Course Redesign to Improve Pre-service Teacher Engagement and Confidence to Teach Mathematics: A Case Study in Three Parts

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Abstract: This article examines pedagogical changes to a mathematics education course for preservice teachers (PSTs) over a three-year period. Transactional Distance Theory (TDT) is used as a conceptual framework underpinning the course redesign. A case study of one campus (Campus A) is presented. It is chosen for analysis because, of the three campuses on which this course is taught, it is this Campus that starkly illuminates the unfolding, three-year drama of course redesign. This redesign increased PST engagement with mathematics and improved their self-confidence to teach mathematics. It is claimed that these improvements resulted in positive outcomes in relation to their mathematics content knowledge (MCK) and also mathematical pedagogical knowledge (MPK). Feedback over the three-year period indicates that changes to course design in terms of structure, dialogue, and autonomy enhanced PST engagement; increased their confidence to teach mathematics in the future; and facilitated a shift in perspective regarding mathematics education. The article also outlines the implications of this course redesign for university mathematics educators utilising blended / online teaching.

Keywords – Pre Service Teacher Mathematics education; Transactional Distance Theory; Student Engagement; Confidence to teach Mathematics; Blended / Online Teaching

Course Redesign to improve pre-service teacher engagement and confidence to teach mathematics: A Case Study in Three Parts

This article outlines a process to change both the underpinning methodology of a primary mathematics education course taught to second year pre-service teachers (PSTs). Mathematics Education Two is a core course in a Bachelor of Primary Education degree and is taught in blended mode (a mix of online and face to face contact) across three geographically distinct campuses in a redbrick Australian university. It is the first occasion in this school where one academic (the author) has been responsible for the design and delivery of a core PST course across all three campuses. Although the same course was taught by the same convenor, in the same mode, across the three campuses, in order to illuminate the contradictions that need to be resolved when redesigning courses, one campus is purposively selected for analysis in this article.

In broad terms, the research literature regarding mathematics education has generally concluded that effective teachers of mathematics exhibit a highly developed understanding of mathematics content and an appreciation of how this content is applied in real-world contexts (Frid, Goos & Sparrow, 2008/2009). However, the research literature also suggests that this level of effectiveness may not be universally present in PSTs, given the concerns regarding the current state of mathematics education in terms of their developing ability to teach mathematics (Rubinstein, 2009). In this research context, there is the additional complication regarding PST mathematics education in relation to an increase in the number of universities offering such courses in blended mode, where a “loss of relational contact” may impact negatively on overall student experience (Kim, 2011, p. 763). In previous research, the author (Kawka & Larkin, 2011; Larkin, Jamieson-Proctor & Finger, 2012; Larkin & Jamieson-Proctor, 2015) has argued that although universities have invested heavily in the use of learning management systems (LMS), there has not been an accompanying emphasis on the development of appropriate mathematics pedagogies to support student learning in blended environments. This article proposes a pedagogical and methodological approach to teaching PSTs that addresses many of the issues raised herewith.

LITERATURE REVIEW AND EPISTEMOLOGICAL FRAMEWORK

There is a clear expectation from professional mathematics bodies that, upon graduation, PSTs are knowledgeable about best practice in mathematics education, including knowledge of students, knowledge of mathematics, and knowledge of students' learning of mathematics (Frid et al., 2008/2009). Given these expectations, a key priority is ensuring that graduates are competent and confident mathematics teachers. Much of the recent research has focused on the importance of developing Pedagogical Content Knowledge (PCK) (see Chick, Baker, Pham & Cheng, 2006; Author, 2012). In addition, Osana, Lacroix, Tucker and Desrosiers (2006) and Livy and Vale (2011) suggest that mathematics teachers require both deep mathematical pedagogical knowledge (MPK) and deep mathematical content knowledge (MCK). Both are necessary, however, given the constraints under which the course is to be delivered (explored in detail in a later section) MPK is discussed in greater detail and is viewed as a highly probable outcome from increased student engagement and self-confidence in teaching mathematics. A key inhibitor to an overall successful experience of pre-service mathematics education, and the subsequent development of MPK, is the high level of mathematics anxiety evident amongst many PSTs (Grootenboer, 2008; Grootenboer & Hemmings, 2007) who exhibit negativity regarding their own learning of mathematics and are also apprehensive about the prospect of teaching mathematics to primary school students (Haciomeroglu, 2014). Although it is my contention that addressing the issue of anxiety in pre-service educators is essential, as self-confidence is fundamental in the development of MPK (see Niess, 2009), it is beyond the scope of this article to address the anxiety issue further; instead, the article focuses on the changes to the course structure, guided by Transactional Distance Theory (TDT) (Moore, 1993), that were made to enhance the development of PST engagement and self-confidence with the anticipated development of their MPK.

