numeracy, will be referred to throughout this report as the Adult Numeracy Initiative. Figure 1 illustrates the relationships between the key participants in the Adult Numeracy Initiative.

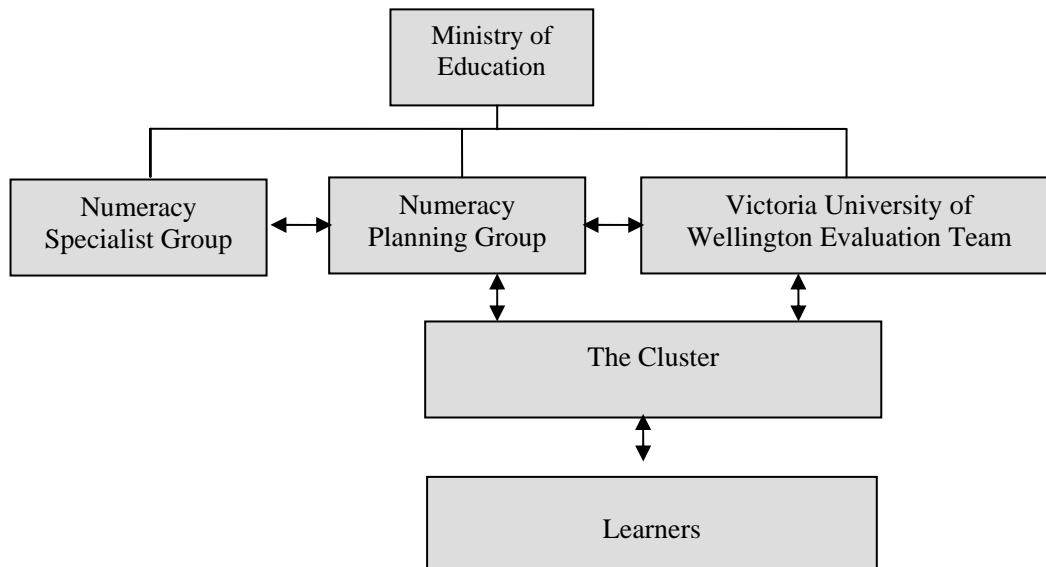


Figure 1 **Adult Numeracy Initiative relationships**

The Numeracy Specialist Group provides advisory support to the Numeracy Planning Group, which is responsible for the planning and implementation of the Adult Numeracy Initiative. The research evaluation team investigates the effectiveness of the project by examining the learning, attitudinal, and resource impacts on the participating developers, tutors, managers, and learners. The evaluation findings address issues of accountability, knowledge generation and project improvement.

The general aim of the Adult Numeracy Initiative is to raise the numeracy achievement of learners in foundation education programmes by improving the quality of teaching. The Adult

Numeracy Initiative is characterised by four key features: the use of a framework to describe progressions in numeracy learning; an individual diagnostic interview to assess learners' numeric thinking and the systematic gathering of learner achievement data; a programme of intensive professional development for tutors and managers; and the evaluation of the initiatives impact on learner achievement, tutor knowledge and practice and systems within organisations.

Draft Foundation Learning Progressions for Numeracy

The Draft Foundation Learning Progressions for numeracy are grouped into three strands: Make Sense of Number to Solve Problems; Reason Statistically; and Measure and Interpret Shapes and Space (TEC, 2006). The focus of the implementation Phase of the Adult Numeracy Initiative is on the six progressions that form the Make Sense of Number to Solve Problems strand. The learning progressions were largely adapted from the Number Framework, which supports the Numeracy Project in the school sector (Ministry of Education, 2007). Three of the progressions focus on number strategies, and three focus on key aspects of number knowledge. Number strategies are the processes that learners use to solve operational problems with numbers. They are strategies that make it easier to solve number problems with understanding. The number strategies can be loosely grouped into counting strategies and partitioning strategies. Counting strategies involve counting in ones to solve problems, often with the support of objects (such as fingers). Partitioning strategies are based on using knowledge of number properties to break numbers apart (partition) and then recombine them in ways that make reaching the solution easier. The number knowledge strands are: number sequences, number facts, and place value.

Diagnostic Assessment

Another key feature of the Adult Numeracy Initiative is the diagnostic assessment designed to provide tutors with valuable information about their learners' number knowledge and number strategies aligned to the learning progressions. Using the diagnostic assessment, tutors develop a number profile for each learner. Tutors participating in the initiative assess their learners at the start of the initiative and then again after 10-15 weeks of teaching. The amount of teaching, however, varies across course types. For instance, some vocational tutors teach block courses with up to four weeks teaching time, with not all of that mathematical. The diagnostic assessment is included in full as Appendix A.

Professional Development Programme

A third feature of the initiative is the professional development programme, which has three phases: an implementation phase (Phase 1), a consolidation phase (Phase 2) and a sustainability and roll-out phase (Phase 3). The professional development approach adopted has been informed by Guskey's (2000) research that identifies key elements of effective programmes. Although professional development "does not directly or exclusively affect improvements in student

learning, high quality professional development is an important and necessary prerequisite to such improvements” (Guskey, 2000, p.75). Guskey contends that the influence of the professional development on student learning is mainly accomplished through its direct influence on the practices and knowledge of teachers and school leaders. If the professional development does not alter tutors’ professional knowledge or teaching practices, then little improvement in learning can be expected. Guskey states that the while school leaders do not directly influence student learning their knowledge and practices indirectly influence students in two ways. The first is their interactions with teachers and, more specifically, in the way in which they value and support efforts to improve. The second way that school leaders affect student learning is through their role in determining school policies regarding such things as the curriculum, assessment, and resources. While Guskey’s research on effective professional development has focused on schools, the Numeracy Planning Group believed that the same principles could be applied to the tutors and managers participating in the Adult Numeracy Initiative. These factors have helped shape the format and content of the professional development programme of the Adult Numeracy Initiative.

The implementation phase involves the participation of two tutors and a representative of each provider’s management team over a six-month period. While the content and format of the meetings varies between clusters, they have three features in common. These are a focus on the learning progressions, a sharing of in-class experiences as tutors implemented numeracy ideas and practices, and a sharing of classroom numeracy resources and activities. Participating tutors are provided with the equivalent of two days release every three weeks to attend cluster meetings and to plan and implement the initiative with their learners. One or two developers with expertise in numeracy and/or adult foundation learning lead each cluster. In this phase the developers run approximately seven cluster meetings and hold provider-based meetings to support the implementation of the initiative.

The consolidation phase builds on the implementation phase by supporting the consolidation of tutors’ new professional knowledge and embedding new teaching practices within classrooms. The provider’s management representatives are supported to develop plans for sustaining the initiative within their organisation. The consolidation phase includes approximately three cluster meetings and monthly provider-based meetings with the developer.

The third phase is the sustainability phase. In this phase the providers are supported to extend the initiative to other tutors within the organisation, and to establish or strengthen communities of practice that enable the new numeracy practices to be sustained.

Research and Evaluation

The impact of the Adult Numeracy Initiative is closely monitored through focused evaluations conducted with each cluster of participants. The evaluations have two important goals: to improve the quality of the initiative for future participants, and to determine its overall effectiveness.

Overview of the Report

This report describes the processes and outcomes of the Adult Numeracy Cluster as experienced by the Unitec Cluster from January to July 2007. Chapter 3 examines the participants' reactions to the professional development received. Chapter 4 describes the participants' perspectives on the impact of the initiative on the tutors' beliefs and knowledge. Chapter 5 reports on the impact of the initiative on the structures or processes within the participating institutions. Chapter 6 examines the impact of the initiative on the numeracy teaching practices of the tutors and Chapter 7 describes the impact of the initiative on the numeracy achievement of learners. The concluding chapter summarises the key findings of the evaluation of the Adult Numeracy Initiative in the Unitec Cluster from January to July 2007.

2. Overview of the evaluation

The Research Evaluation Framework

The evaluation approach is adapted from the work of Shaha, Lewis, O'Donnell and Brown (2004) and Guskey (2000, 2002). The approach considers both the "Levels of Impact" and the "Perspectives" of the key participants (see Figure 2). It also incorporates features of good research design that maximise the validity and interpretability of the findings. The key difference between the approach adopted in the evaluation projects (July – December 2006; January to December 2007) and the approach used in the evaluation of the first round of professional development initiatives (October 2005 – June 2006) is a clearer distinction between the levels of impact. The four levels of impact are derived from the work of Guskey (2000) and include: tutor attitude and tutor knowledge, organisational structures and processes, tutor teaching practices in numeracy, and learner outcomes. Each of these aspects is important in evaluating the effectiveness of a professional development initiative.

Figure 2 outlines the focus evaluation questions linked to the four levels of impact. The focus questions formed the basis for surveys used to gather the perspectives of the participating tutors, managers and developers.

Perspectives of tutors, managers, developers		
		Focus evaluation questions
Levels of impact	Tutor attitude and tutor knowledge	To what extent have tutors' existing beliefs and expectations been challenged/ changed? To what extent tutors' level of subject knowledge and pedagogical content knowledge been raised?
	Organisational structures	What organisational structures and processes to support change have been implemented? To what extent have providers established on-site communities of practice? To what extent is the cluster operating as an effective community of practice?
	Tutor practice	To what extent are tutors more able to analyse and use the numeracy demands of courses and the numeracy needs of their learners as the basis for teaching decisions?
	Learner outcomes	What are the numeracy achievement and attitudinal outcomes experienced by learners?

Figure 2 **The evaluation approach**

The Participants

This section provides demographic information on the providers, tutors, learners and developers participating from January to July 2007 in the Unitec Cluster.

Table 1 summarises the profile of six tutors in the Unitec Cluster. The demographic information was gathered in the surveys and/or interviews that were completed in June 2007.

Table 1 **Profile of tutors**

Characteristic	Profile of the six tutors
Gender	5 male, 1 female
Length of experience in adult education	More than 10 (0), 6-10 years (2), 1-5- years (4), Less than 1 year (0)
Type of position	Specialist (4), vocational (2)

Table 2 details the qualifications, work experiences, and numeracy professional development experiences of the six tutors. Four of the tutors have a compulsory sector teaching qualification while a further one has an adult sector teaching qualification. Six of the tutors have vocational qualifications and related work experience.

