

Numeracy for Learners and Teachers: Evaluation of an MTeach coursework unit at Monash University

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In 2015, a new MTeach coursework unit, *Numeracy for Learners and Teachers*, was introduced at Monash University. The impetuses for this unit were the Australian Institute for Teaching and School Leadership numeracy standards for graduate teachers, and the inclusion of numeracy as a general capability in the Australian Curriculum. In this paper, we describe the content and organisation of the unit, and its delivery modes. An evaluation was conducted with students using pre- and post-unit questionnaires and interviews. A major finding was that students' confidence to incorporate numeracy into their teaching across the curriculum increased after studying the unit.

Introduction

There were two main drivers for the introduction of a new unit, *Numeracy for Learners and Teachers* (EDF5017), which was introduced into the MTeach program at Monash University in 2015: (1) The graduate expectations of the Australian Institute for Teaching and School Leadership (AITSL, 2014), and (2) The curriculum expectations and pedagogy associated with numeracy, one of seven general capabilities in the Australian Curriculum (Australian Curriculum, Assessment and Reporting Authority [ACARA], n.d.).

The AITSL standards for teachers include a *Literacy and Numeracy Strategies* standard (2.5): graduates are expected to “know and understand literacy and numeracy teaching strategies and their application in teaching areas” (AITSL, 2014). They are also expected to be able to demonstrate the capacity “to interpret student assessment data to evaluate student learning and modify teaching practice” (5.4) (AITSL, 2014). According to AITSL (2015), the accreditation of any pre-service teacher education course across Australia is founded in ensuring “that all graduates of initial teacher education meet the Australian Professional Standards for Teachers at the Graduate career stage” (p. 2).

All Australian teachers are now charged with developing students' numeracy capabilities (ACARA, n.d.). According to ACARA (n.d.), “[T]he general capabilities play a significant role in the Australian Curriculum in equipping young Australians to live and work successfully in the twenty-first century”. Numeracy is defined as encompassing:

the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations. It involves students recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully. (ACARA, n.d.)

As noted by Klein (2008), “Preservice teachers are expected to teach their students for numerate participation in a global world, even though they themselves oftentimes lack the necessary mathematical foundations and strategic and critical skills” (p. 321).

Content of Numeracy for Learners and Teachers (EDF5017)

The guiding principles underpinning the development of the new unit, *Numeracy for Learners and Teachers*, were that our teacher education students (1) develop an understanding of what numeracy is and how it relates to mathematics, (2) learn to recognise numeracy opportunities across the curriculum, and (3) identify ways to engage their future students in relevant and critically challenging curriculum-based activities that will build numeracy skills. The 21st Century Numeracy Model (Goos, Dole, & Geiger, 2014) was central to the pedagogy and the numeracy lesson ideas with which the MTeach students engaged and learned to develop.

The MTeach program at Monash has five pre-service teacher education streams: Early Years, Early Years/Primary, Primary, Primary/Secondary, and Secondary. EDF5017 is a core unit for all streams except Early Years and is delivered face-to-face for on-campus students and online to off-campus students. In 2015¹, the unit was divided into nine modules, as the teaching semester of 12 weeks includes three weeks of professional experience. All teaching materials were uploaded to Moodle for off-campus students to work through and for on-campus students to draw upon. The nine weekly modules were:

1. Introduction. What is numeracy?
2. Numeracy and persuasive writing
3. Numeracy and health, well-being, and body image
4. Numeracy and sustainability
5. Numeracy and visual, graphic, and performing arts
6. Numeracy and critical orientation and statistical literacy
7. Numeracy and history
8. Numeracy and technology
9. Financial literacy

On-campus students were expected to engage with the weekly online lecture (30 minutes) prior to attending 1.5 hour tutorial classes; an additional 30 minutes per week were spent completing readings, watching selected video clips, and exploring selected websites. For off-campus students, the online lecture and tutorial materials (the same as those engaged in face-to-face by on-campus students) were posted on Moodle. There were two assignments for the unit. The first involved four short tasks based on the work covered in Weeks 1-4; the second included responses (posted to online discussion forums) to provocative statements or questions related to the work covered in Weeks 5 to 9, as well as two written tasks: a lesson idea founded in Australian Curriculum content to build students' numeracy capabilities, and the interpretation of NAPLAN data to exemplify the numeracy demands in their future workplace, the school.