TDT encompasses a range of educational approaches currently in use in higher education (face-to-face, blended, and totally online). Transactional distance is the "psychological and communications space" (Moore, 1993, p. 22) that occurs between learners and teachers and is shaped by the patterns of activity of individuals within the environment. TDT is influenced by three interrelated factors: the structure of the program; the dialogue which exists between the teacher and the learner; and the level of autonomy of the individual learner (Moore, 2007), and these elements can be manipulated by mathematics educators to cater for the various educational needs of PSTs studying mathematics education in blended courses (see Figure 1).

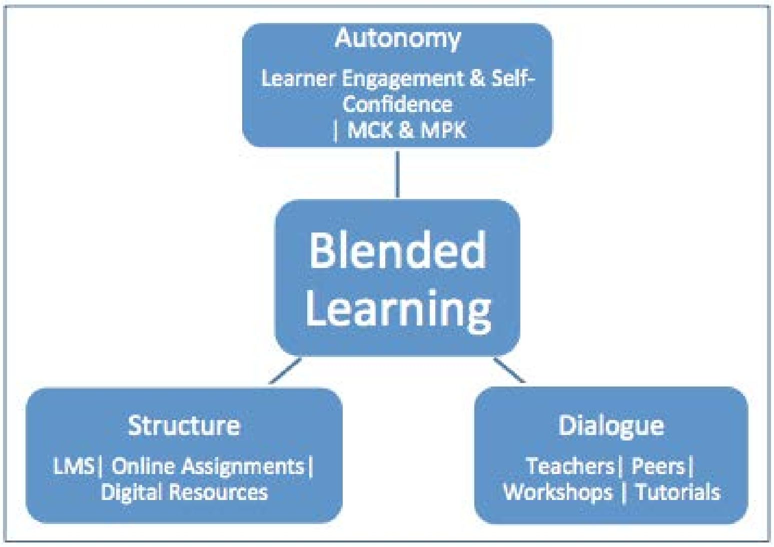

FIGURE 1: A graphical representation of TDT and key blended course design elements.

Structure refers to the extent to which an educational program, or course within a program, can be responsive to the learning needs of individual students. Dialogue refers to the interplay of words and actions between teacher and learner, and learner and learner, when one gives instruction and the other responds, and includes opportunities for students to "articulate their own emerging theories and generalisations, formalise their ideas, and test them in the public domain" (Tanner & Jones, 2002, p. 79). The third variable of transactional distance is learner autonomy, which is referred to as the agency of individual learners. This element recognises that it is ultimately "the learner rather than the teacher who determines the goals, the learning experiences and the evaluation decisions of the learning programme" (Moore, 1993, p. 31). Gokool-Ramdoo (2008) suggests that manipulations of structure and dialogue increase or decrease transactional distance, which in turn demands more or less autonomy from students in managing their learning. Benson and Samarawickrema (2009) note that learners early in their degree program, such as the PSTs in this research, generally demonstrate low levels of autonomy and thus require, at a minimum, high levels of structure in order to minimise transactional distance. Therefore, I needed to design the course to offer high levels of dialogue and structure in order to support the PSTs in the early years of their university degree. By way of specific examples, in this particular context, structure includes the online LMS (Blackboard); the various digital mathematics resources uploaded for PSTs (e.g. movies demonstrating mathematics concepts) and assignment tasks. Dialogue refers to the face-to-face interactions in workshops and tutorials, and, to a lesser degree, email correspondence and course announcements. Autonomy refers to what the PSTs bring to their own learning and includes elements of anxiety, levels of confidence, and knowledge of mathematics content.