Table 2 **Qualification and professional development profile of tutors**

	Number of tutors (out of a possible six)
Compulsory sector teaching qualification	3
Adult sector teaching qualification	1
Postgraduate qualifications	1
Related vocational qualification	5

Thirty-one learners completed both assessments. Many of these learners had special needs and in interpretations of their progress should take this factor into account.

Data Collection Approaches

Two primary data sources were used to inform the evaluation of the Adult Numeracy Initiative from January to July 2007. Each of these data sources is described briefly in this section.

Learner Assessment Information

Information on the learners was based on their performance on the Learning for Living numeracy assessment. This is a diagnostic assessment designed to provide tutors with information about the number knowledge and number strategies of their learners and is aligned to six of the Draft

Foundation Learning Progressions for numeracy described in Chapter 1. Also included in the assessment are three items to help identify learners' current attitudes towards learning mathematics. The strategy and knowledge assessments, and the three attitude items are contained in Appendix A.

The two main sections of the diagnostic tool are the 'strategy assessment' and the 'knowledge assessment'. Both the strategy assessment and the knowledge assessment provide a script for tutors to use. The script suggests what to say, enables the tutor to omit questions that will be too difficult for the learner, and explains how to rate learners on each learning progression according to their results. It is expected that as tutors gain familiarity with the items and find out how to evaluate learners' responses, they will become quicker and more competent at working out where to start and when to finish each part of the assessment with a learner.

The strategy assessment takes the form of an individual interview with a learner. It assesses the learner's number strategies in terms of the learning progressions for additive strategies, multiplicative strategies, and proportional reasoning strategies. When asking the interview questions, the tutor's focus is on how the learner solved the problem. For each problem, the interviewer asks the learner "How did you work that out?" in addition to the scripted questions.

The knowledge assessment has been designed to assess a group of learners but could also be used for individual interviews. It assesses learners' knowledge about number in terms of the learning progressions for number sequence, place value, and number facts. When assessing groups, the tutor can display each question on overhead transparency. When displaying the questions, the tutor allows sufficient time for the learners to access their existing knowledge, but not enough time for them to work out the answer by using a strategy. The purpose of this assessment is to discover which items of knowledge each learner can provide immediately and automatically, not which problems they can work out if given enough time. The tutor rates each learner according to the instructions given, which means at the highest step at which they answer every item correctly in the allotted time.

Tutors participating in the Adult Numeracy Initiative were expected to assess their learners using the diagnostic interview on two occasions. The first was near the beginning of the professional development (after completing a workshop on the use of the diagnostic interview) and the second after approximately 12-15 weeks of teaching in June.

Tutor, Manager and Developer Surveys

The perspectives of the tutors, managers and developers on the Adult Numeracy Initiative over the evaluation period (January – July 2007) were obtained through online surveys. In addition to the focus questions the surveys had a number of questions that more generally sought the tutors', managers' and developers' reactions to the professional development. Some participants were interviewed only. Summary of online surveys is shown in Table 3.

Table 3 **Respondents**

	Number of participants	Number (%) of returns
Tutors	8	4 (50%)
Managers	4	1 (25%)
Developers	2	2 (100%)

3. Effectiveness of the professional development

This chapter discusses the perspectives of participants in the Unitec cluster on the effectiveness of the professional development. Participant comments come from the online surveys and follow-up interviews. The perspectives of each group of participants – tutors, managers and developers are discussed separately.

Perspectives of the Tutors

Tutors were generally enthusiastic about participating in the professional development. The tutors' reasons included comments pertaining to improving their own abilities, as well as comments about new ideas and techniques they could use.

It has highlighted the areas where I may be a little weaker on in numeracy and has given me a chance to improve in those areas quite dramatically.

This is a good opportunity to develop our ability to meet the numeracy needs of our students.

Excited to implement into my programme what had been discussed and taught at cluster meetings.

Learnt some new techniques which I can pass to students with math problems.

Tutors were asked to rate the aspects of the professional development that were most helpful. The aspects included cluster meetings, between meeting tasks, in-provider meetings with and without the developer, in-class observations and reflective journals. Highly rated aspects of the professional development were the on-site meetings with the developer and the cluster meetings. Many tutors found the contribution of the developer to be very helpful. In-class observations generally were not rated highly by tutors, but the most helpful were observations by the developer. Some tutors rated the reflective journal as moderately helpful.

Several tutors specifically made favourable comments about the cluster meetings. One tutor commented that “the cluster meetings really worked as I had no knowledge of the initiative. The two developers did a good job of bringing this across”. Similarly a tutor commented that, “the cluster meetings went very well. You could try out things in the cluster meetings and gauge the response ... this has helped build up collegiality. Good at the cluster meetings to have lots of different ideas”. Others commented:

The cluster meetings turned out to be really important – more than I thought in the beginning – it kept us on track – it is easy when there are so many demands on time to do the immediate rather than the most important tasks. ... The developers were good at running meetings – refocusing people who got off task a bit.

I liked the way that the cluster meetings were cut in the second part. In the first phase of cluster meetings there could have been more implementation. I wanted to get out and do it. The first set of cluster meetings was good as they set the project up. The second set we were able to get more time for implementation – this could have come sooner.

One tutor commented “in this last phase I got a bit lost. The developers were very helpful with email and face-to-face meetings”.

In listing the three outcomes of the professional development most important to them as *tutors* in the phase January to June 2007, one tutor listed knowledge of the progressions and the consequent changes to courses.

Develop knowledge of progressions. Begin to change courses to reflect numeracy needs.
Discuss numeracy with other tutors to bring about change.

Another tutor specifically mentioned changes to the numeracy diagnostic interview.

Developing numeracy diagnostic assessment to suit own students - giving a clear indication as to how well developed their numeracy strategies are. Developing initial assessment to group students into three ability groups at inception of the 2-year programme. Exploring the possibility of moving students on to the next strategy level by implementing material discussed and explained at cluster meetings.

A third tutor spoke of how the professional development had given them confidence in teaching numeracy.

It has given me extreme confidence in front of the class doing calculations. It has given me the chance to incorporate more numeracy within lessons. It has given me a great sense of achievement when students thank me after completing their external examinations and they have nailed the calculations.

In listing the three outcomes of the professional development most important for their *organisation* in the phase January to June 2007, tutors' comments centred on improved outcomes for learners.

Improved outcomes for students. Student needs more closely met. Courses updated to reflect changes in pedagogy.

Tutors gained insight into how numeracy fitted with the programmes taught by the different schools at Unitec. Information was shared and discussed and taken by those tutors who were not part of the cluster group. [There was] implementation and awareness of the numeracy strategies and assessment by the various schools participating in Adult Numeracy Initiative.

We are more aware that most students do struggle with numeracy. [The project] highlighted the fact that over the years numeracy has been put to one side because of the syllabus set down by the ITO. Tutors have addressed their individual weak areas and improved in these.

In listing the three outcomes of the professional development most important for their *cluster* in the phase January to June 2007, tutors commented on “Improved communication and collaboration between the various participants”, and “learning from each other. Learning other teaching styles. Learning in general”. One tutor felt that fewer cluster meetings “left more time for implementation and research [and] focus on specific needs of the students we work with [and the opportunity to] involve other numeracy tutors we work with”. Another commented that it was important for the cluster to be “working as a team, developing new ideas”.

In terms of aspects of the professional development that could be improved only two of the tutors gave suggestions which were:

By involving more tutors who face the same issues with students – e.g. tutors from maths bridging courses at other institutions.

Show us new techniques and let us practise them.

None of the tutors had comments about the structure of this phase of the professional development.

Perspectives of the Managers and Developers

Managers were asked to describe how they felt about taking part in the professional development. One manager commented:

I think that numeracy is essential in the development of our learners in maths. Our courses have not looked at this aspect of maths learning prior to the initiative. There is a huge amount of work to be done to embed numeracy in our courses. It has been good to have the time to explore this and to start the process.

What was most effective for me was quite difficult because what the developers did in terms of the professional development I had already done as maths teacher. Sharing expertise is what it is all about, rather than maths knowledge. Making it a shared body of knowledge about how students learn is the issue.

The Adult Numeracy Initiative has made me go off in a new direction. It will certainly inform my practice. What do adults need to know and how can we do this best? I've enjoyed being part of the initiative and I like the numeracy lens rather than the maths lens.

We are supportive of the initiative because numeracy is integral to our teaching and learning environment and the students need this for our programme. We try to open in our

programme to other initiatives. The positives are just being able to participate through knowing the depth of support around. It highlighted our weakness and showed us ways of improving our numeracy. There were no negatives apart from people getting involved such as students being interviewed. Although we've got funding pressures on time so things are sometimes hard to manage. If we can plan it better we may be better able to participate.

Managers and developers from the Unitec cluster also commented on other aspects that they thought were helpful. These included "using primary and secondary numeracy resources on the web" (Manager) and "having staff from the other sections involved attend the cluster meetings" (Developer).

In listing the three outcomes of the professional development most important to them as *managers* in the phase January to June 2007, one manager listed "simplification of assessment for our learners [and] sharing learning progressions with the rest of the maths team".

In listing the three outcomes of the professional development most important to *tutors* in the phase January to June 2007 one manager commented:

Exploration of numeracy issues in measurement. Exploration of numeracy issues in statistics. Further exploration of numeracy progressions and how to assess our learners more easily.

While developers mentioned:

A deeper understanding of the Making Sense of Number strand, a quicker understanding of where their learners are starting at, [and] providing some useful ideas about how to approach the other two strands.

Continuing to trial teaching numeracy/calculations in a way to develop understanding of concepts. Modifying teaching approach as a result of learning how low the numeracy levels were of some of their learners. Modifying courses to reincorporate learning about numeracy from Phase 1.

