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Developing Pre-Service Teachers: The Impact of an Embedded Framework in Literacy and Numeracy.

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Abstract: This paper focuses on the development of the academic and personal literacy and numeracy skills of pre-service teachers. It examines how an embedded enhancement framework of literacy and numeracy support named the DEER (Developing, Embedding, Extending, Reflecting) framework by the researchers was created in initial teacher education (ITE) programs in regional Victoria. The implementation of the DEER framework will be discussed and an evaluation of the impact of the DEER framework will be presented. Quantitative data draws on two test results in both literacy and numeracy, comparing the performance of students. These tests were undertaken by pre-service teachers, before and after the implementation of the DEER framework. Effect sizes for the changes in the test results are presented with the effect size for the numeracy testing calculated as 0.99, while the effect size for the literacy testing was 0.75.

Introduction

Amidst considerable national and international debate regarding the literacy and numeracy capabilities of pre-service teachers, Initial Teacher Education (ITE) providers are seeking ways to address this concern. Despite lingering uncertainty about potential pre-service teacher cohorts and how they are to be determined, ITE providers are being urged to select into their programs, pre-service teachers who can demonstrate that their literacy and numeracy competencies are "within the top 30 per cent of the population in personal literacy and numeracy" (Craven et al., 2014, p. xiii). Additionally, national literacy and numeracy testing for undergraduate teaching candidates is now compulsory with the introduction of the Literacy and Numeracy Test for Initial Teacher Education (LANTITE). The pursuit of these objectives is complicated by the varied literacy and numeracy needs of an increasingly diversified student population. Currently, university ITE providers are seeking ways to ensure the literacy and numeracy standards promoted by policy and cultural expectations are met. ITE providers have employed a range of approaches to meet these standards by implementing initiatives that develop pre-service teachers' literacy and numeracy skills. The research discussed in this paper demonstrates the impact of the implementation of a literacy and numeracy framework introduced into an Australian regional University. The paper introduces the DEER framework, exploring the research question "Does the implementation of the DEER framework lead to improved literacy and numeracy results?"

Literature Review

Literacy and numeracy are recognised as key areas of the curriculum which need to be understood by all pre-service teachers. In the next section, literacy and numeracy literature that examines a range of approaches that enhance pre-service teachers' personal and academic skills will be reviewed.

Literacy

Discourses about literacy standards proliferate in the political arena, media and wider community, emphasising a deficit view that pre-service teachers do not have the required literacy skills and understandings to successfully support classroom literacy learning (Devereux & Wilson, 2008; Louden & Rohl, 2006). The complex debates in relation to literacy competencies and the importance of accounting for new literacies of the 21st century global world and conflicting stakeholder interests are highlighted by Honan, Exley, Kervin, Simpson and Wells (2013), who question what are deemed as the important literacies required by pre-service teachers teaching in contemporary classrooms. The expanding contexts of literacies need to be addressed as educational institutions move between the traditional skills of reading and writing and new literacies using a range of multimodal texts and digital communication (Honan et al., 2013). Academic literacy skills and personal literacy competence are both important factors for pre-service teachers entering University and successfully completing their programs. Some pre-service teachers might commence their studies without the required literacies to successfully engage with and complete their program (Moles & Wishart, 2016) and may lack the confidence to seek clarification of expectations (Moles & Santoro, 2013). Academic literacies can be defined as a set of practices that include critical thinking and reading; using a range of genres; the appropriate register when writing, considering the field, tenor and mode; and a range of academic and other language conventions to communicate a specific message (McWilliams & Allan, 2014). Personal literacy competence comprises language conventions such as grammar, spelling and punctuation. Inadequate knowledge of these areas impacts on the capacity of pre-service teachers to provide appropriate instruction in the classroom (Moon, 2014). It is the combination of both academic literacy skills and personal literacy competence that are important in ITE (Moon, 2014). However, as Moon (2014) argued pre-service teachers who choose to work in secondary schools might not see the "professional relevance" (p. 112) of academic and personal literacy competencies as they view "their teaching practice through the lens of subject specialisation" (p. 112). Moon (2014) proposes three dimensions of professional, pedagogical and discipline specific literacies to build pre-service teacher capacities at the secondary level.

The need for pre-service teachers to understand their current skill levels was demonstrated in a study undertaken by Bostock and Boon (2012) who examined pre-service teacher self-efficacy and literacy competence focusing on personal literacy, knowledge of literacy and pedagogical understandings of literacy across all years of a Bachelor of Education degree. Results cited by Bostock and Boon (2012) suggest that although pre-service teachers were initially confident in their literacy capabilities, testing of their competencies did not necessarily match their confidence. Louden and Rohl (2006) espouse that the idea of understanding current skill level (Bostock & Boon, 2012) can be taken further. In their study of graduate teachers in their first or second year of teaching, Louden and Rohl (2006) found that although beginning teachers were confident in their personal literacy skills, they identified gaps in their pedagogical knowledge resulting in less

confidence in their ability to teach specific elements of literacy and cater for a range of students in the classroom.

Literacy Support

Ensuring pre-service teachers are supported in their academic and personal literacy development is a priority for ITE programs when taking into account current government targets and testing regimes (Craven et al., 2014). Multiple approaches are required to ensure pre-service teachers have a comprehensive knowledge of language for effective teaching and learning across a range of literacy experiences (Carey, Christie & Grainger, 2015). The literature mentions some of the approaches used by different ITE providers. One approach used an online learning management system with immediate individual feedback that covered a range of language conventions. Pre-service teachers also engaged with face to face classes that provided further knowledge in teaching techniques with reflective learning opportunities (Carey, Christie & Grainger, 2015). Another approach sought to embed academic literacies across a range of core courses to build pre-service teacher competencies (McWilliam & Allan, 2014; Thies, Wallis, Turner & Wishart, 2014). Identifying and mapping academic literacies and building staff capacity provided initial frameworks to develop pre-service teacher support (Thies et al., 2014). Devereux and Wilson (2008) contend that by mapping assessment tasks and embedding critical reading and writing through support mechanisms across all content areas of ITE programs, pre-service teachers develop their literacy capabilities for effective classroom teaching. A specific focus on isolated aspects of grammar, spelling and punctuation do not appear to be highlighted in any approach to building pre-service teacher competency and confidence in literacies.