Whilst TDT is generally well received in the academic literature, there have been some concerns raised regarding its usefulness. Gorsky and Caspi (2005) suggest that whilst the theory is important conceptually, its usefulness is limited as research has yet to show a correlation between student outcomes and variations of course design intended to minimise transactional distance. Murphy and Rodriguez-Manzanares (2008) indicate a weakness of TDT in that it narrowly focuses on an analysis of interactions between teacher, learner and learning materials, rather than investigating the more important element of the development of a community of learners. While cognisant of these differing perspectives, TDT is, from my perspective, an appropriate framework for analysing this particular context (PSTs early in their program; likely high levels of mathematics anxiety; limited mathematical backgrounds; studying in blended mode) and then determining the correct balance of dialogue and structure to likely match the projected level of learner autonomy and learning needs. This perspective is based on the use of TDT by the author in separate research investigating PST learning in both blended and online environments (Larkin & Jamieson-Proctor, 2015).

RESEARCH PROBLEM

In my current context, there were two key drivers shaping course redesign: firstly, my beliefs regarding effective mathematics education and the subsequent need to deliver mathematics education with an explicit focus on mathematics pedagogy; and secondly, the opportunity to utilise my extensive experience of online education to investigate the affordances of blended mode in mathematics education in a context where offering blended learning is a university priority. Separate research by the author (2015) focussed on changes to a course at a different university as it moved from face-to-face to solely online delivery of mathematics education. To better understand the impact of these changes on the PSTs at my current university, this article focuses longitudinally on one particular campus where the methodological changes to the course were initially resisted (by many PSTs and some colleagues) but eventually embraced by PSTs and most colleagues. Although I teach across three campuses, the focus here is on changes made at a particular campus which required significant course re-development. The decision to focus on one campus was taken because it was at this campus where the impacts of the methodological changes were most clearly felt. Although I will argue in the next section that the student cohorts are largely homogenous in terms of demographics, their experience of university mathematics education was not. At the campus under investigation, I was employed to replace two long retiring mathematics educators who both had utilised a largely didactic approach to teaching mathematics – supported by self-authored textbooks in both cases. One of the academics had previously taught Mathematics One to the cohorts in Iteration One and Two and hence their views about mathematics education were different to what they would receive from me. Additionally, the teaching approach I took was challenging to the mathematics educators on this particular campus. The primary aim across the three iterations discussed here was the use of TDT principles to provide high levels of structure and high levels of dialogue so that a learning environment would be created where PSTs felt engaged with the course and supported in developing the necessary self-confidence to commence teaching primary school mathematics at the conclusion of their degree. In so doing, I anticipated that they would simultaneously develop both MCK and MPK.

A secondary aim was to provide a positive experience of mathematics education to minimise anxiety about teaching mathematics, to challenge existing attitudes towards mathematics education, and to develop self-confidence regarding the teaching of mathematics.

Given this contextual background, the guiding research question for this article is, "What was the impact of methodological changes, guided by TDT, on PST engagement and self confidence to teach mathematics at Campus A?"

METHODOLOGY

The research methodology used in this article is a design-experiment approach which incorporates a cycle of data collection and reflection, course re-design, and then implementation of design changes (see Figure 2) to an existing face-to-face course in order to reduce transactional distance when offered in a blended learning environment. In so doing, the aim was to provide an appropriate balance among dialogue, structure, and learner autonomy to develop PST engagement and self-confidence (see Figure 2). In brief, a design-based experiment is concerned with the study of learning in specific contexts and then extending knowledge by generating models of successful innovation (Design-Based Research Collective, 2003). The design-based experiment cycle of data collection and reflection is an authentic research approach as academics involved in a teaching context are best placed to identify, at the local level, changes that need to be made to improve learning and teaching (Cohen, Manion & Morrison, 2002). The data set for this research consists of formal university end-of-course Student Evaluation of Course (SEC) and Student Evaluation of Teaching (SET) judgements, informal correspondence, and my reflections on the course delivery at Campus A over the period under investigation (2012-2014).