Managers and developers were also asked what, from their perspective, were the most important outcomes of this professional development for the *organisation*. An important theme in their comments was embedding numeracy in the courses.

A determination to embed numeracy more fully in our maths courses. Use of a numeracy tutor to focus on individual student needs. (Manager)

It's also providing opportunities for all the tutors to be supported, but ongoing and now we're working to embed numeracy in the courses, probably through writing a more prescribed course in terms of the numeracy skills. Doing it for the research and doing it for your teaching are two different things. (Manager)

For some cluster members incorporating the assessment into their diagnostic process. Modifying courses to incorporate learning about numeracy from Phase 1. Incorporating

other tutors into discussions and implementation of the new approach to numeracy and calculations. (Developer)

Setting up of action plans by most sections. Engaging other tutors who have numeracy demands in their courses. (Developer)

The cluster model was generally seen by managers and developers to be an effective means of delivering professional development. As one developer put it,

The standout has been getting diverse people in the cluster environment. This helped to allay suspicion about the project. The cluster model is a good one rather than a just “fly by the seat of your pants” approach where there is just changing things at will without a lot of reflection. There was evidence that people have tried out new things and people have got serious about it. Even experienced people have tried things who have been practitioners for a long time. They came to meetings with the things that they had done with their learners. As developers we asked the question, “What do you need to make this work?”

When asked what, from their perspective, were the most important outcomes of this professional development for the *cluster*, managers and developers responded:

Continued development of numeracy issues related to the courses we teach. Sharing of ideas. Further development of the numeracy perspective in viewing our teaching. (Manager)

New people on board as original cluster participants brought them on board, either in internal meetings, or with cluster work. (Developer)

Provided ongoing PD to original cluster members and other tutors who were working with those original tutors who also attended cluster meetings. Provided the momentum to continue working for on the initiative. Cluster members were required to report back to the cluster on what they had been doing in the initiative time and to model a teaching session they had been working on. This requirement ensured that work on the initiative got done. (Developer)

When commenting on the aspects of the professional development that could be improved, the managers and developers identified:

As maths tutors we would have benefited from sharing with like tutors who have similar students. There is quite a difference between the numeracy needs in the courses in different parts of our cluster. (Manager)

More time being made available for cluster members in our section. Being able to offer more support to tutors to address the large gap between the low numeracy level of some learners and the level of maths required in some of the calculations. (Developer)

Not a lot – really dependent on the input of the teaching sections, which many did very well with. Perhaps a realisation to take little steps when engaging others, particularly with the diversity of staffing – maths and vocational. (Developer)

When asked to comment on the structure of this phase of the professional development, a manager said, “There is so much more to do. Resources and professional development is needed for all maths tutors. Probably doing this once a week – it is not enough to do it once. Those who have practised the skills improve. We need to reinforce the teaching”.

The developers commented:

At Unitec it was solely for embedding learning from Phase 1 with no "roll out". This was very necessary - and there is room for more of it!

Three meetings were about right.

The developers were specifically asked to comment about any providers who had withdrawn from the initiative since the start of the professional development. While one developer commented that “None [had withdrawn], though some had less presence than others in the last meetings”, the other developer said, “One School [has withdrawn] due to the two tutors in Phase 1 leaving Unitec”.

4. Impact on the tutors' beliefs and knowledge

This chapter examines factors that impacted on tutors' beliefs and knowledge from the perspectives of the tutors, managers and developers. The data for the chapter have been drawn from the surveys completed in June 2007. The research evaluation questions related to this chapter were:

- To what extent have tutors' existing beliefs and expectations been challenged and/or changed?
- To what extent have tutors' levels of subject knowledge and pedagogical content knowledge been raised?

The perspectives of each group of participants – tutors, managers and developers – are presented separately.

Perspectives of the Tutors

Most tutors considered that the professional development had impacted on their beliefs and knowledge. As for the previous evaluation of the Unitec cluster they specifically referred to learning about the importance of numeracy knowledge and its relationship to learners' strategy development.

The professional development has impacted on my own knowledge. I'm now aware of knowledge strategies, but at the lower stages. I went to the primary numeracy project on the web and got ideas for teaching basic facts skills such as time.

On the whole I found it exciting, something fresh and new. It can only benefit the students and me. I am really thrilled that I agreed to do it.

The maths I learnt as a teenager is very different to how it is now.

The whole issue of numeracy has become more important. I had the view that if the students could do things with a calculator then I left them. Now since being involved in the initiative I now realised how numeracy is so important. The example the other day when I was teaching was that students had no idea of how to work out 20% - even though they could work out 10%. They were mostly older students. The issue is what are we teaching them if they don't have basic numeracy skills. So it reasserted the importance of maths –

their need for their everyday maths –then we need to teach this. However, this is much harder than I thought it would be – it turns out that teaching numeracy is not a linear process. I’m feeling concerned about how to approach it. I realised that it is not as easy as I thought. I made the assumption that we were merely revising things. However, maybe it is that they never understood these things. A researcher talked about the idea of having a constituted identity - students having agency through being able to talk about how they did something gives them an identity with others such as “being good at maths”.

As a follow-up because I wanted to keep going with what we did in cluster meetings, I made a decision to enrol in a masters paper in education.

Perspectives of the Managers and Developers

The manager and developers felt that in the period January to June 2007 tutors had developed their knowledge of how to numeracy effectively as well as how to integrate numeracy into their teaching.

One of the managers, however, commented:

Two things that stood out were that it focused our attention on lack of knowledge of numeracy. Firstly, you can’t teach numbers on their own as they need to be based on the context. Unless there is understanding of the context, then you can’t understand the numbers. More effort needs to go into explaining of concepts. There are problems of not understanding basic concepts such as volume and pressure. The second thing is that tutors are often the major problem as they don’t understand the maths themselves so they skip-over subjects that involve maths concepts. So when the tutors aren’t getting it right, then everyone’s wrong. It’s a generational thing because we employ trade people who have gone through avoiding numbers. The initiative has exposed the problem. We made too many assumptions that a) tutors had a degree of knowledge, and b) students had a degree of knowledge, so they avoid maths when they are in the room together. Through focusing our minds on numeracy, we went through the lesson plans, but found that maths was in the lesson plan, but not covered. We figured things were wrong, but the initiative gave a requirement to see things were wrong.

The numeracy part was very pertinent and has answered the questions of the last 4 to 5 years. I’m still wondering whether adults really fit the maths programmes. I’ve shifted in my thinking so they probably do fit. It takes a long time to really grasp the progressions in your mind. I’m still coming to terms with learner knowledge. We know that adults know some things, but not others. It is the first time that I’ve dealt with the lowest learners and that is the class that fit the numeracy things best. The initiative has in particular helped the bottom two layers by providing the nuts and bolts.

Both developers felt that Adult Numeracy Initiative had impacted on tutors' beliefs and knowledge of teaching numeracy. They commented on the impact of tutors in terms of the areas of Unitec in which they worked.

In our section the understanding of numeracy concepts was probably at a higher starting level. There may have been a couple who were shaky. One of the tutors was teaching for understanding and at the same time he attended numeracy parent teaching at his sons/daughters school.

5. Impact on institutional systems or processes

This chapter considers the wider implications of the initiative on the practices and systems of participating institutions. The discussion is based on data from surveys and interviews completed in June 2007 from the perspectives of the participant groups. The research evaluation questions with respect to institutional systems and processes are:

- What organisational structures and processes to support change have been implemented?
- To what extent have providers established on-site communities of practice?
- To what extent is the cluster operating as an effective community of practice?

Perspectives of the Tutors

Tutors reported that there had been few barriers to successfully participating in the professional development. For those who reported barriers, staff shortages were key.

In terms of structures put in place by their organisation to help them to implement the practices from the professional development with the class, initial assessment of students was identified as a new structure.

The tutors at Unitec, where the professional development was single-site, generally looked forward to future collaboration with others in their organisation. Those in the one area saw their programme being “unique compared to others at Unitec”. However, despite that, tutors in that area felt that they had:

Good insights into other parts of Unitec. It was good to know more about how maths is being used and what their problems are. The professional development put things into perspective and shed more light on what others were doing. It also gave other departments an opportunity to see what we were doing. They gave suggestions about how I could do things. The initiative helped to build networks across departments.

Other tutors commented that it was helpful finding out what happened in other parts of Unitec.

It was interesting learning about other people’s styles of teaching in the cluster meetings. It was interesting to see how they incorporated numeracy.

In terms of the organisation of the clusters – single-site versus multi-site – I enjoyed listening to people from other sections as I was interested to see what they have to deal

with – so they have developed their own explanations, and rationale for the way they teach. But the most valuable bits came from the developers’ practice as that was closer to our section and they share similar problems – so I would have preferred more tutors in areas who had similar views (e.g. nursing, civil engineering) which may mean going beyond Unitec or perhaps from MIT. That would be helpful in terms of development and sharing resources.

Tutors teaching in some courses described the impact of the initiative on their programmes.

We have made modifications in the distance learning courses sparked by the professional development that have helped the students. For our area the biggest problem is with the curriculum as set by the ITO. The initiative was useful because it highlighted the lack of emphasis on calculations – due to the training nature of the Unit Standards. In the past tutors have typically relied on two or three calculations whereas now we need a better understanding of maths. What was interesting was the different styles people have been taught. It made me realise that we need to learn different ways of doing these. What my daughter is bringing home from primary numeracy is helpful. My role is theory material so since the initiative I’ve introduced numeracy into all lessons so we’re able to swing it with the trade material.