The literature has highlighted that high level literacy skills are seen as vital for pre-service teachers to make the transition to teachers. The need for a realistic determination of skill levels (Bartock & Boon, 2012) and the development of professional, pedagogical and discipline specific literacies (Moon, 2014) are seen as crucial to the development of highly literate graduate teachers.

Numeracy

The competence of pre-service teachers in numeracy and mathematics has been widely acknowledged as important in the educational community (Henderson & Rodrigues, 2008; Hine, 2015; Ponte & Chapman, 2006; Young-Loveridge, Bicknell & Mills, 2012). With the recent introduction of the national literacy and numeracy testing in Australia for all pre-service teachers as suggested by a 2014 report into initial teacher education (Craven et al., 2014), it is now more vital than ever that academics in initial teacher education ensure that their graduates are competent in the vital area of numeracy.

This area of numeracy in the university environment can be considered to be academic numeracy practices (Prince & Archer, 2008) or academic numeracy (Galligan, 2013; Galligan & Hobohm, 2013). Prince and Archer (2008) suggest that the word practice is important to associate with academic numeracy as it then implies that academic numeracy practice is more than just mathematics since numeracy is more context driven, while mathematics moves away from context and moves into abstract thinking.

Galligan (2013) highlights the need to embed academic numeracy in university courses and suggests that there are three critical elements to embedding such numeracy. Galligan (2013) suggests that contextual mathematical competence is vital for students studying to be admitted into a particular profession, that students need to be critically aware of their own

knowledge in the mathematical area and that students need to have mathematical confidence. There is also a need to design curriculum for university students that supports academic numeracy by understanding the numeracy skills that students currently have and that identify skills that students are experiencing difficulties in understanding (Galligan, 2013). Academic numeracy is particularly vital in pre-service teachers as potentially they will be working with our young people (Hine, 2015), making it essential that education academics understand the level of competence in numeracy that their learners currently have. This level of numeracy can be determined through testing current skills in a wide range of mathematical areas (Afamasaga-futa'i, Meyer, Falo & Sufia, 2006; Galligan, 2013; Galligan & Hobohm, 2014; Skalicky, Adam, Brown, Caney & Lejda, 2010). Galligan and Hobohm (2014) suggest that the testing that could be used could be in the form of a self-test where students can self-diagnose and determine their own mathematical ability to undertake their undergraduate course. Part of this self-diagnosis included students completing a reflection on each incorrect answer to develop critical awareness of the mathematics that was part of the questions that they were unable to correctly answer (Galligan & Hobohm, 2014). Skalicky, et al. (2010) states that their university uses a self-test in numeracy to allow self-assessment, but that they follow this self-test up with offers of support for students who find themselves struggling with numeracy before requiring students to do another test in a more controlled environment.

Numeracy Support

Research into numeracy support in early childhood, primary and secondary school settings suggest a range of strategies that can be used to enhance numeracy learning. Strategies for such enhancement include using assessment to inform teaching, (Breed, 2012); building connections between school, home and the community to ensure students gain a sense of numeracy in their own community (Goos, 2004), encouraging families to involve children in everyday numeracy activities (Kennedy, 2010) and using ICT based systems of homework to build numeracy capacity in students (Kerawalla et al., 2007). The idea of integrating numeracy across the school curriculum (Goos, Dole & Geiger, 2012) is another strategy that is reported to have positive effects. Such programs can be very beneficial to students, but can be a challenge for teachers with all teachers needing to "take advantage of unplanned numeracy moments", (Goos Dole & Geiger, 2012, p. 6).

Universities have also recognised the need to monitor and support students in the area of numeracy (Afamasaga-Futa'I et al., 2006; Ferrier, 2013; Galligan, 2013; MacGillivray, 2009; Skalicky et al., 2010). Skalicky et al. (2010) highlight that their university investigated the implementation of an elective to support pre-service teacher in Education degrees where testing shows that pre-service teachers are struggling with their numeracy skills. Ferrier's (2013) university took a less formal approach to building the numeracy skills of students studying Life Sciences. Ferrier (2013) reports on numeracy drop in sessions, where students are given a brief introduction to the subject matter and then given some mathematical problems to complete with staff offering assistance to any individual who was still experiencing difficulties. These numeracy drop in sessions were complemented by the availability of an interactive numeracy resource that allows students to further explore particular content and complete interactive questions. Galligan (2013) suggests a university approach which has some similarities to integrating the numeracy approach described by Goos, Dole and Geiger (2012) in the school system. Galligan (2013) espouses that academic numeracy needs to be embedded at three particular levels within a university, these being the program level, the course level and the student and teacher level. To deliver such embedded academic numeracy approach, Galligan (2013) highlights the importance of staff

development and staff working together to ensure a flow of ideas and approaches of delivering numeracy outcomes in all courses. MacGillivray (2009) highlights that universities are using a suite of approaches to supporting learners in critical areas such as mathematics and numeracy including bridging courses in mathematics, drop in assistance centres, sessions or classes on specific topics, diagnostic testing that determines appropriate assistance and then provides same and appointments with academic staff where one to one assistance can be tailored to each students' needs.