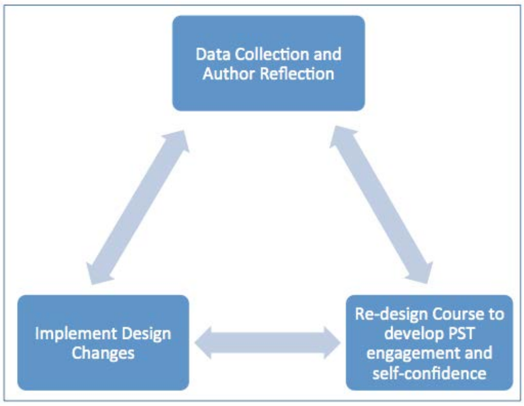

FIGURE 2: Design-experiment process of data collection, reflection, design change, and implementation.

This design-experiment cycle was followed across three consecutive years (2012, 2013 and 2014) to make on-going course modifications. The three iterations involved a total of 330 students at Campus A. Although the students changed each year, they were relatively homogenous from year to year at Campus A (and indeed across the three campuses during this period). I base this claim of homogeneity on a number of indicators. Firstly, the entry requirements in terms of school leaving scores were consistent across the three campuses; secondly, my experience of teaching across the three campuses for three years indicated a high degree of similarity among the cohorts; Thirdly, the students completed the same assessment tasks, with the same lecturer and mean overall attainment scores were very similar. The clear difference between Campus A and Campuses B and C was in the initial SEC and SET scores, which were highly variable. Given these factors, positive changes to

Student Evaluation of Course (SEC) and Student Evaluation of Teaching (SET) scores at Campus A, although potentially impacted upon by a range of factors outside the scope of this research, are likely to be indicative of successful course modifications, given the homogeneity established above.

RESULTS AND DISCUSSION

Iteration One (Semester 2, 2012)

My initial design decision was to pre-record an hourly lecture each week, which the PSTs were to view prior to attending their weekly two-hour tutorial. A second design decision was to emphasis different aspects of MPK according to mode of delivery. The one-hour online lecture primarily focused on theories of mathematics learning – e.g. theories of geometric development or principles for teaching measurement, as these MPK elements could most efficiently be delivered via this format. The tutorials (and optional workshop) were designed as collaborative, hands-on sessions such that PSTs could implement the learning theories in practical contexts and also have greater access to face-to-face support. The tutorials contained smaller numbers of PSTs (between 25-28), and incorporated access to a range of concrete and digital resources similar to those they will use in future classrooms. This was the first occasion I had taught these PSTs, who were in the second or third year of their degree. They had completed an introductory mathematics education course with another lecturer. This earlier course focused heavily on Number and was quite prescriptive and based on the lecturer's textbook. In terms of TDT, the initial course design included high levels of structure both within the LMS and also in the delivery of the weekly lecture and tutorials. In terms of dialogue, my expectations of the PSTs regarding lecture engagement, tutorial activities, course readings, and assessment were clearly outlined each week. Unfortunately the initial offering provided only limited opportunities for face-to-face dialogue with the PSTs, as I was required to use online delivery for the lectures and only offered a face-to-face workshop for the Campus A cohort once every three weeks. It became apparent that this lack of regular face-to-face dialogue required a high level of autonomy that was beyond the capacity of many PSTs.

PST feedback on Iteration One indicated that the course was unsuccessful at Campus A. Overall scores on a five-point Likert scale for the end-of-course university feedback question "I am satisfied with the quality of this course" was 2.6 (SEC scores for the author's other courses are consistently in the 4.6 – 4.9 range). This prompted a process of reflection, following the cyclical process suggested by Figure 2, as it was clear that there were specific factors at play on Campus A which limited the level of PST satisfaction and mathematical learning (See Table 1).