I have rewritten the course booklet and highlighted calculations from the initiative. I’ve given this to another tutor to trial with his class. The next thing is to give it to other tutors to trial. I’ve also given it to a mature student for a student’s point of view. The workbook has been rewritten and trialled (not distance but could be). The initiative has led to a similar way of writing this. We’ve assumed things in the past. We expected the students to be at a particular level so testing provided surprises. The surprises were around seeing the wide range of abilities in terms of numeracy and the language was enlightening. What has changed is to go back to basics. We’ve created a glossary of technical terms. There is the technical language. In the calculations we are expecting them to know both the technical language and the mathematical language. We build on lessons from a lower base. We allow these to be used flexibly. The structure is there, but you don’t need to start from the beginning and follow the sequence. Previous to the initiative we had assumed that students knew the terms. We assumed that they had done 5th form maths but when we gave them the assessment we saw them counting on their fingers under the table. Previously we didn’t realise the broad spectrum within a class. So we have now devised a test for tutors to use initially in class to assess the baseline. Previously we didn’t assess initially as they had been accepted into the course. It is going to evolve more as other tutors use it and iron out the pitfalls. It is good because it highlights the differences between students. It is very

difficult to have a set programme to present as it is so difficult to move at the right pace for everyone. However, we have generally done really well. And all are very positive.

My area has always been innovative. We see something good so we adopt it straightaway so often we are ahead of other divisions. For us at the institutional level there has been minimal change.

Sometimes with our area the numeracy is higher than for other areas.

Other tutors talked about the impact on the assessment of students in their area.

The three tutors (in our area) working with the maths assessment have adapted the assessment tool so we have two initial assessments to divide them into two groups and then into a middle group. The developer worked with us on this. The initiative brought up questions that got us to think about our initial assessment.

The issue of what we're saying is important because it doesn't match what we do in assessment. We're now pushing that we should have in our assessment some numeracy issues. Now schools are pushing for numeracy standards and that students do without a calculator.

Perspectives of the Managers and Developers

In response to being asked to describe the actions taken within their organisation to support the professional development in the period January to June 2007, the manager noted that tutors in their area had a reduced teaching load.

In terms of structures or systems that had been put in place within the organisation to help tutors implement the professional development with their classes, the manager noted "greater liaison with the numeracy tutor" and also noted "casual meetings with others in the team in their area". Another manager noted:

Just asking tutors to change their performance may not do anything, but if they see the results from evidence then we can track progress. We changed the basic team structures to practical delivery, theory delivery, and assessment delivery. It is driven by the assessment team. We have got to focus on a problem then we need to do something about it.

All of the managers who were interviewed talked of making substantial changes to their courses as a result of their organisation's participation in the Adult Numeracy Initiative. As one manager explained:

It is the first time as a department that we have been involved in a programme, so we decided to continue to the next phase – this was a unanimous decision by all the staff. We all feel that we need to be using proven methods. Starting right now we are redesigning the

level 3 and 4 programme to incorporate numeracy as well as other things. We still need to be working across our school. We need to have more in our tool kit for numeracy. The time to develop our tool kit is what we'll focus on now. We're in it for the long haul because it is essential for students if they want to go on to higher learning, and it's integral to have the base there first.

We're going to make huge changes to the bottom level courses – the entry – and I'm very worried about getting the other tutors on board. As a course leader and as a maths teacher who has been content focused, now I'm refocusing on learner development. I'm trying to put it all together. I want learners to be empowered through numeracy strategies and this needs to be explicitly taught. Taking time out to be really explicit. The rest of the tutors, I've spent the term pointing out the numeracy issues – what students don't understand when you teach maths – and they need to put these all together. We're making the move to have people who are interested in looking at the numeracy needs of their students. They need to know a few things themselves about numeracy, for example, how numbers operate, work together. You're not going to change anything unless people understand.

One of the developers also noted that:

One area began to look at their programme, their own procedures, and in phase 2 began to embed the progressions, but that there were some difficulties because of time. Another area looked at the way they taught calculations and shifted to an emphasis on understanding the concept and using materials. In terms of understanding the underlying numeracy they clearly recognised that there was a gap between that and what is required of them in terms of calculations.

Developers generally felt that there had been few new barriers to the organisations' successful participation in the professional development in the period January to June 2007. However, they noted the following barriers:

Not in one of the areas. Difficulty in obtaining staff in the other area so tutors in cluster were unable to be easily given the time required to work on the initiative. It may be a better model to negotiate school by school for Unitec.

Not really aware of any from a Unitec standpoint, other than the loss of the person who originally organised this.

In terms of collaboration that might have been developed with other tutors within the organisation, one developer noted:

This assumes pathways are established and maintained, between contributing sections within the organisation.

I do think some collaboration has developed within one part of the organisation in that they recognised they have similar issues around numeracy and can share ideas about dealing with it.

The manager and developers agreed that because Unitec was a single-site cluster it was unlikely that the professional development had fostered collaboration with tutors and managers from other organisations. The manager noted “we haven’t met with other managers from other organisations”, while the developers pointed out that, “they were all from within one organisation”, and “this cluster was internal, so not really relevant here”.

6. Impact on numeracy teaching

This chapter considers the impact of changes of the Adult Numeracy Initiative on classroom practices of tutors in the Unitec cluster. The perspectives of tutors and developers are included. The research question of relevance to this chapter is:

- To what extent are tutors more able to analyse and use the numeracy demands of courses and the numeracy needs of their learners as the basis for teaching decisions?

Perspectives of Tutors

Tutors reported that the most significant changes that they had made to their numeracy teaching since the start of the project included,

Group students in my class in levels of strategy as per outcome of numeracy assessment.

I make fewer assumptions about what students already know.

I take a lot more time and assess constantly to ensure that they have a good grasp.

When asked specifically about the period January to June 2007, tutors described their most significant changes as:

Exploring methods of teaching to raise strategy levels.

I make more effort to create a context for the mathematics that is taught.

I take it a little slower.

When asked to elaborate on items in which tutors indicated “considerable change”, one tutor noted that they had, “devised initial assessment to suit their students to group them at beginning of each year and to monitor students' numeracy”. They said that they had been “modifying the tool with input for all tutors as they just used the basic facts before”.

Many of the tutors described the different approaches that they had tried. These included the following:

I have always taught in groups, but now it is about how to move the students on. All the students have an opportunity to participate. Now I'm asking them all to think about it and the students can see there are many different ways to solve a problem so that's okay.

There are new ideas of how to teach it that I haven't heard of before, for example, the number line – $18 + 10$. 18 is almost 20, so plus 2. I'll know I'll use that.

I used powerpoint to do GST. Blocks of chocolate 10×10 is 100 squares. Divide it in half and do the maths, divide in quarters then divide in half again – $12 \frac{1}{2}$. $12 \frac{1}{2}\%$ of 100. 100 divide by 8. Then apply it to GST. GST's added – got $9 \frac{1}{2}$ 12 $\frac{1}{2}$ s. Divide by 8 and add it. Divide by 9 take it away. So light bulbs went on. Given the basic idea as a team to develop a strategy and we developed that.

I got tips – this method would work for this. I would have liked more of this. For me personally there has been minimal impact on teaching practice apart from a few different ways of doing things which I might use. My maths is pretty good anyway.

In terms of introducing it into courses, I noticed a difference between students just out of school – they think about why do I need this? – just use a calculator - and the older students who thought it is not good to use a calculator.

My approach has changed as it is now more geared to thinking about how they think. It is very geared to everyday life skills.

I have applied the ideas, for example, I'm now giving them an exercise which requires them to use graphs to represent two or three magnetic fields. Whereas before I would have just told them that the currents produce a magnetic field. The initiative has helped me to think about ways of representing physical and mathematical ideas.

In describing the changes they would make, tutors mentioned using the assessment tool introduced through the professional development.

The assessment tool was very helpful. When I did the testing I could understand what I'm testing for. It is more *how* they think about concepts. It's easy to follow – the phrasing is very good.

In particular it helped because I could ask them about their thinking. I took more note of what was in their head. They took a while to explain themselves. It was helpful because it was not just one way - but a range of ways that enabled me to meet their needs.

The tool was very helpful because I could pitch my lessons because I knew where they're at.

Perspectives of Managers and Developers

The Unitec manager perceived that the greatest change in tutors' numeracy teaching as a result of the professional development in the period January to June 2007 was "greater awareness of the numeracy needs in our learners".

Developers believed that tutors had made considerable changes to their numeracy teaching during the same period. They described these changes as:

People have been explaining the Adult Numeracy Initiative to others in their sectors and therefore have had to bring people up to speed with what has been going on.

Teaching for understanding and using concrete materials.

One of the most important changes identified by developers was a shift of focus – “Now there is much more of a focus on the learner, rather than on the content and that’s incredibly powerful”. One noted that “there is a willingness to not be process based, but whether people teaching did follow the initiative’s approach I don’t know”.

That shift of focus included changes to assessment practice. As one of the developers commented,

Going to your learners and asking “the basics” has revealed things that they don’t know. Just knowing where your learners are at is worth volumes. They got the message that it is important to know where students are at.

However, there are challenges with the timeframe of the courses offered as one of the developers explained:

The nature of their programmes means that it is challenging to fully assess learners as they only had four weeks. We need to do some thinking around, a) how is the assessment used in this context, and b) how to bridge the gap between content, calculations and the underlying approach to numeracy. They all were willing, but there are issues around the practicalities of administering the assessment tool in the manner that was meant.

7. Numeracy outcomes for learners

Performance and Progress of Learners on the Number Strategy Learning Progressions

This section of the chapter investigates the performance of the learners on the three number strategy learning progressions. Number strategies are the mental processes learners use to solve operational problems with numbers. Number strategies can be grouped into counting strategies and partitioning strategies. Counting strategies involve counting in ones to solve problems, often with the support of objects such as fingers. Partitioning strategies are based on using knowledge of number properties to split numbers (partitioning) and combining them in ways that make it easier to reach the solution. In each case the results of the Unitec learners are compared to the January – June 2007 results (Thomas, 2007).

Additive Strategies Progression

The additive strategies progression investigates the strategies that learners use to solve addition and subtraction problems. Table 4 presents the results of the Unitec learners with two assessment points on this progression.