On the Moodle site, we also prepared "Self-help kiosks". Here, resources were provided for students who wished to refresh their skills in a range of mathematics content areas; students could complete quizzes to check their understanding. The "Self-help kiosks" were not an integral component of the unit but were there for those who lacked confidence in their own mathematical capabilities and were motivated to brush up on pertinent mathematical skills. In providing this opportunity for our students, there was the potential to address the deficiency in teacher education programs as identified by Klein (2008) and noted above.

Pertinent research studies that guided the design of the unit are discussed next.

¹ In 2016, minor modifications were made to the unit, based on student feedback.

Literature Review

The concept of numeracy (i.e., mathematical literacy) has a long history. More than a half-century ago, numeracy was defined as the mirror image of literacy (Crowther, 1959). Cockcroft (1982) maintained that it was “the responsibility of teachers of mathematics and other subjects to equip children with the skills of numeracy” (p. ix). In the Australian Association of Mathematics Teachers’ (1997) policy on numeracy, a definition of what it is to be numerate was provided: “to use mathematics effectively to meet the general demands of life at home, in paid work, and for participation in community and civic life” (p. 2). Many people (particularly in popular media) mistakenly view the results of the Programme of International Student Assessment (PISA) as a measure of mathematics achievement. PISA documentation, however, makes it very clear that it is *mathematical literacy* (i.e., numeracy) that is being assessed. As discussed earlier, numeracy is now recognised in the Australian Curriculum as a general capability, and it is the responsibility of all Australian teachers (primary and secondary) to build students’ numeracy capabilities.

Research on numeracy and pre-service teacher education students is limited. Watson and Moritz (2002) reported on a quantitative literacy (i.e., numeracy) component of a mathematics unit in a BTeach program at the University of Tasmania. A website focussing on chance and data in the news (drawn from the *Hobart Mercury*) had been developed earlier. Students were required to select one article and complete four tasks, including the development of a lesson idea to be implemented while on practicum. Watson and Moritz concluded that “projects like this quantitative literacy project will assist teachers to help high school graduates become quantitatively literate citizens in society” (p. 54).

Leder, Forgasz, Kalkhoven, and Geiger (2015) reported findings from a pilot study with teacher education students enrolled at one Australian university. The instrument used was a pre-cursor to the one adopted in the present study. It was found that the majority of students recognised the importance of mathematics and its applications in everyday life, but that fewer than 50% believed that there were mathematical demands on teachers beyond their classrooms. Leder et al. (2015) claimed that their findings had particular relevance to teacher education students whose specialism was not mathematics.

Geiger, Forgasz, and Goos (2015) reported findings from a study in which practicing teachers (not all of whom taught mathematics) were involved in a professional development program focussing on the incorporation of numeracy activities in subjects other than mathematics. The program was based on Goos et al.’s (2014) 21st Century Numeracy Model. One element of the model, the critical dimension (involving decision-making and justification), proved more challenging than the other dimensions of the 21st Century Numeracy Model, to incorporate into lesson ideas. Successful classroom vignettes were included in the report: one from a social studies lesson, the other from an English class. Geiger et al., (2015) concluded that “the professional learning program based on the numeracy model provided sufficient support for teachers to design and implement numeracy activities in subjects other than mathematics” (p. 622).

The study

EDF5017 was introduced in 2015. From the outset, we decided that we wanted more information about the outcomes of students’ experiences in the unit than would be provided by the university’s unit evaluation process.

Aims

Our aims were to explore students' learning about numeracy and its role in teaching (consistent with the Australian Curriculum), gauge their beliefs about numeracy, investigate their feelings about the expectations of graduate teachers with respect to numeracy, and determine whether their perspectives following participation in the unit were different from their prior held views. This research was conducted with the permission of the Dean of Education and the Monash University Ethics Committee.