TABLE 1: PST feedback scores from Campus A. Semester 2, 2012

SEC Statement	Score	SET Statement	Score
This course was well-organised.	3.1	This staff member presented material in a clearly organised way.	3.8
The assessment was clear and fair.	3.0	This staff member presented material in an interesting way.	3.4
I received helpful feedback on my assessment work.	3.3	This staff member treated students with respect.	4.4
This course engaged me in learning.	2.7	This staff member showed a good knowledge of the subject matter.	4.3

The teaching (lecturers, tutors, online etc.) on this course was effective in helping me to learn.	2.8	Overall I am satisfied with the teaching of this staff member.	3.9
Overall I am satisfied with the quality of this course.	2.6		

A critical synthesis of SEC and SET scores and PST qualitative feedback indicated that the very poor outcomes at Campus A were likely due to four factors. Firstly, there was a focus on MPK in this course (as opposed to a strong MCK emphasis that the PSTs experienced in Mathematics One, taught by a different academic, in their first year of study). My expectation was that the tutorials would develop the PSTs' MPK as they had the opportunity to use materials to embed theories developed in the lectures; however, due to minimal engagement with the online lectures (see below), many PSTs lacked the pre-requisite theories of mathematics learning upon which to build the more practical components of MPK. The theory/practice praxis approach was also actively resisted by many PSTs who indicated that their expectation was a course that would focus on improving their content knowledge (See Thanheiser, Browning, Edson, Kastberg & Lo, 2013), and one that included very specific strategies to teach specific content. Many clearly expressed the view that mathematics education should solely be about learning (a) content and then (b) the "correct way" to teach the content. From their perspective they expected tutorials to consist of, for example, how to teach the multiplication algorithm or the area formulae. This contrasted with the approach I took which was more holistic in terms of concept development with only minimal focus on prescriptive teaching. PST feedback did not support my MPK approach e.g. "*Overall, the course should be more meaningful through practical activities… rather than theoretical research, given that teaching is a PRACTICAL profession"*. Secondly, some PSTs were simultaneously completing an elective mathematics course where they received messages regarding mathematics education substantively different from the approach taken in this course. PST feedback regarding this conflict included "*this course would benefit through advice and information from the teaching team for [course name withheld]*" and "*the course needed to provide concrete examples of content not just providing us with theories*". This is, of course, a teaching dilemma as there is a case to be made that teaching, if it is to be responsive to the PSTs needs, should be tailored to their requirements – in this case, more content. A counter claim could be made that content knowledge can be developed concurrently with pedagogical knowledge. In any event, this is largely a moot point given that I was explicitly directed to focus on mathematics pedagogy and I am broadly in agreement with this focus. However, I also recognise that low content knowledge is a problem to be addressed; consequently, the following scaffolds were in place for students with low content knowledge. One, worked examples in the workshops (e.g. authentic development of Area formula, taxonomies for shape classification etc.); Two, personal consultations regarding individualised study plans for developing numeracy; and Three, use of external (e.g. Khan Academy) and internal (e.g. university developed resources for mathematics numeracy development) web sites. Feedback from students indicated that they were appreciative of these highly personalised scaffolds.

Thirdly, there were issues regarding PST engagement with the online lectures and attendance / engagement at some tutorials. Consequently, for some PSTs, there was no understanding of the connection between the theory discussed in the lectures and its practical implementation in tutorial tasks. Finally, there was also a lack of personal connection with me as the lecturer. This was evident in PST feedback that also indicated a misconception concerning the cost of online versus face-to-face lectures (many students thought that online course offerings were less costly and therefore they were being financially taken advantage of) and also the view that I was offering the course in mixed mode for my convenience rather than as a consequence of my workload allocation - "*I am not paying for distance education*" and "*Online lectures may been more convenient for course convenor but it was not for some students*". These four concerns made it obvious that modifications would be required for future iterations of the course. The following reflection points were recorded for the redesign process in 2013:

- Offer a weekly blend of online lecture, face-to-face workshops, and face-to-face tutorials and also reduce the amount of content to be covered.
- Modify the online lectures to make them more engaging for the PSTs via the use of various technologies.
- More clearly articulate that the intent of the course is to develop MPK, not solely MCK.