Whilst there is no one approach in a university setting that appears to be favoured, it is clear that the demand for learning support in critical areas such as numeracy from students is increasing (MacGillivray, 2009).

After examining the literature, several under-researched areas regarding current literacy and numeracy programs were identified. These included the need to embed academic literacy and numeracy in the university curriculum and the development of support programs that recognise the learners' points of need. While much of the formal literature concerning ITE literacy and numeracy programs opposes the use of a deficit framework (Honan, Exley, Kervin, Simpson & Wells, 2013; Jonsmoen & Greek 2016; McWilliams & Allan 2014; Moles and Wishart 2016; Rosetto & Wilkins, 2015; Thies, Wallis, Turner & Wishart 2014), policies that target teacher education standards and rely on scored selection processes support a deficit view as they focus on standardised testing and results. With the commencement of LANTITE testing within a higher education landscape, in which pre-service teacher populations are increasingly diverse, universities are finding that it is imperative that they establish workable and effective literacy and numeracy programs for pre-service teachers.

University Context

The University where this research was conducted has an open access policy, focusing on the skills that their graduate teachers leave the university with, rather than the score (and associated skills) at the commencement of their university studies. Support for pre-service teachers within the university is high with access to a wide range of both academic and wellbeing services. Lecturers and tutors work closely with pre-service teachers in smaller classroom environments enabling them to understand the learning needs of all pre-service teachers who attend their classes. The support mechanisms in literacy and numeracy have differed slightly. In the next section, the contexts will be discussed separately and then the similarities summarised by the introduction and embedding of the DEER framework.

Numeracy Context

Our university works with all pre-service teachers to develop strong numeracy skills that can be used in the classroom to promote mathematics as an important area that is used constantly in everyday life. All initial teacher education pre-service teachers are required to sit a purpose designed Level 4 Australian Core Skills Framework (ACSF) test. All education students are required to achieve what we call a mastery level of 90% or higher on the numeracy test to be considered classroom ready. The results of testing are discussed with pre-service teachers individually, with a focus on the mathematical thinking rather than showing the pre-service teachers how to get the right answer. If pre-service teachers demonstrate mastery (above 90%) on this purpose designed test, no further direct action is taken and the pre-service teachers complete their course work in mathematics. Tutors examine all test results to determine areas that need to be a focus of tutorials with those who score a mid-

range score (between 80 and 90%) supported through these tutorials. If a pre-service teacher scores lower than 80% on this test, a Numeracy Learning Plan (NLP) is developed in conjunction with the pre-service teacher. This NLP could include the pre service teacher taking extra classes in mathematics, individual or small group support from academic staff and working individually in topic areas that the pre-service teachers' test has shown to be problematic. All pre-service teachers who score less than 90% on this test are re-tested later in their course and any pre-service teacher who does not improve their test scores undertakes further diagnostic questioning to make sure that their mathematical ability has been accurately identified, so that they can be supported in an appropriate manner. In 2016, we aimed to have all initial teacher education students tested with the purpose designed test. It is also envisaged that any 3rd or 4th year initial teacher education students who score less than 80% on the internal test have a Numeracy Learning Plan discussed with them with action that they need to undertake identified. Any pre-service teacher in 4th year who fails the numeracy section of the external test is given additional support to improve skills. At this stage, data indicates that only a very small number of pre-service teachers require additional support.

Confidence in mathematics is another area that is a focus of all of our mathematics curriculum courses, as our staff see confidence in mathematics as a major issue with many of our pre-service teachers. To develop confidence, our pre-service teachers are given hands on materials and asked, in a small group, to devise lessons that use these materials to teach students at particular Victorian Curriculum levels. These lessons are then shared with all members of the tutorial group, where discussion focusses on adapting such activities for students at both higher and lower levels. Test results are discussed, with student being given feedback around the areas that they still need to develop and additional content in these areas is added to tutorials. Mathematical thinking and reasoning are also a focus to ensure that pre-service teachers can develop this thinking and reasoning in their students so that the students can apply mathematical concepts to everyday situations. It is important to note that this paper does not measure change to mathematical confidence, but is seen as an important factor in the DEER framework.

Literacy Context

The ITE program at this University works with all pre-service teachers to develop a deep understanding of academic and personal literacy skills to ensure pre-service teachers are well prepared when they enter the classroom. In the first semester of the first year, all ITE students complete a language conventions and reading comprehension test, based on the Level 4 Australian Core Skills Framework (ACSF). The goal is to reach a mastery level of 90%. Pre-service teachers are provided with individual feedback based on the identified areas of strength and areas that require development. Where further support is required, pre-service teachers can attend opt-in group sessions to work at 'point of need' or attend specific individual support sessions conducted with a member of the academic team or a Learning Advisor. All pre-service teachers then complete another test in the second and third year of the program. The tests are similar in layout and question types but with greater difficulty in the third year of the program. Where further assistance is still required, pre-service teachers are directed to individual support services.

Academic and personal literacies are embedded in core education courses with an emphasis on developing the understanding that literacies form an important part of how we construct meaning and communicate our understandings. Tutorial tasks include a focus on grammar, spelling, and punctuation with specific connections to teaching and learning in educational contexts. The importance of working with language conventions within a broader

context of a range of text types is highlighted using a range of texts as examples for reading and text construction. It is envisaged that pre-service teachers would then transfer their knowledge and understandings to enhance their own literacies and the literacies of the students they teach in schools. Connections are drawn between professional literacy knowledge and discipline specific literacy knowledge to enable pre-service teachers to better understand their own literacy and the literacy required for their discipline area. Other tasks such as personal goal setting to further develop areas of need, ways of reading academic material, reflective writing and assessment construction are embedded into a range of core courses. Increasing pre-service teacher confidence to embed literacies in their own teaching requires a deeper knowledge about language.