Research Design

As with the conception and implementation of the unit itself, our research was framed by the 21st Century Numeracy Model (Goos et al., 2014), which is consistent with a social constructivist theoretical stance. To investigate students' views of and experiences with numeracy and the unit, we employed a mixed-methods design. Namely, data were collected through online questionnaires, before and after the unit was taught, and semi-structured interviews held after the unit had finished.

Because of space constraints, in this paper, we will focus on the pre- and post-unit questionnaires completed by the students in the *Numeracy for Learners and Teachers* unit (EDF5017). The questionnaires were completed anonymously by participants, which means that pre- and post-unit responses can only be considered in aggregate. In the following sections, we will discuss the pre- and post-unit questionnaire design, participants, and methods of data analysis.

The online questionnaires were developed in Qualtrics (qualtrics.com.au) and featured a mix of open-ended (e.g., definitions, explanations) and closed items (e.g., yes/no/unsure responses, Likert-type response formats). The first two sections of the questionnaire were identical in both iterations. The first section was comprised of a few demographic questions (e.g., age range, educational background), while the next section featured open-ended questions regarding the participants' definitions of "numeracy" and "mathematics", as well as the connection between these two concepts. In this section, participants were also asked about their perceptions of their own mathematics abilities (in general and for teaching) and about the numeracy demands on teachers.

The third section of the pre-unit questionnaire featured six mathematical questions, two of which had multiple parts. These questions were drawn from the 2010 Grade 9 NAPLAN test and the publicly-released 2012 PISA items (with permission), plus two questions were developed by the researchers and their colleagues. The questions addressed mathematical topics such as basic arithmetic, unit conversions, combinations, and interpreting data from tables and graphs. For all of the mathematical questions, participants were asked to indicate their confidence in their responses (right/wrong/unsure). In the final section of the pre-unit questionnaire, volunteers for the interview portion of the research were sought, and participants were given an opportunity to provide feedback on the questionnaire. In the final section of the post-unit questionnaire, students were asked to indicate their pre- and post-unit levels of confidence in incorporating numeracy in their teaching, and to provide their understandings of "numeracy" as a concept, feedback on the unit, and their "take-away" message from the unit. As with the pre-unit iteration, participants could also provide feedback on the questionnaire in this section.

In this paper, we report on participants' views of the relationship between numeracy and mathematics, their perceptions of numeracy demands on teachers, and their feedback

on the unit. To address the first two topics, we use data from both the pre-unit and post-unit questionnaires. The latter topic is addressed using data from the post-unit questionnaire.

Participants

All students who were enrolled in EDF5017 were invited, via discussion forum posts on the unit's Moodle site, to complete the questionnaires. In each case, the questionnaire was open for approximately one week, at the start and end of the semester, respectively. The students were in the second semester of the first year of their two-year MTeach teacher education program. Students from the Primary/Secondary and Secondary streams were enrolled in the Numeracy unit when the study was conducted (The Early Years/Primary and Primary stream students are enrolled in the unit in 2016).

Across 12 tutorial groups at two campuses and one online group, approximately 300 students were enrolled in this unit, of whom approximately 90% were on-campus students. Approximately two-thirds of the students were enrolled in the Secondary stream. The students had a wide range of subject area specialisms (e.g., geography, visual arts), but most were not preparing to become mathematics teachers.

In the pre-unit iteration, 53 participants started the questionnaire and answered most demographic items. Forty participants completed every question. The varying numbers completing each question reported in this paper are noted in the findings below. The sample of 53 was comprised of 43 (81%) women, nine (17%) men, and one participant (2%) who did not respond to this item. Most participants were between the ages of 25 and 34 ($n = 41$, 77%); the rest identified as being under 25 ($n = 12$, 23%). More participants were enrolled in the Secondary stream ($n = 39$, 74%) than in the Primary/Secondary stream ($n = 14$, 26%). Thirty (57%) participants had completed their undergraduate degrees at a university other than Monash University. Of the 22 who indicated where they had studied, 17 (77%) had been at other Australian institutions; the rest had studied outside Australia. Of the 53 participants, 35 (66%) had not studied any university level mathematics.