Table 4 **Performance of learners with two assessments on the additive strategies progression**

Step	Unitec Cluster	
	Assessment 1	Assessment 2
1	23%	10%
2	43%	47%
3	10%	7%
4	20%	13%
5	3%	17%
6	0%	7%
n	31	31

Table 4 shows that the percentage of Unitec learners who have reached the level of competence (steps 4 and above) increased from 23% to 37%. This compares with the overall results for the period from January to June 2007 of 54 to 70 percent. These learners “solve multi-digit addition and subtraction problems, using partitioning strategies or alternatively justify the reasonableness of answers to problems solved using a calculator or algorithm” (TEC, 2006, p.38). At the lower end of the progression, the percentage of Unitec learners still at the lowest step and exclusively using counting strategies dropped from 23 percent at the first assessment and 10 percent at the second assessment compared to those in the January to June 2007 phase results of 3 percent to 1 percent.

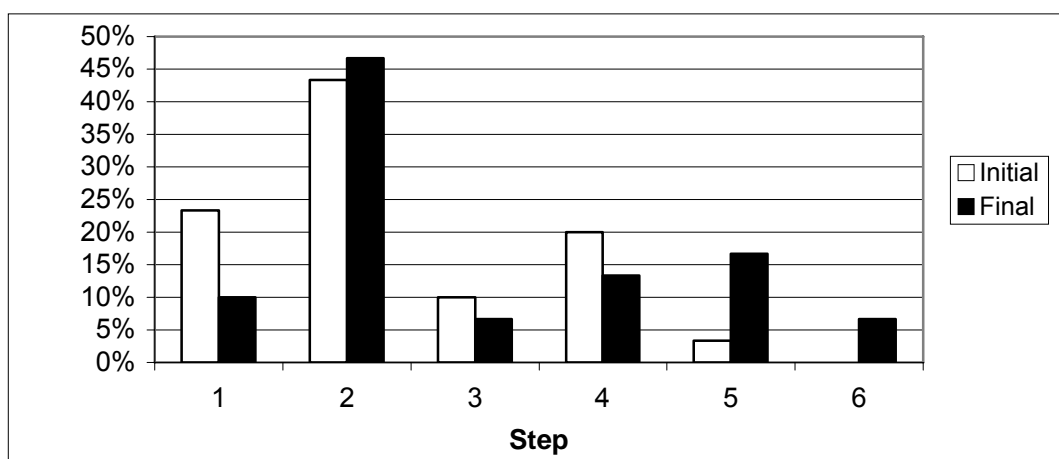


Figure 3 **Performance of learners with two assessments on the additive strategies progression**

Multiplicative Strategies Progression

The multiplicative strategies progression investigates the strategies that learners use to solve multiplication and division problems. Table 5 presents the results of the Unitec learners with two assessment points on this progression.

Table 5 **Performance of learners with two assessments on the multiplicative strategies progression**

Step	Unitec Cluster	
	Assessment 1	Assessment 2
1	26%	11%
2	37%	37%
3	22%	19%
4	15%	19%
5	0%	15%
6	0%	0%
n	31	31

Table 5 shows that the percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the multiplicative strategies progression increased from 15 to 34 percent. This compares with the overall results for the period from January to June 2007 of 51 to 68 percent. These learners are able to “solve multiplication and division problems with single-digit multipliers and divisors mentally, using partitioning strategies and deriving from known facts” (TEC, 2006, p. 39). At the lower end of the progression, the percentage of Unitec learners still at the lowest step and exclusively using counting strategies dropped from 26 percent at the first assessment and 11 percent at the second assessment compared to those in the January to June 2007 phase results of 7 percent to 2 percent.

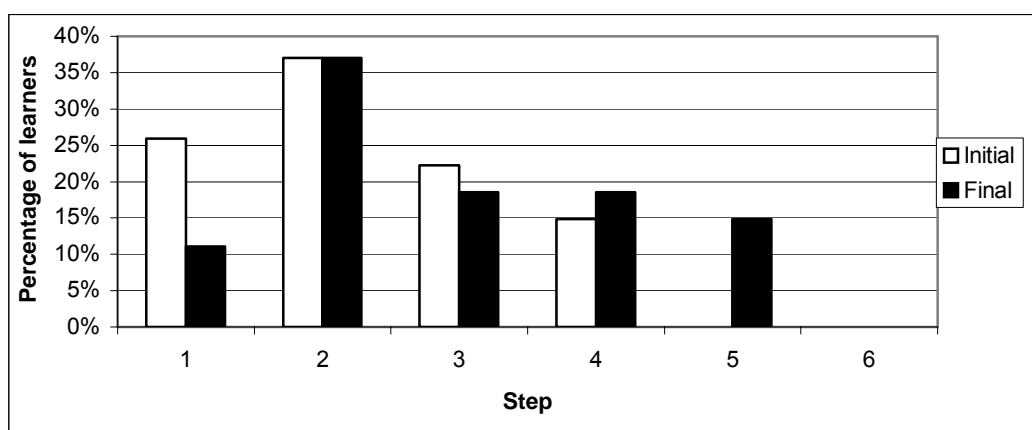


Figure 4 **Performance of learners with two assessments on the multiplicative strategies progression**

Proportional Reasoning Strategies Progression

The proportional reasoning strategies progression describes the strategies that learners use to solve problems involving ratios and proportions. Table 6 presents the results of the Unitec learners with two assessment points on this progression.

Table 6 **Performance of learners with two assessments on the proportional reasoning strategies progression**

Step	Unitec Cluster	
	Assessment 1	Assessment 2
1	11%	0%
2	33%	22%
3	0%	0%
4	44%	67%
5	11%	11%
6	0%	0%
n	31	31

Table 6 shows that the percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the proportional reasoning strategies progression increased from 55 to 78 percent compared to the overall results for the period January to June 2007 of 45 to 62 percent. These learners are able to use “known multiplication and division facts to find fractions of a whole number” (TEC, 2006, p. 40). At the lower end of the progression, the percentage of Unitec learners still at the lowest step and unable to use partitioning strategies decreased from 11 to 0 percent compared to the overall results of 30 to 16 percent.

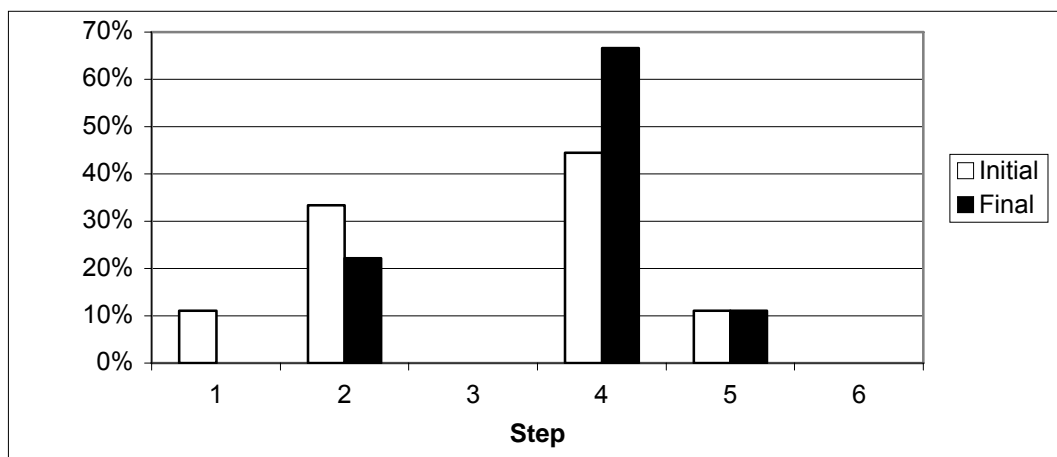


Figure 5 **Performance of learners with two assessments on the proportional reasoning strategies progression**

Performance and Progress of Learners on the Number Knowledge Learning Progressions

This section of the chapter investigates the performance of the learners on the three number knowledge learning progressions. Number knowledge describes the key items of knowledge that learners are able to recall immediately. Development of number knowledge is important as the immediate recall of knowledge is fundamental to allowing learners to apply more sophisticated strategies when operating with numbers. In the number knowledge assessment learners are rated at the stage at which they can answer questions with fluency and certainty.

Number Sequence Progression

The number sequence progression investigates learners’ ability to identify numbers before and after a given number. At the higher steps learners are asked to identify numbers ten, one hundred or one thousand more or less than a given number, and to order fractions and decimal numbers. Table 7 presents the results of the Unitec learners with two assessment points on this progression.

Table 7 **Performance of learners with two assessments on the number sequence progression**

Unitec Cluster		
Step	Assessment 1	Assessment 2
1	13%	6%
2	26%	19%
3	29%	26%
4	29%	29%
5	3%	19%
n	31	31

Table 7 shows that the percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the number sequence progression increased from 32 to 48 percent compared to 53 to 74 percent for the overall results from the period January to June 2007. These learners are able to give the number one, ten, one hundred, one thousand, one tenth, or one hundredth before or after a given number, and to order unit fractions.

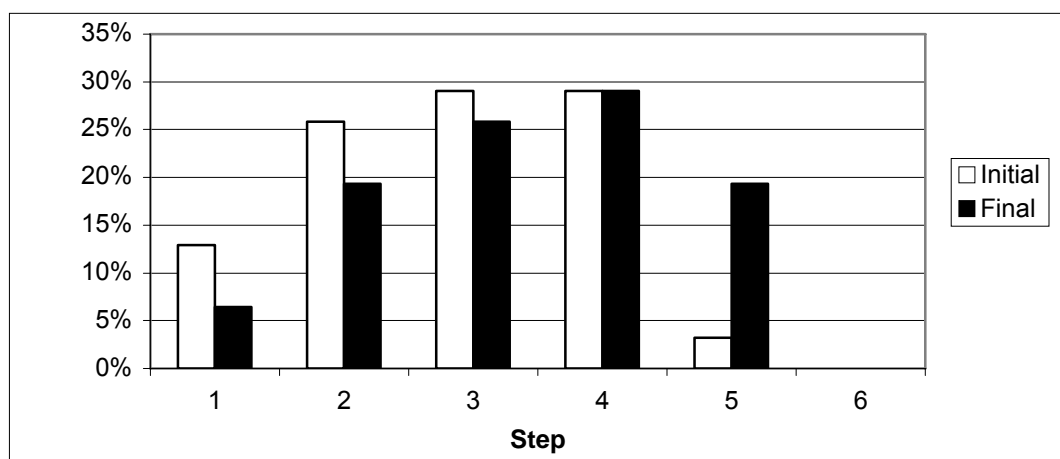


Figure 6 **Performance of learners with two assessments on the number sequence progression**

Place Value Progression

The place value progression investigates learners' ability to partition whole numbers and decimals using their place value. Table 8 presents the results of the Unitec learners with two assessment points on this progression.