A Framework to Develop Literacy and Numeracy

In an attempt to enhance literacy and numeracy further, the literacy and numeracy team developed the DEER (Developing, Embedding Extending and Reflecting) framework (See Figure one). This framework was developed after the literacy and numeracy team identified the following key ideas:

- The diversity of literacy and numeracy skill levels in our student population and the need to cater for and support all learners.
- The multimodal nature of literacy and the real world contexts needed to make numeracy meaningful.
- The need to develop critical thinking and reflection skills.
- The notion that literacy and numeracy should be highlighted in all courses.
- The need for pre-service teachers to be effective communicators.

The aim of the DEER framework is to enhance pre-service teachers' literacy and numeracy skills to ensure that they have the literacy and numeracy skills needed to teach effectively in the classroom. In so doing the literacy and numeracy team are simultaneously ensuring that the literacy and numeracy requirements of the recently introduced LANTITE are met. The implementation of the DEER framework was a pilot project that was embedded in many of our core first year education courses in 2015 with the inclusion of second and third year education courses in 2016.

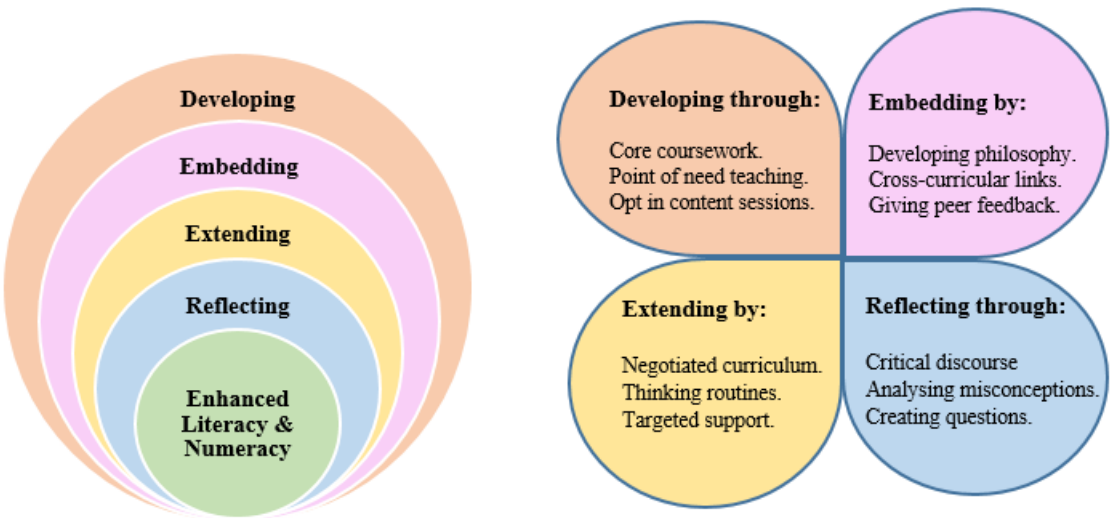

Figure 1: The DEER (Developing, Embedding, Extending, Reflecting) Framework

Figure 1 shows the DEER framework that is being used to enhance literacy and numeracy. The DEER framework contains four aspects which are implemented in classrooms as well as in optional literacy and numeracy support activities. This framework, which draws on a social constructivist approach suggests that enhanced literacy and numeracy skills can be ***developed*** through point of need teaching where data sets are used to determine appropriate coursework that assists the pre-service teacher to move forward. These enhanced literacy and numeracy skills need to be ***embedded*** in courses, so that pre-service teachers strengthen their understanding of these skills. Our framework also highlights the need for learning to be ***extended*** so that learning meets their personal and professional needs through targeted support and understanding the thinking needs of both disciplines. These personal learning needs must be ***reflected*** upon by the pre-service teacher so that they understand where they are in their personal learning journey and what the next steps of their journey need to be. In developing the DEER framework, the researchers considered that it was important that the focus on pre-service teacher learning was not in terms of the ways in which the pre-service teachers fell short of the standards that needed to be achieved, rather the focus was on developing capabilities that would in the future assist them to teach their own students. The implementation of the DEER framework enabled a pro-active approach to improve pre-service teacher outcomes in terms of professional, personal and academic literacy and numeracy.

An overview of the way that the DEER framework was implemented for pre-service teachers is shown in Figure 2.