In the post-unit survey, 35 participants started the questionnaire; only 20 completed it. Again, varying numbers of participants completed each of the questions. This lower response rate was likely to be due to the timing of the data collection – end of semester when students were busy completing assignments. The demographic profile of the post-unit respondents was similar to those who answered the pre-unit iteration: the majority were women ($n = 26$, 74%) aged 25 to 34 ($n = 25$, 74%), in the Secondary stream ($n = 28$, 80%), who had not studied mathematics at the university level ($n = 20$, 63%).

Analyses

The questionnaire data were analysed in multiple ways. For the purposes of this paper, descriptive statistics were calculated for responses to the closed questions, such as the multiple-choice demographic questions. The responses to the open-ended questions were analysed through a process of emergent coding; the responses were read multiple times and then grouped into categories by response type.

Findings

In the following sections, we discuss findings from our analysis of the pre- and post-unit questionnaire data. We focus on the participants' views of numeracy, mathematics, and numeracy's role in teaching more broadly, as well as their views of the unit.

General Views

Through a series of related open-ended and closed questions, participants' views of numeracy, mathematics, and the role of numeracy in teaching more broadly were investigated. Here, we report on their responses to questions regarding the links between numeracy and mathematics, as well as their views of numeracy demands for teachers.

In the pre-unit questionnaire, of the 45 students who responded to the item, 34 (76%) thought that there were differences between numeracy and mathematics, compared to two (4%) who thought there were no differences and nine (20%) who were unsure. Some examples of "unsure" responses included "I'd never really given it much thought before now. Both scare me!!!" and "I genuinely have no idea. I would guess that numeracy is the language that allows us to engage in mathematics". In contrast, there were 21 responses on the post-unit questionnaire and all but one of the participants ($n = 20$, 95%) thought that there were differences between numeracy and mathematics; the other participant was unsure. Examples of "difference" responses included "I think that numeracy is a broader concept than mathematics, because otherwise we wouldn't have pure maths" and "Numeracy is the application of mathematics in real life contexts".

To investigate the participants' understandings of numeracy demands for teachers in their roles outside the classroom, participants in both iterations of the questionnaire were asked whether there were "mathematical demands on teachers in schools apart from what is taught to students". In the pre-unit questionnaire, 44 students responded, and 28 (64%) reported that there were such demands, compared to three (7%) who disagreed and 13 (30%) who were unsure. Although there were only 21 responses to the item on the post-unit questionnaire, no student disagreed, two (10%) were unsure, and 19 (90%) agreed, a much higher proportion than on the pre-unit questionnaire. In both iterations, the "yes" responses included such topics as assessment, planning excursions, budgeting, and salaries.

Influence of Unit

In the last section of the post-unit questionnaire, participants were asked specific questions about their experiences in the unit and the ways that their participation in it may have influenced their views about numeracy. In Figure 1, the 21 participants' reported pre-unit and post-unit levels of confidence in "incorporating numeracy into the teaching of [their] subject area(s)" are shown.

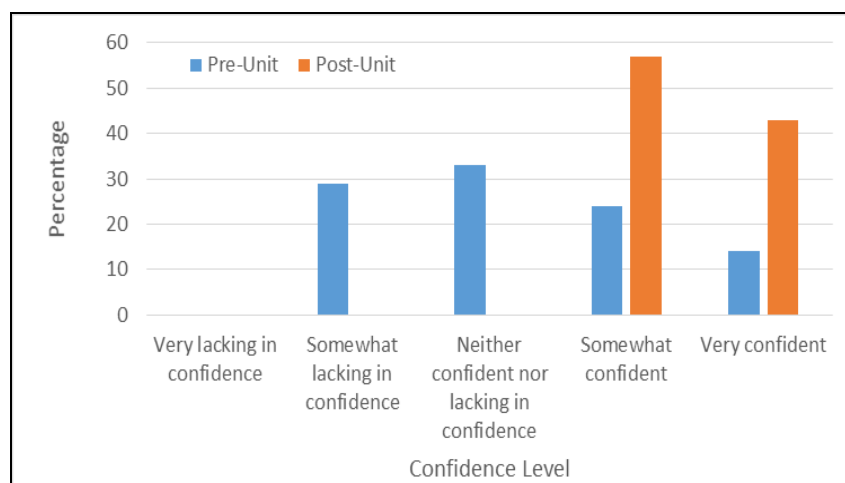


Figure 1. Participants' reported pre- and post-unit confidence levels.