Table 8 **Performance of learners with two assessments on the place value progression**

Unitec Cluster		
Step	Assessment 1	Assessment 2
1	37%	10%
2	13%	30%
3	40%	50%
4	10%	10%
5	0%	0%
n	31	31

Table 8 shows that the percentage of the Unitec learners who have reached the level of competence (steps 4 and above) on the place value progression had remained the same at 10 percent compared to that of the overall results from January to June 2007 of 23 to 39 percent. These learners are able to identify the number of tens or hundreds in a whole number and understand that 10 tenths makes a whole.

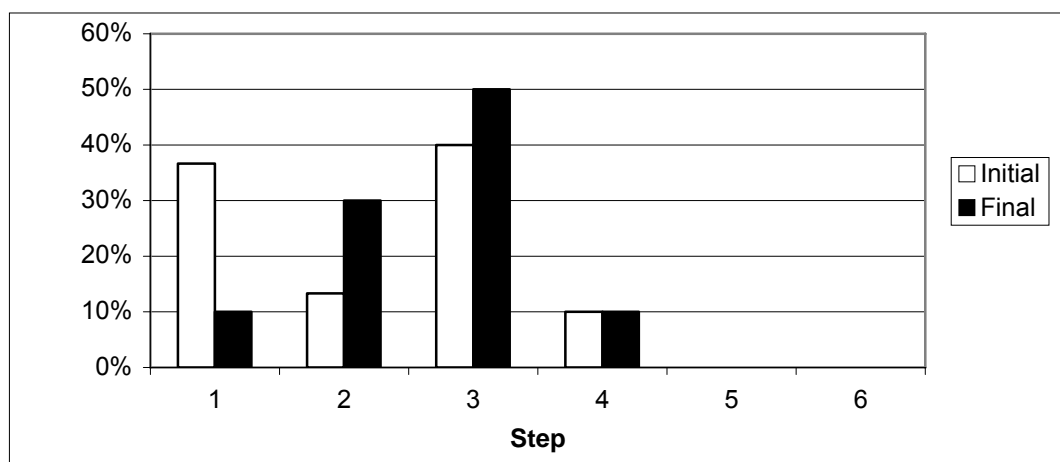


Figure 7 **Performance of learners with two assessments on the place value progression**

Number Facts Progression

The number facts progression describes learners' ability to recall basic number facts. Table 9 presents the results of the Unitec learners with two assessment points on this progression.

Table 9 **Performance of learners with two assessments on the number facts progression**

Step	Unitec Cluster	
	Assessment 1	Assessment 2
1	52%	39%
2	26%	29%
3	16%	19%
4	3%	0%
5	3%	13%
n	31	31

Table 9 shows that the percentage of learners who have reached the level of competence (steps 4 and above) on the number facts progression at the second assessment increased from 6 to 13 percent compared to the overall Phase 1 results of 34 to 38 percent. These learners are able to “recall the basic multiplication facts with tens, hundreds and thousands, and fraction and decimal groupings that make 1” (TEC, 2006, p.43).

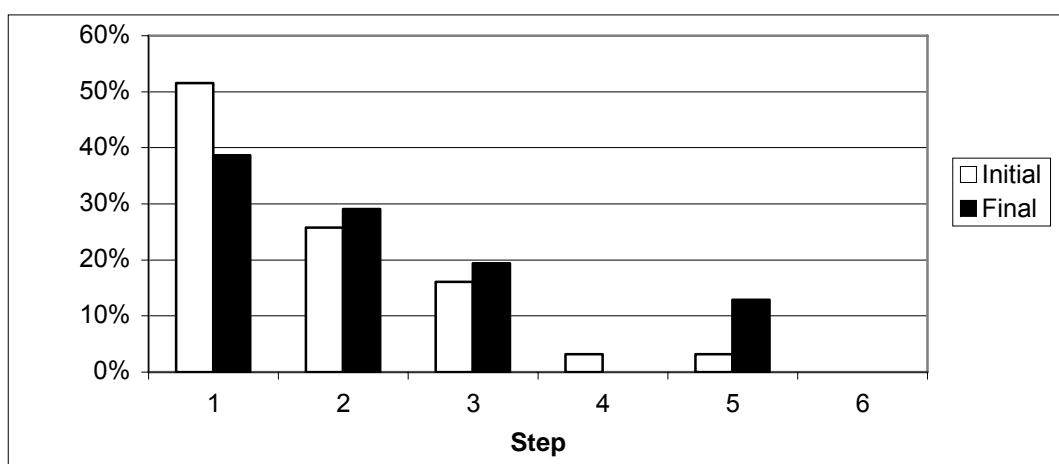


Figure 8 **Performance of learners with two assessments on the number facts progression**

Comparisons of the results

The final two graphs (Figures 9 and 10) compare the results from the Unitec cluster with the overall results for the period January to June 2007 across the numeracy progressions.

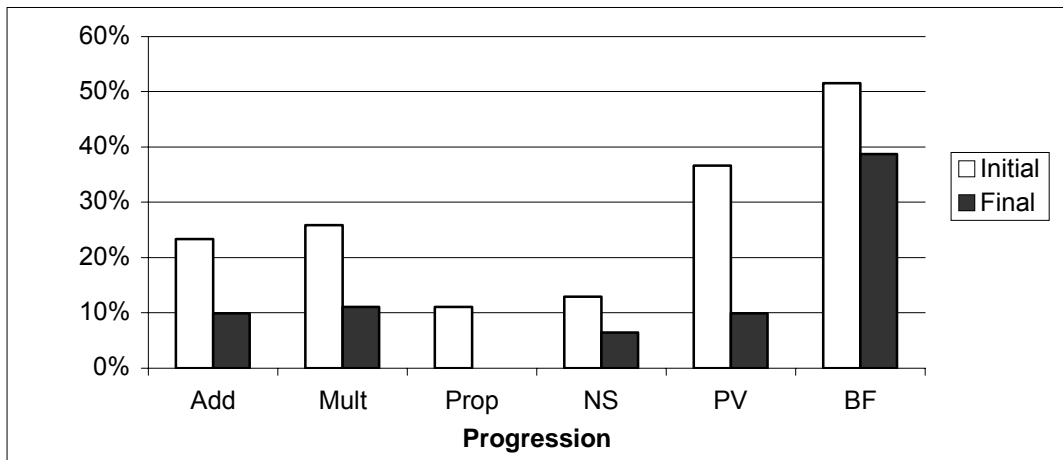


Figure 9 Results from the Unitec cluster

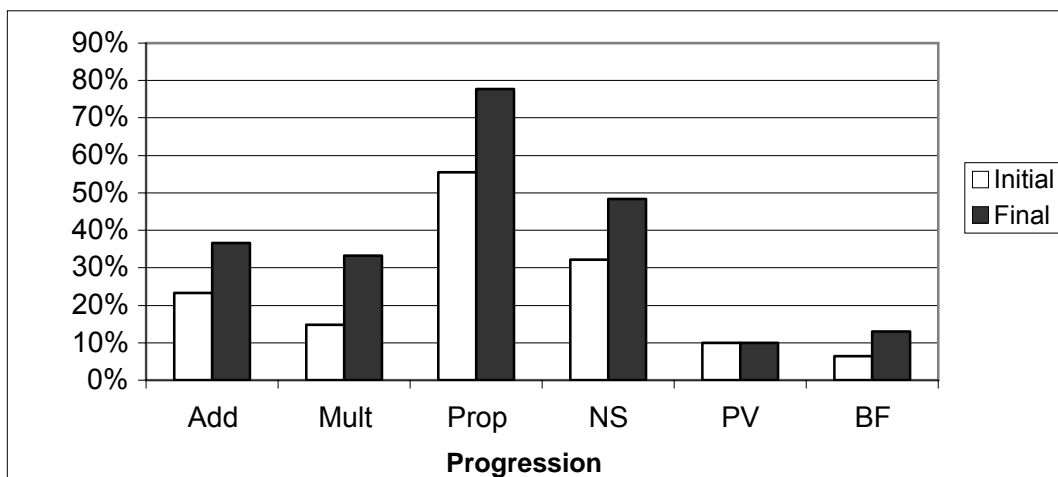


Figure 10 Results from all Numeracy clusters for the period January – June 2007

Perspectives of the Tutors, Managers and Developers

Tutors, managers and developers felt that many to most learners needed help to meet the numeracy demands of the courses. However, the tutors mostly believed that many to most of the learners improved their numeracy over the course. Tutors cited the following evidence:

Assessment done at beginning 2007 showed that three of eleven students fully retained their numeracy over the holiday break (11 weeks), two students improved, two reverted to initial testing results (2006), and four students partially retained numeracy.

Hope to see more pass their courses. (Awaiting results).

I have reassessed all of them just last week and over the past two weeks they have been wanting more calculations, as opposed to the start of the project where they were very apprehensive about the whole thing. Our apprentices come in for two week block courses three times a year.

Informal evidence (observation) and test results.

I was very surprised that some students moved up a stage and how they had retained the information over the holidays. So the assessment tool was good for us because we could test their retention over the holidays, and use the assessment tool at the beginning and we can see where they're at in terms of the strategy stage.

The group that I did most interviews with (and I had in the first year) made a noticeable shift in their maths.

The impact on students is outstanding. The tool has helped ascertain where students are at. In the second year students wanted more calculations at the end, whereas in the first year the same students showed no interest.