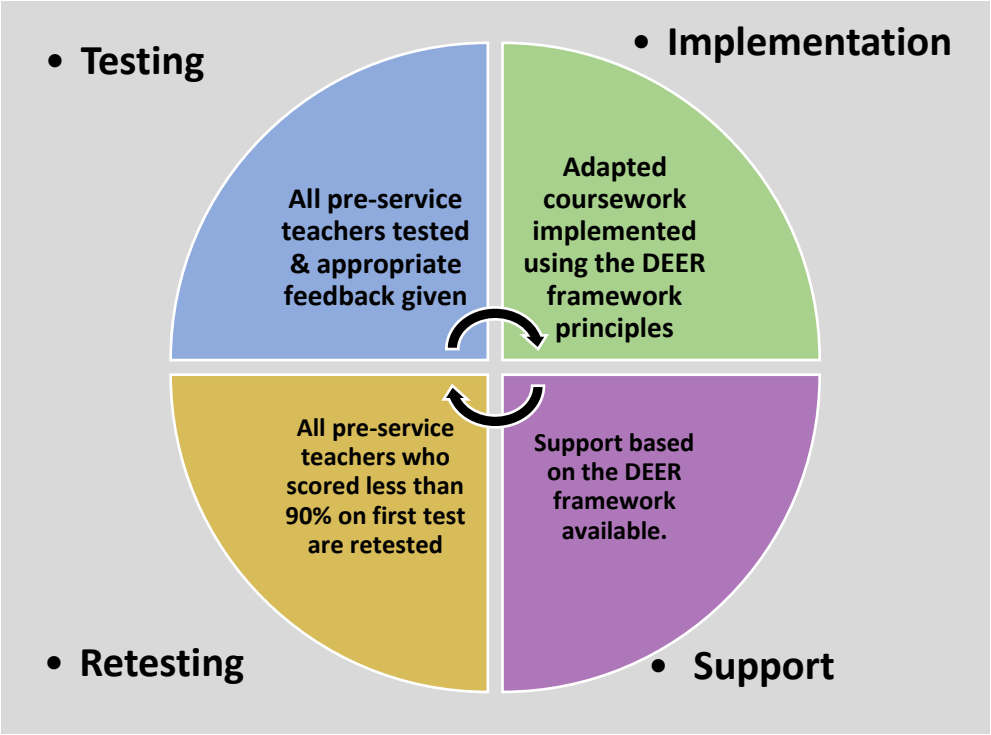

Figure 2: An overview of the implementation of the DEER framework.

Figure 2 depicts the implementation process for the DEER framework. All pre-service teachers were firstly tested, areas of focus were identified and incorporated into coursework using the DEER framework principles. Pre-service teachers whose testing indicated that they needed additional assistance were then offered opportunities in small groups and individually in content areas where the testing had suggested support was required. Finally, after the completion of their course with the embedded DEER framework, the pre-service teachers

were retested with an emphasis on improvement. Pre-service teachers who initially tested at 90% or above were not required to be retested, however some of them chose to re-sit the test.

Implementation

All pre-service teachers were exposed in some way to the DEER framework. For many of our pre-service teachers, this was only through lectures and tutorials, where material was redesigned to include the DEER principles. These redesigned courses made use of data to inform teaching practices and included a range of strategies and approaches to ensure a collaborative learning approach that developed thinking skills and reflective practices.

Data used for this purpose was derived from the literacy and numeracy tests that were completed by students in an earlier course. This gave an indication of where our pre-service teachers were at with their literacy and numeracy learning and what difficulties significant numbers of students were having. An example of this in literacy was that many students were struggling to understand formal written passages, so a series of activities were developed to overcome this difficulty. Using small group work, each tutor used the reading guide to promote discussion and written commentary concerning a range of short formal passages. An example of the use of data in numeracy was the content used in an assessment of a child's work activity. Each year the child's work sample is changed to a content area where testing suggests the pre-service teachers are struggling. One year this content area was measurement, another year it was fractions. It is this type of data driven practice that assists in building pre-service teachers' content knowledge through the DEER principles.

Pre-service teachers who score lower than 80% on the initial testing are offered additional support. Approximately 10% of our pre-service teachers take advantage of this offer of additional support. The actual support that this group of pre-service teachers were offered varied between literacy and numeracy. In literacy, pre-service teachers were offered online workshops and information sessions. For example, in core education courses, workshops were conducted on preparing for and delivering oral presentations, grammar, academic writing and essay writing. Additional resources were also made available with a focus on reading academic material; research skills; essay writing; quoting and paraphrasing; and editing and proof reading. In addition, the team worked with a number of pre-service teachers on an 'opt-in' basis concerning their essay writing and research skills.

In numeracy, pre-service teachers were offered additional sessions on fractions, decimals, percentages, measurement and patterns. One to one support was provided in other areas such as rounding off, scientific notation and interpretation of graphs. In a small number of cases, individual numeracy plans were set up for pre-service teachers, to improve targeted skills.

Methods

This research uses quantitative data to determine an answer to the following research question:

- Do literacy and numeracy results improve after the introduction and embedding of the DEER framework?

Hypotheses:

1. Did the numeracy skills of pre-service teachers' improve after the introduction and embedding of the DEER framework?

2. Did the literacy skills of the pre-service teachers' improve after the introduction and embedding of the DEER framework?

As discussed previously, the literacy and numeracy team developed ACSF level 4 testing to determine the skill level of all first year pre-service teachers.

Participants

The sample size varied between literacy and numeracy. In literacy, there were 475 tests undertaken by first year pre-service teachers. Of these 475 tests, there were 87 pre-service teachers who scored less than 90% and had been retested. In the case of numeracy, the numbers were larger with 711 tests undertaken by pre-service teachers with 156 of these pre-service teachers who scored less than 90% completing a second test.

Instruments

The numeracy tests used were purpose designed 30 question multiple choice tests which contained questions written at an Australian Core Skills Framework (ACSF) level 4. Test items covered the specific areas of number, algebra, measurement, statistics and probability. Participants were required to choose the correct response with no credit given for any other response.

The literacy tests were purpose designed 50 question multiple choice and short answer tests that contained questions on spelling, grammar, punctuation, language conventions and reading comprehension. This literacy test is again written at the ACSF level 4. Again, participants were required to choose the correct response with no credit given for any other response.

Procedure

This testing was conducted at Australian Core Skills Framework (ACSF) level 4. Our first year pre-service teachers were tested and additional content was included with all content based around the DEER principles and implemented into all tutorial groups. A support regime based on test results was developed using the DEER framework and all pre-service teachers who scored less than mastery (90%) were offered the opportunity to participate in this support regime. It must be noted that all support in both numeracy and literacy is optional, but pre-service teachers were encouraged to take advantage of the opportunity. If pre-service teachers still had not reached mastery level at their second testing, they were offered further support and were tested approximately six months later (using the same initial test).