Iteration Two (Semester 2, 2013)

The primary design weakness of Iteration One was an imbalance between online and face-to-face contact. This resulted in difficulties in establishing a productive relationship between me and the PSTs, or an authentic connection with them and the methodological intent of the course. In order to increase the level of dialogue, critical for developing MPK, a design decision for Iteration Two was an increase in the amount of time I was present on each campus each week. University restrictions remained the same for Iteration Two as they had been for Iteration One; that is, three hours weekly contact, the same convenor (the author), and consistency of assessment. In this paragraph I outline, from a TDT perspective, how changes in Iteration Two maintained the high structure, increased the level of dialogue, and reduced student autonomy when compared to Iteration One. High structure included self-contained, week-to-week modules (e.g., Week One - Linear Measurement, Week Six - Data Interpretation, etc.) and also very clear expectations as to the activities to be completed at the tutorials (e.g. task sheets). These changes improved PST understanding of how mathematics should be taught to encourage conceptual development. An increase in the level of dialogue was achieved via the delivery of a face-to-face workshop each week (by me) as well as my increased availability for individual consultations on the same day as the workshop (again modelling an approach to be used when they are teachers). As a consequence of high structure and increased opportunities for dialogue, there was less opportunity for autonomy as the PSTs received clear, weekly instructions about the course tasks. For example, a video was created explaining step by step how to complete the assignment which ensured a more consistent student response but at the cost of some student creativity. Although these changes reduced autonomy, it was a further example of MPK in that, at particular times in the teaching sequence, the school students they will one day teach will require more explicit instruction – e.g. initial teaching of algorithms where high levels of procedural accuracy are required.

The core design changes that affected dialogue and autonomy were (a) a re-allocation of the available three contact hours, (b) modifications to tutorials, and (c) a minor change in how the online lecture was delivered. The contact hours were re-allocated according to a "1+1+1" delivery model which incorporated a one hour online pre-recorded lecture with a focus on theories of mathematics learning; a one hour weekly workshop on each campus with a focus on demonstrations of correct language, materials and symbolic representations; and a one hour tutorial with tutors which specifically enacted MPK in various teaching scenarios – e.g. how, as an early years mathematics teacher, will you use Van Hiele's teaching sequence to assist students with visualising 2D shapes. This 1+1+1 structure operated in a similar way to the "flipped classroom" model (Zappe, Leicht, Messner, Litzinger & Lee, 2009). Using this approach, I primarily delivered theories of mathematics learning in the online lectures with the emphasis in the workshops on the practical implementation of these theories.

Secondly, the two-hour weekly tutorials offered in Iteration One were now divided into a weekly one-hour workshop (described above) and a weekly one-hour tutorial on each campus. I was guided in this redesign by considering what mathematical learning and teaching would be most effectively demonstrated in workshop scenarios (large number of PSTs), and what would best be taught in the tutorial (smaller numbers of PSTs – 25-28 PSTs in each tutorial). In terms of the student profile, this was the first occasion I had taught these PSTs who were in the second year of their degree. As with Iteration One, these PST's had completed Mathematics One with another lecturer. As before, this course focused heavily on Number and was quite prescriptive and based on the lecturer's textbook. Mathematical theories of learning from the lectures were developed further in the workshops, which had a strong focus on the use of concrete and digital manipulatives and appropriate mathematical language. The workshops were also an opportunity for me to model exemplary MPK, for example, authentic problem solving activities, scaffolding of tasks, inquiry learning, use of accurate external representations, and so on. The weekly tutorials were a final opportunity for PSTs to incorporate interactive learning opportunities with high levels of discussion and group tasks designed to a) further embed the lecture theory in practical activities; and b) encourage dialogue between lecturer and learners. The tutorials also provided a venue for the PSTs so that they could demonstrate their burgeoning MPK via activities, which mirrored what they could expect when completing their practical teaching experience - "*The tutorials felt as if we were already teachers on prac because we had to work in groups to explain and demonstrate how we would introduce maths concepts".*