Some students even got bad results on the knowledge test and wouldn't do the interview. They were either embarrassed or arrogant. They found English hard. For example they didn't recognise the word "divisible" – "is 34 divisible by 3 Yes/No. Their command of English where they are ESL is not strong. I had the question on powerpoint so it was good to identify students with maths problems and get them help. The knowledge test has been valuable by giving us a baseline – particularly for the level 2 certificate. Another tutor has done some research which shows that if students don't have NCEA level 1 maths then they have a 80% chance of passing the certificate and vice versa. There may be 4 to 5 people who we can help with low maths.

We all agree that there is quite a lot of work to do and it has provided a focus. We had expected a bigger improvement than there has been. The students have spikey profiles – for example they could factorise a quadratic, but can't put decimals numbers in order from smallest to largest. What an earth is going on when students can factorise quadratics, but have no place value? What do we do with these students?

I still can't gauge the impact on the students as I'm not teaching them numeracy at the moment. We are dependent on their co-operation. Students are a bit reluctant to come to the interview – there are very few volunteers. Next semester I'll be trying with a different lot of students.

8. Key findings of the Unitec Numeracy Cluster

The Unitec cluster was part of the Adult Numeracy Initiative that took place in 2007. The initiative is characterised by several important aspects that include the use of a research-based framework to describe progressions in numeracy learning; an associated individual diagnostic interview to assess learners' mathematical thinking; an intensive programme of professional development for tutors; the systematic gathering of learner achievement data; and the evaluation of shifts in tutors' knowledge and practice. The report describes the impact of the project from the perspectives of learners, tutors, managers, and developers. The following bullets are the key findings for the different aspects of the initiative.

Effectiveness of the Professional Development

- The most highly rated aspects of the professional development were the cluster meetings. The most effective aspect of the cluster meetings at supporting change from the perspective of the tutors was the introduction of new learning ideas by developers and other tutors. Particularly mentioned was developing knowledge of the progressions as well as of the assessment tool.
- As in the previous phase a challenging aspect of the professional development was meeting the needs of a diverse group of tutors. This meant that the numeracy needs of courses were diverse across the cluster.
- Managers and developers were also asked what, from their perspective, were the main outcomes of this professional development for the organisation and cluster. An important theme in their comments was embedding numeracy in courses through improving tutor knowledge and modifying course content.
- In terms of outcome of the professional development most important for their institution and cluster, tutors identified improved outcomes for learners and the sharing of information between different schools at Unitec.

Tutors' Knowledge and Practice

- All the tutors specifically referred to learning about the importance of numeracy knowledge and its relationship to learner strategy development.
- In elaborating on their change in emphasis, many responses mentioned the differences to how they had learned maths and the numeracy presented in the initiative.
- The two developers and one manager believed that tutors had developed greater content knowledge of numeracy as a result of their participation in the professional development as well as how to integrate numeracy into their teaching.
- Managers noted that some tutors had shaky mathematical content knowledge.

Institutional Impact

- Most tutors considered that there were no barriers to their successful participation in the professional development. However, some mentioned staff shortages as a challenge to participation.
- Most tutors thought that their organisation had put in place structures and systems to help them implement practices. These structures supported the assessment of students.
- Most tutors, managers, and both developers considered the professional development to have fostered more collaboration with other tutors within the organization particularly in terms of sharing practices or ideas. An important discussion was the balance between context and the mathematical ideas.
- A major impact for many areas was the redesigning of courses as a result of areas of weakness identified through participation in the initiative.

Impact on Numeracy Teaching

- Most tutors monitored the progress of current learners informally and formally throughout the course and used this information in their planning and teaching.
- The major impact on numeracy teaching, from the tutors' perspective, was a shift to identifying learner needs as the basis for teaching decisions. The managers and developers described the shift as focussing on the learner rather than the content.
- Tutors reported trying different representations in presenting everyday numeracy such as calculating GST and perimeter.

Learners

- Overall the Adult Numeracy Initiative has had a positive impact on the learners' use of number strategies and their number knowledge over the evaluation period.
- The percentage of Unitec learners who have reached the level of competence (steps 4 and above) on additive strategies increased from 23% to 47%. This compares with the overall results of 54 to 70 percent. These learners "solve multi-digit addition and subtraction problems, using partitioning strategies or alternatively justify the reasonableness of answers to problems solved using a calculator or algorithm" (TEC, 2006, p.38). At the lower end of the progression, the percentage of Unitec learners still exclusively using counting strategies dropped from 23 percent at the first assessment to 10 percent at the second assessment compared to those in the overall period from January to June 2007 results of 3 percent to 1 percent.
- The percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the multiplicative strategies progression increased from 15 to 34 percent. This compares to 51 to 68 percent for the overall Phase 1 learner results. These learners are able to "solve multiplication and division problems with single-digit multipliers and divisors mentally, using partitioning strategies and deriving from known facts" (TEC, 2006, p. 39). At the lower end of the progression, the percentage of Unitec learners still exclusively using counting strategies decreased from 26 to 11 percent compared to the overall results from January to June 2007 of 7 to 2 percent.
- The percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the proportional reasoning strategies progression increased from 55 to 78 percent compared to the Phase 1 learners of 45 to 62 percent. These learners are able to use "known multiplication and division facts to find fractions of a whole number" (TEC, 2006, p. 40). At the lower end of the progression, the percentage of Unitec learners still unable to use

partitioning strategies decreased from 11 to 0 percent compared to the overall results from January to June 2007 of 30 to 16 percent.

- The percentage of Unitec learners who have reached the level of competence (steps 4 and above) on the number sequence progression increased from 32 to 48 percent compared to 53 to 74 percent for the overall results for January to June 2007. These learners are able to give the number one, ten, one hundred, one thousand, one tenth, or one hundredth before or after a given number, and to order unit fractions.
- The percentage of the Unitec learners who have reached the level of competence (steps 4 and above) on the place value progression remained the same at 10 percent compared to that of the overall results of 23 to 29 percent. These learners are able to identify the number of tens or hundreds in a whole number and understand that 10 tenths makes a whole.
- The percentage of learners who have reached the level of competence (steps 4 and above) on the number facts progression at the second assessment increased from 6 to 13 percent compared to the overall Phase 1 results of 34 to 38 percent. These learners are able to “recall the basic multiplication facts with tens, hundreds and thousands, and fraction and decimal groupings that make 1” (TEC, 2006, p.43).
- Nearly all of tutors believed that their learners’ numeracy had improved. Their evidence of this was often the second assessment compared with the first.

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Appendix A: The Number Framework

Strategy Domains

Additive Domain: Stage Indicator	
0–3	Counting All The learner counts from one to solve addition problems.
4	Advanced Counting The learner's most advanced strategy is counting-on, or counting-back.
5	Early Additive The learner shows any strategy to solve addition or subtraction problems mentally by reasoning the answer from basic facts and/or place value knowledge.
6	Advanced Additive The learner is able to use at least two different mental strategies to solve addition or subtraction problems with multi-digit numbers.
7	Advanced Multiplicative The learner is able to use at least two different mental strategies to solve addition or subtraction problems with decimals and simple fractions.

Multiplicative Domain: Stage Indicator	
2–3	Count From One The learner solves multiplication problems by counting all of the objects.
4	Advanced Counting The learner solves multiplication problems by skip counting where he/she has a known sequence or by using a combination of skip counting and counting in ones; for example, 5, 10, 15, 20.
5	Early Additive The learner solves multiplication problems by forming the factors where they have a known multiplication fact or using repeated addition; for example, for 5×8 : $5 + 5 = 10$, $10 + 10 + 10 + 10 = 40$.
6	Advanced Additive The learner solves multiplication problems by deriving from known multiplication facts; for example, $3 \times 20 = 60$ so $3 \times 18 = 60 - (3 \times 2) = 54$.
7	Advanced Multiplicative The learner is able to use at least two different mental strategies to solve multiplication and division problems with whole numbers.
8	Advanced Proportional The learner is able to use at least two different mental strategies to solve multiplication and division problems with decimals and fractions.

Proportional Domain: Stage Indicator	
1	Unequal Sharing The learner is unable to find a fraction of a number by sharing of the objects into equal subsets.
2–4	Equal Sharing The learner finds a fraction of a number by sharing the objects into equal subsets.
5	Early Additive The learner finds a unit fraction of a number mentally using trial and improvement with addition facts; for example, $\frac{1}{3}$ of 12 as $4 + 4 + 4 = 12$.
6	Advanced Additive The learner finds a fraction of a number mentally using a combination of addition facts and multiplication.
7	Advanced Multiplicative The learner finds a fraction of a number using division and multiplication. The learner understands the relationship between decimal numbers and tenths and hundredths; for example, 5.89 contains 589 hundredths.
8	Advanced Proportional The learner uses at least two different strategies to solve problems that involve equivalence with and between fractions, ratios, and proportions.

Knowledge Domains

Forwards and Backwards Number Word Sequence: Stage Indicator	
2–3	Emergent The learner cannot produce the number just before and after a given number in the range 1 to 100 without dropping back.
4	FNWS and BNWS up to 100 The learner can produce the number just before and after a given number in the range 1 to 100 without dropping back.
5	FNWS and BNWS up to 1000 The learner can produce the number before and after a given number in the range 1 to 1 000.
6	FNWS and BNWS up to 1 000 000 The learner can produce the number before and after a given number in the range 1 to 1 000 000.

Fractional Numbers: Stage Indicator	
2–3	Unit Fractions Not Recognised The learner cannot write symbols for unit fractions.
4	Fractions Recognised The learner can write unit fraction symbols.
5	Ordered Unit Fractions The learner can compare unit fractions.
6	Co-ordinated Numerators and Denominators Describes the size fractions with reference to both the numerator and denominator; for example, the fraction $\frac{8}{6}$ is one whole and two-sixths.
7	Equivalent Fractions Names equivalent fractions.
8	Ordered Fractions Orders fractions with unlike denominators and numerators.