Our pre-service teachers were later re-tested, some 6 months after initial testing and some later. These two test results form the basis of the quantitative data used to answer the research question. Measures of central tendency are reported on to determine if differences in in pre-test and post-test scores are significant, while effect sizes, as discussed by Cohen (1992) are calculated to determine the size of any change. Data documenting the pre-test and post-test scores are displayed in graphs and tables.

Analysis

As there was no control group, the dependent variables (numeracy and literacy scores) were assessed twice, once before the embedding of the DEER framework and then immediately after the intervention. A paired samples t-test assessed significance differences between the dependent variable (numeracy & literacy scores) for the pre and post conditions. Alpha was set at p=.05 to determine if changes in test scores were significant. In terms of measuring the impact of any significant differences, effect sizes for dependent samples were calculated (Cohen's d) as a measure of meaningfulness. The level of meaningfulness was set at d=.40 or above.

Ethics approval for the use of the data associated with this project was received from the university Human Research Ethics Committee (HREC) in October 2016.

Results: Numeracy & Literacy Tests

All pre-service teachers were initially tested in both literacy and numeracy. Pre-service teachers were re-tested in 2nd year (in the case of literacy) or 3 months after initial testing (in the case of numeracy. Initial retesting occurs with a test that tests the same skills but contains different test questions.

Results in each testing cycle are categorised into three bands with band 1 (Mastery) being 90% and above, band 2 being between 80% and 90% and band 3 being less than 80%. Pre-service teachers who score less than the 90% are offered support in some form. For band 2 pre-service teachers, this is generally provided through flexible tutorials and point of need teaching, while for band 3 pre-service teachers this is more intensive with offers of one-one support or small group workshops. In the case of numeracy, pre-service teachers who scored less than 60% were offered individual numeracy plans, where a pathway for numeracy development is discussed, with individual work assigned and one to one support provided.

Evidence.

To determine if the literacy and numeracy supports were successful, initial pre-service teacher test results were compared to the latest result that the same pre-service teacher had obtained. In the case of numeracy, 156 of the pre-service teacher who initially gained less than 90% on the test were re-tested with all of these results included, while in literacy, 87 pre-service teachers who initially gained less than mastery (90%) were retested. The later tests were different tests at the same ACSF4 level, but essentially tested the same skills in a different context.

It must also be noted that not all pre-service teachers improved on their latest test with some recording the same test results, while a small number (n = 9) in numeracy were less successful on the later test than their initial test. The number who were less successful in literacy was higher than in numeracy (n = 12). There were also a small group of pre-service teachers (n = 11) whose latest numeracy test result was the same as their initial test result. The literacy pre-service teachers who scored the same on both tests was relatively low (n = 5). Some pre-service teachers were tested more than twice and if a pre-service teacher was in the tested more than twice category, the latest result was included. A comparison of the initial test results and the latest test results in both literacy and numeracy is shown in table 1.

Score	Numeracy Pre-Test (n = 156)	Numeracy Post Test (n=156)	Literacy Pre-Test (n = 87)	Literacy Post Test (n = 87)
Below 50%	3	1	1	0
50 – 59%	5	2	3	1
60 – 69%	21	5	8	0
70 – 79%	52	26	21	16
80 – 89%	75	40	54	44
90% or higher	N/A*	82	N/A*	26

Table 1: Distribution of scores in pre-condition and post condition numeracy and literacy tests.* There were no pre-service teachers with an initial score of 90% or above included in the sample.

Table 1 shows that the test scores in the pre-service teachers' latest test result in both literacy and numeracy is on average considerably higher than their initial test scores. While this could be due to a number of factors, the implementation of the DEER framework and the support that pre-service teachers have been given in numeracy is considered by the researchers to be the greatest influence on these pre-service teachers.

The mean scores on these tests for both literacy and numeracy as well as the standard deviation is shown in Table 2.

	Initial Testing numeracy (n = 156)	Latest Testing numeracy (n = 156)	Initial testing literacy (n = 87)	Latest testing literacy (n = 87)
Mean (M)	22.76	25.64	39.48	42.43
Standard Dev. (SD)	2.67	2.92	4.33	3.78

Table 2: Mean raw scores and standard deviations for the test results.

A paired-samples t-test revealed a significant difference in scores for the pre-test level of numeracy condition (M=22.76, SD=2.67) and post intervention level of numeracy condition (M=25.64, SD=2.92) was significant (t (156) = -12.34, $p<.05$). Effect size was large ($d = .99$).

A second paired samples t-test for literacy for the pre-test level condition (M=29.48, SD=4.33) and the post-test condition (M=42.43, SD=3.78) was significant t (86) = -7.04, $p<.05$). Effect size was large ($d = .75$).

Taking into consideration the significant t-test results and the effect sizes, both research hypotheses were accepted. Thus, implementation of the DEER framework was a successful strategy for improving numeracy and literacy levels in pre-service teachers.

Discussion

Student literacy and numeracy results improved significantly after the implementation and embedding of the DEER framework. The two results were consistent with the literature in that targeted pedagogical based interventions are effective in addressing numeracy and literacy shortcomings. For the embedded DEER framework, there are several reasons for the improvement of results in both literacy and numeracy. First, the implementation of the DEER framework allowed pre-service teachers and their tutors to identify each pre-service teachers' current skill level and better understand the areas that required further development. This is consistent with the approaches (in numeracy) suggested by Afamasaga-futa'i, et al. (2006) and Galligan, (2013) as the testing is used to develop teaching and support activities that can be used to target any areas that pre-service teachers need to further build skills. Secondly, the multi-faceted approach of the embedded DEER framework gives pre-service teachers the

opportunity to build skills in both literacy and numeracy in a number of different ways and in multiple contexts. This approach fits well with that suggested in literacy education by Carey, Christie and Grainger (2015) and by MacGillivray (2009) in numeracy. The multi-faceted approach supports pre-service teachers to acquire not just through literacy and numeracy courses, but also through other education courses and through support activities that aim to give the pre-service teachers an opportunity to reflect on teaching techniques. Thirdly, the need to monitor literacy and numeracy skills regularly throughout each pre-service teachers' course is one that is embedded in the DEER framework so that their learning is better understood by themselves and by their tutors. This monitoring has been recognised in numeracy by Afamasaga-futa'i, et al. (2006) and Ferrier (2013) and allows pre-service teachers to reflect on their learning and further develop their understanding of learning processes that they will need to use once they are fully qualified teachers.