As is clearly evidenced in Figure 1, the students' experiences in the unit had a substantial impact on their reported levels of confidence. Before beginning the unit, while no participants reported being "very lacking in confidence", more than half of the participants reported being less than "somewhat confident". In comparison, nearly half ($n = 9$, 43%) reported being very confident after completing the unit. Encouragingly, all participants reported being at least somewhat confident in their abilities to incorporate numeracy into their teaching after completing the unit. For example, one participant wrote:

I have a clearer understanding of what numeracy entails, have been provided examples with how it would work in my method curriculum areas, and feel confident that I have adequate mathematical reasoning and numeracy skills to be able to handle this in my teaching.

Participants were also asked more generally if the unit had made an impact on their views of numeracy. Perhaps unsurprisingly, nearly all of the 21 respondents ($n = 18$, 86%) reported that their views had changed. Some representative responses included "I did not know the word before this unit" and "I now understand there is a difference between numeracy and mathematics". When questioned about their overall impressions of the unit, 13 (76%) of the 17 who responded to the question were positive, with comments such as "good" and "brilliant course [unit]. My favourite." Finally, when asked about the overall message they would take away from the unit, the 15 who responded tended to discuss the ubiquitous nature of numeracy/mathematics/numbers and the importance of numeracy for all teachers. For instance, one participant noted, "Opportunities for numeracy can be found in many lessons/disciplines. Take advantage of them."

Concluding Remarks

The expectation of a numerate citizenry primarily came to the fore in the late 20th century (Steen, 1999). However, the translation of this general expectation into educational systems took a little longer. In the Australian context, the expectation of students and teachers being numerate is explicit in the statement on the numeracy general capability in the Australian Curriculum (ACARA, n.d.) and in AITSL's standards for teachers (AITSL, 2014). As demonstrated from our findings, participation in a numeracy-focused MTeach unit, *Numeracy for Learners and Teachers*, impacted participants' views and self-perceptions. In particular, the teacher education students garnered a much greater awareness of the differences between numeracy and mathematics. Additionally, participants became more aware of the out-of-classroom numeracy demands on teachers. When considering the participants' self-confidence in incorporating numeracy in their teaching, we were encouraged to see such an increase in confidence after teaching the unit.

Since these participants will soon be teaching in primary and secondary classrooms across a wide variety of subject areas, it is vital that they are not only aware of ways in which numeracy can be incorporated in their teaching, but also that they are confident in their ability to do so. This confidence includes not only their own abilities and understandings, but also their willingness to seek assistance from, and network with, colleagues. This has the potential to lead to cross-curricular educational explorations, enriching the learning experiences of the students in their classrooms. In turn, their students' understandings of mathematical concepts may be strengthened, motivating them to venture into stimulating engagement with challenging mathematics both inside and outside the mathematics classroom. Some teacher education students may have already decided that they are not "maths people". Yet, if they are within a subject area in which

they feel confident, they may be more willing to engage their future students in numeracy-based activities. Indeed, we witnessed this very phenomenon in our *Numeracy for Learners and Teachers* classes. Students with performing and visual arts specialisms, for example, even those who identified themselves as weak at mathematics and anxious about incorporating numeracy into their teaching, were particularly engaged during the Visual, Graphic, and Performing Arts week of the unit, and supported their peers from non-arts specialisms.

Arguably, some of the changes in the teacher education students' views were initiated in the first module of the unit, where various conceptions of numeracy, as well as the differences between numeracy and mathematics, were explored. As the unit progressed, students encountered classroom-based examples highlighting numeracy opportunities across a wealth of subject areas. Since confidence plays a role in the implementation of any new topic and/or pedagogy, the participants' increased confidence to incorporate numeracy into their teaching augurs well for the future.

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