Place Value: Stage Indicator	
2–3	One as a Unit The learner finds the total number of objects in collections by counting all of the objects by one. He/she does not use ten as a counting object.
4	Ten as a Counting Unit The learner uses ten as a counting unit, knows the tens in numbers to 100; for example, six tens are sixty and recognises the place value of digits in whole numbers to 999.
5	Tens in Numbers to 1 000 The learner knows how many tens are in numbers to 1 000 and orders numbers to 10 000.
6	Tens, Hundreds, and Thousands in Any Whole Number The learner knows how many tens and hundreds are in any whole numbers, orders any set of whole numbers, and recognises that ten tenths make one.
7	Tenths in Decimals/Ordered Decimals The learner knows how to order decimals to three places; for example, 0.39, 0.478, 0.8.
8	Decimal Conversions The learner knows how many tenths, hundredths, and thousandths are in decimals, and can identify decimals between others. The learner names a percentage as a decimal and vice versa; for example, 137.5% as 1.375.

Basic Facts: Stage Indicator	
0–1	Non-grouping with Five The learner is unable to recall instantly groupings within five and within ten.
2–3	Within and with Five, within Ten The learner instantly recalls groupings within, and with five; for example, nine is five and four, and groupings to ten; for example, ten is three and seven.
4	Addition with Tens and Doubles The learner recalls doubles to 20, and “teen” facts; for example $14 = 10 + 4$.
5	Addition Facts The learner recalls the basic addition facts and the multiplication facts for 2, 5, and 10.
6	Subtraction and Multiplication Facts The learner recalls the basic subtraction and multiplication facts.
7	Division Facts The learner recalls the basic division facts, and names all the factors of numbers up to 100.

Appendix B: Diagnostic Assessment

Strategy Interview

The questions that the tutor reads out loud to the learner are in bold. These questions are written down and shown to the learner as they are read. Comments for the interviewer appear in italics.

Addition and Subtraction

- 1. What is $8 + 5$?**
If the learner was unable to solve $8 + 5$ correctly or used a “counting from 1 strategy” rate them at stage 0–3. If the learner solves the question using a strategy proceed to (3). If the learner solves the question by counting on or if the learner obviously recalls it as a basic fact proceed to (2) as this may provoke thinking.
- 2. What is $29 + 7$?**
If the learner was unable to solve $29 + 7$ correctly or used a “counting from 1 strategy” rate them at stage 0–3. If the learner solves the question by counting on or if the learner obviously recalls it as a basic fact proceed to (3) as this may provoke thinking.
- 3. You have 37 chocolates and you eat 9 of them. How many have you got left?**
If the learner used any partitioning strategies for either (1) or (2), but counted back to solve (3), rate her/him at stage 5. If the learner used a partitioning strategy on (3) proceed to (4).
- 4. There are 53 people on the bus. 26 people get off. How many people are left on the bus?**
If the learner fails to solve this question correctly rate the learner at stage 5. If the learner successfully solves the problem by imaging a standard written method, ask “Can you do that in a different way?” and if she/he is unable to provide an alternative strategy, ask them to explain how the written method works. Regardless, proceed to (5).
- 5. Sandra has 394 raffle books to sell. Her brother gives her another 79 books. How many raffle books does she have to sell?**
If the learner gets both (4) and (5) correct using part/whole strategies proceed to (6). Otherwise rate the learner at stage 5.
- 6. Maria has a 5.3 metre length of fabric. She uses 2.89 metres of it to make a tracksuit. How much fabric has she got left?**
Regardless of the learner’s answer proceed to (7).
- 7. Harry and Sally buy two pizzas. Harry eats $\frac{3}{4}$ of a pizza and Sally eats $\frac{7}{8}$ of a pizza. How much pizza is left over?**
If the learner gets both (6) and (7) correct using partitioning strategies, rate him/her at stage 7 for addition and subtraction. Otherwise rate the learner at stage 6.

Multiplication and Division

8. Robert has 8 five-dollar notes in his wallet. How much money does Robert have altogether?
If the learner was unable to solve 8×5 correctly or used a "counting from 1 strategy" rate them at stage 2–3. If the learner solves the question by skip-counting, rate her/him at stage 4. If the learner uses an additive strategy or knows the basic fact proceed to (9) and (10).
9. What is 3×20 ?
Screen the answer to 3×20 until learner responds correctly.

*So, if $3 \times 20 = 60$, what is 3×18 ?
If the learner answers correctly using a strategy proceed to (10).*
10. What is 5×8 ?
Screen the answer to 5×8 until learner responds correctly.

*So, if $5 \times 8 = 40$, what is 5×16 ?
If the learner does not derive the answers to both (9) and (10), rate him/her at stage 5. If she/he does derive the answers to (9) and (10) proceed to (11) and (12).*
11. A shop has 6 baskets of muffins for sale. There are 24 muffins in each basket. How many muffins are there altogether?
Where the learner images a written algorithm no assumption can be made about their stage. Question the learner about their understanding of the processes involved in the algorithm and what other strategies they could use to solve the given problem. If the learner fails to solve this problem correctly using a strategy rate the learner at stage 6. Otherwise, proceed to (12).
12. At the car assembly plant they use 4 lights to make each car. How many cars can they make with 72 lights?
If the learner correctly solves both (11) and (12) using two or more different part/whole strategies rate the learner at stage 7 and proceed to (13) and (14). Otherwise, rate the learner at stage 6.
13. Ian has 2.4 kilograms of mince. Each pattie takes 0.15 kilograms of mince. How many patties can Ian make?
Regardless of the learner's answer, proceed to (14).
14. On a kayaking trip 26 litres of water is shared equally among the 8 people on the trip. How many litres of water does each person get?
If the learner correctly solves both (13) and (14) using two different part/whole strategies, rate the learner at stage 8. Otherwise, rate the learner at stage 7.

Proportions and Ratios

15. 12 candles are spread evenly on top of a birthday cake. You are given one-third of the cake. How many candles are on your piece?
If the learner cannot solve the problem mentally, ask if they want to use pen and paper. Rate them at stage 1 or stage 2–4 as appropriate. If the learner solves the problem mentally proceed to (16).
16. What is $\frac{3}{4}$ of 28?
If the learner cannot solve the question correctly rate them at stage 5. Otherwise, proceed to (17).
17. A shop is selling jeans with 15% off. You buy a pair that originally cost \$70. How much do you save?
If the learner cannot solve the question correctly rate them at stage 5. Otherwise, proceed to (18).
18. 12 is $\frac{2}{3}$ of a number. What is the number?
If the learner cannot answer the question correctly rate them at stage 6. Otherwise, proceed to (19).
19. There are 21 men and 14 women in Ana's cultural group. What percentage of Ana's cultural group are men?
If the learner cannot solve the problem correctly rate them at stage 7. Otherwise, proceed to (20).
20. It takes 10 balls of wool to make 15 hats. How many balls of wool does it take to make 6 hats?
If the learner correctly solves both (19) and (20) using two or more different part/whole strategies rate the learner at stage 8. Otherwise, rate the learner at stage 7.

Knowledge Questions

These questions are asked of the whole class. The questions are presented on overheads to the class and the learners are instructed to answer all that they can in the 1–2 minutes of time allocated. If the items are read to the students, reveal each for approximately three seconds. Learners write their answers on a supplied sheet.

Forwards and Backwards Number Word Sequence

1. What number is one more than 9?
2. What number is one less than 16?
3. What number is one more than 89?
4. What number is one less than 50?
5. What number is one more than 499?
6. What number is one less than 840?
7. What number is one more than 989 999?
8. What number is one less than 603 000?

Fractional Numbers

9. Write one half as a fraction.
10. Write one sixth as a fraction.
11. Which of these fractions is the smallest?
 $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{6}$
12. Which of these numbers is the same as eight sixths?
 $\frac{6}{8}$, $1\frac{2}{6}$, 1, $\frac{2}{14}$
13. Which of these fractions is the same as two thirds?
 $\frac{2}{6}$, $\frac{6}{8}$, $\frac{8}{12}$, $\frac{9}{12}$, $\frac{3}{9}$
14. Which of these fractions is the smallest?
 $\frac{2}{5}$, $\frac{3}{10}$, $\frac{5}{16}$

Place Value

15. A CD player costs \$80. How many \$10 notes do you need to pay for it?
16. Which of these numbers is the largest?
488 620 602 448
17. Which of these numbers is the smallest?
4 650 5 046 5 406 4 506
18. A radio costs \$270. How many \$10 notes do you need to pay for it?
19. You have this amount of money (\$2 408 000) in \$1000 notes. How many notes do you have?
20. Which of these numbers is the smallest?
352 097 90 325 79 532 297 320
21. What number is three tenths more than 4.8?
22. What number is one million more than 1.4m (or 1.4 million)?
23. What number is one thousand less than 690k (or 690 thousand)?
24. Which of these numbers is the smallest?
0.478 0.8 0.39
25. In this number (78.912) the 7 is in the tens column. What number is in the tenths column?
26. Write a number that lies between 7.59 and 7.6?
27. What is 137.5% as a decimal?
28. 30 times 20 equals?
29. 5 000 divided by 10 equals?
30. 20 divided by 0.1 (or one tenth) equals?

Basic Facts

Say questions (26) to (40) out loud pausing for three seconds between each one. Display the problem (as written in the brackets) as it is spoken. Show only one problem at a time.

31.	2 plus 3 equals	(2 + 3 = ?)
32.	5 plus 4 equals	(5 + 4 = ?)
33.	6 plus what equals 10	(6 + ? = 10)
34.	9 plus 9 equals	(9 + 9 = ?)
35.	10 plus 4 equals	(10 + 4 = ?)
36.	7 plus 10 equals	(7 + 10 = ?)
37.	5 times 7 equals	(5 x 7 = ?)
38.	17 minus 9 equals	(17 - 9 = ?)
39.	6 times 7 equals	(6 x 7 = ?)
40.	8 times 4 equals	(8 x 4 = ?)
41.	56 divided by 7 equals	(56 ÷ 7 = ?)
42.	63 divided by 9 equals	(63 ÷ 9 = ?)