The implementation of the DEER framework and the associated embedding of this framework has not been without difficulty. While the literacy and numeracy components of the program were embedded in a number of literacy and numeracy courses, the DEER framework was also implemented in a number of core courses that had previously not included literacy and numeracy as part of their content. This was, at times challenging, with some tutors having to re-examine their pedagogical practices.This is consistent with findings by Jonsmoen and Greek (2016) who suggest that academic staff reconsider their pedagogical practices and how they embed academic literacies into their content teaching. This is also supported by Thies, Wallis, Turner & Wishart, (2014) who suggest a model of building staff capacity to enhance pre-service teacher capabilities.It should be recognised that some of our pre-service teachers found the DEER framework confronting because of the perceived relevance of the literacy and numeracy content. For instance, pre-service teachers, completing a degree in secondary education, in the fields of humanities and/or arts appeared to be more willing to accept the notion that all teachers were teachers of literacy but struggled with the concept of the relevance of numeracy to their discipline areas. Similarly, STEM pre-service teachers sometimes had difficulty in connecting to the idea that literacy teaching was an important element for all teachers regardless of their discipline area. This concern was also raised by Moon (2014) who argued that all secondary teachers required explicit understandings of the content of their discipline area including the specific discourses and particular forms of texts, styles and vocabulary.

It must also be noted that a small number of individuals who re-sat the literacy and numeracy tests did not improve their results and in some cases they attained lower marks than in their initial test sitting. This might have been due to several different reasons. Firstly, there was a small group of pre-service teachers who did not believe that they had any problems with literacy or numeracy. These pre-service teachers tended to suggest that their performance was lower than their ability and test conditions impacted on their thinking. While tutors would point out that some additional work would help these pre-service teachers, there was often a response along the lines that they would improve next time. This was in fact rarely the case. Secondly, some pre-service teachers appeared to have a superficial understanding of the material being tested and were unable to apply literacy and numeracy knowledge to unfamiliar situations. In this case, pre-service teachers needed to be given a number of opportunities to learn, practise and demonstrate understanding of the requisite concepts and skills. Thirdly, another possible reason for results to decrease rather than improve could be linked to anxiety experienced during examinations. The DEER framework attempts to overcome this kind of anxiety by building confidence through the discursive nature of literacy and numeracy activities.

Conclusions

This paper introduced the DEER framework and demonstrated the significant impact that it has had on the development of pre-service teacher literacy and numeracy competencies in a regional Australian University. The implementation and embedding of the DEER framework has assisted our pre-service teachers to develop a higher level of competence in both numeracy and literacy as evidenced by effect sizes of 0.99 and 0.75 respectively. Overall, results were significantly higher for the later tests with pre-service teachers generally improving more in the area of numeracy rather than literacy. These improved results, after the implementation of the DEER framework, could be due to a range of factors. These factors include ensuring that pre-service teachers understand their own skill level; targeted responses from lecturers identifying the point of need of pre-service teachers; and additional support programs with a reflective approach. The multi-faceted approach highlighted in the DEER framework saw changes to the core curriculum and small group or individual activities that enabled the pre-service teachers to develop deeper understandings of the relevant concepts. We would therefore argue that the success of the DEER framework was a result of the combination of targeted response and support, point of need teaching, student agency and reflection.

The researchers observed that as pre-service teachers participated in activities introduced as part of the DEER framework implementation, the pre-service teachers grew not only in their conceptual understandings, but also in their confidence to teach literacy and numeracy. The researchers suggest that with the continued use of the DEER framework, the skill and confidence levels of our pre-service teachers in all aspects of numeracy and literacy will continue to improve.

One of the limitations identified was the absence of a control group. The framework was created as an inclusive strategy using a multi-faceted approach. A control group would have created an equity issue, depriving the pre-service teachers in that group of the same educational opportunities. Also, a crossover control model was considered as impractical in a higher education context. The improved literacy and numeracy skills evident in our pre-service teachers will not only better prepare them for their future career, but will also assist them to be successful in LANTITE testing. While the DEER framework was implemented in a regional Australian context, we argue that our research has implications for other universities in both regional and metropolitan areas.

A future research direction could include the continued impact of the DEER framework, and how well it supports specific groups of students. Another research direction could entail an examination focusing on the improvement in specific concepts in literacy, such as grammar, spelling, punctuation and reading comprehension; and in numeracy of measurement, number and statistics.

References

Afamasaga-Fuata'i, K., Meyer, P., Falo, N., & Sufia, P. (2006). Future teachers' developing numeracy and mathematical competence as assessed by two diagnostic tests. Paper presented at the AARE Annual Conference Adelaide 2006.

Breed, M. (2012). Using the scaffolding numeracy in the middle years' assessment material to support student learning. *Australian Primary Mathematics Classroom, 17*(4), 28-32.

Bostock, L., & Boon, H. (2012). Pre-service teachers' literacy self-efficacy and literacy competence. *Australian and International Journal of Rural Education, 22*(1), m19-37.

Carey, M.D., Christie, M., & Grainger, P. (2015). What benefits can be derived from teaching knowledge about language to pre-service teachers? [online]. *Australian Journal of Teacher Education, 40*(9), 16-30. http://search.informit.com.au/documentSummary;dn=490591630672879;res=IELAPA

Craven, G., Beswick, K., Fleming, J., Fletcher, T., Green, M., Jensen, B., Leinonen, E., & Rickards, F. (2014). *Action now: Classroom ready teachers*. Retrieved March 2015 from http://docs.education.gov.au/node/36783.

Cohen, J. (1992). A prime power. *Psychological Bulletin, 112*(1), 155-159. https://doi.org/10.1037/0033-2909.112.1.155

Devereux, L., & Wilson, K. (2008). Scaffolding literacies across the Bachelor of Education program: an argument for a course-wide approach. *Asia-Pacific Journal of Teacher Education, 36*(2), 121-134. https://doi.org/10.1080/13598660801971633

Ferrier, C. (2013). A multifaceted approach to numeracy support for life sciences students. *MSOR Connections, 13*(2), 24-30. https://doi.org/10.11120/msor.2013.00013

Galligan, L. (2013). A systematic approach to embedding academic numeracy at university. *Higher Education Research & Development, 32*(5), 734-747, https://doi.org/10.1080/07294360.2013.777037

Galligan, L., & Hobohm, C. (2013). Investigating students' academic numeracy in 1st level university courses. *Math Education Research Journal (27),* 127 – 145. https://doi.org/10.1007/s13394-014-0132-9

Goos, M. (2004). Home, school and community partnerships to support children's numeracy. *Australian Primary Mathematics Classroom, 9*(4), 18-20.

Goos, M., Dole, S., & Geiger, V. (2012). Numeracy across the curriculum. *Australian Mathematics Teacher, 68*(1), 3-7.

Henderson, S., & Rodrigues, S. (2008). Scottish student primary teachers' levels of mathematics competence and confidence for teaching mathematics: some implications of national qualifications and initial teacher education. *Journal of Education for Teaching, 34*(2), 93-107. https://doi.org/10.1080/02607470801979533

Hine, G. (2015). Strengthening pre-service teachers' mathematical content knowledge. *Journal of University teaching and learning practice, 12*(4), 1-14.

Honan, E., Exley, B., Kervin, L., Simpson, A., & Wells, M. (2013). Rethinking the Literacy Capabilities of Pre-Service Primary Teachers in Testing Times. *Australian Journal of Teacher Education, 38*(10). https://doi.org/10.14221/ajte.2013v38n10.3

Jonsmoen, K.M., & Greek, M. (2016). Lecturers' text competencies and guidance towards academic literacy. *Educational Action Research.* http://dx.doi.org/10.1080/09650792.2016.1178156

Kennedy, A. (2010). Family support for early literacy and numeracy: Examining events in the home and community. *Exchange, 191,* 18-21.

Kerawalla, L., O'Connor, J., Underwood, J., duBoulay, B., Holmberg, J., Luckin, R., Smith, H., & Tunley, H. (2007). Exploring the potential of the homework system and tablet PCs to support continuity of numeracy practices between home and primary school. *Educational Media International, 44*(4), 289-303. https://doi.org/10.1080/09523980701680904

Louden, W., & Rohl, M. (2006). "Too many theories and not enough instruction": perceptions of preservice teacher preparation for literacy teaching in Australian schools. *Literacy, 40*(2), 66-78. https://doi.org/10.1111/j.1467-9345.2006.00440.x

MacGillivray, (2009). Learning support and students studying mathematics and statistics. *International Journal of Mathematical Education in Science and Technology, (40)*4, 455–472. https://doi.org/10.1080/00207390802632980

McWilliams, R., & Allan, Q. (2014). Embedding Academic Literacy Skills: Towards a Best Practice Framework, *Journal of University Teaching & Learning Practice*, *11*(3), 1-19. http://ro.uow.edu.au/jutlp/vol11/iss3/8

Moles, J., & Santoro, N. (2013). Bend me, shape me, anyway you want me: constructing teacher identities across different learning paradigm. *New Zealand Research in Early Childhood Education Journal*, *16*, 29-44.

Moles, J., & Wishart, L. (2016). Reading the map: Locating and navigating the academic skills development of pre-service teachers. *Journal of University Teaching & Learning Practice, 13*(3), Available at:http://ro.uow.edu.au/jutlp/vol13/iss3/4

Moon, B. (2014). The literacy skills of secondary teaching undergraduates: Results of diagnostic testing and a discussion of findings. *Australian Journal of Teacher Education*, *39*(12) https://doi.org/10.14221/ajte.2014v39n12.8

Ponte, J., & Chapman, O. (2006). Mathematics teacher's knowledge and practices. In A. Gutierrez & P. Boero (Eds.), *Handbook of Research on the Psychology of Mathematics Education: Past, Present and Future* (pp. 461-494). Rotterdam: SENSE.

Prince, R., & Archer, A. (2008). A new literacies approach to academic numeracy practices in higher education. *Literacy & Numeracy Studies, (16)*1, 63-75.

Skalicky, J., Adam, A., Brown, N., Caney, A., & Lejda, A. (April, 2010). Tertiary Numeracy Enquiry. Centre for the Advancement of Learning and Teaching (CALT), University of Tasmania.

Thies, L., Wallis, A., Turner, A., & Wishart, L. (2014). Embedded academic literacies curricula: the challenges of measuring success. *Journal of Academic Language & Learning*, *8*(2), 43-59.

Young-Loveridge, J., Bicknell, B., & Mills, J. (2012). The mathematical content knowledge and attitudes of New Zealand pre-service primary teachers. *Mathematics Teacher Education and Development, 14*(2), 28-49.