The final design change was a modification to the online lectures that now included the use of annotations on the lecture slides. In addition, the weekly lectures were re-recorded as two, 25-30-minute mini-lectures that included 'homework" and "stop and think activities" to enhance MPK – e.g. which resources would you use to introduce the concept of angles as opposed to resources appropriate for determining the size of angles. Formal end-of-course evaluations and informal feedback throughout suggested that, as a consequence of these changes, there was a deepened development of MPK including an increased understanding of the importance of a mathematical approach emphasising concepts, skills, and strategies while at the same time developing their content and procedural knowledge e.g. "*It was the perfect course in balancing our need for primary school mathematics content and primary mathematics pedagogy*" and "*this course was engaging and helpful in developing an understanding of the content and pedagogies associated with Maths in primary schooling*".

As indicated earlier, although there was a different cohort in Iteration Two, the cohorts were largely homogenous from year to year, and the course offering they received was consistent in that they had one primary convenor (the author), the same tutors, and the same quantum of time allocation. With these considerations in mind, PST feedback indicated a clear preference for Iteration Two at Campus A. Overall scores on a five-point Likert scale for the end-of-course university feedback question "I am satisfied with the quality of this course" was 4.0, a significant positive change of 1.4 when compared to Iteration One.

TABLE 2 PST feedback scores from Campus A. Semester 2, 2013

SEC Statement	**Score**	**SET Statement**	**Score**
This course was well-organised.	4.3	This staff member presented material in a clearly organised way.	4.6

The assessment was clear and fair.	4.1	This staff member presented material in an interesting way.	4.5
I received helpful feedback on my assessment work.	3.7	This staff member treated students with respect.	4.6
This course engaged me in learning.	4.1	This staff member showed a good knowledge of the subject matter.	4.8
The teaching (lecturers, tutors, online etc.) on this course was effective in helping me to learn.	4.2	Overall I am satisfied with the teaching of this staff member.	4.6
Overall I am satisfied with the quality of this course.	4.0		

Drilling down further into the data, whilst there were improvements under each of the criteria, the most startling improvements were in the two areas arguably most important to the development of MPK: engagement in their learning (2.7 to 4.1 – a 1.4 improvement), and teaching being effective for learning (2.8 to 4.2 – a 1.6 improvement). This claim is based on the fact that the pedagogy used in the course to assist PST learning is the same pedagogy they will hopefully use when they are teachers – e.g. structured learning experiences, utilisation of accurate mathematical language, use of manipulatives etc. The positive changes to the scores are taken as a strong endorsement of the TDT design changes made to the course, given that the cohort had the same convenor and largely the same content and assessment. An examination of the written feedback further support this claim.

Although there were still some negative comments in relation to online lectures e.g. "*I didn't like the online lecture as I wasn't motivated to watch them. It was also hard for me to understand the concepts without having a visual example";* a majority of the PSTs indicated that they enjoyed the weekly blend of online lecture, face-to-face workshops, and face-to-face tutorials and felt that this contributed to their developing MPK, e.g. *"I liked the fact we had a 1 hour online lecture, a 1 hour workshop and a 1 hour tute - structure really worked for me and allowed us to work from a theoretical and practical perspective"* and *"the online lectures were extremely helpful and I enjoyed being able to refer back to the lecture content for both assessment and tutorial activities at any time"*.

PST feedback also suggested they benefitted from the flexibility of listening online combined with the opportunity to embed their knowledge with me each week with practical activities e.g. *"I liked the workshops as they gave us an opportunity to practice the skills we were learning about. It was very practical."* and *"The workshops were fantastic for further exploration of ideas and the lecturer made them interactive and engaging. The tutorials were helpful and insightful and gave me a better understanding of the course content."* Student feedback also suggested increased levels of teaching knowledge and confidence e.g. *"Maths has never been a strong point for me…I have really enjoyed maths this year and feel much more confident teaching the subject"* and *"This course has significantly changed my perspective of maths and maths education. Prior to the course I found anything maths related quite daunting. But I'm genuinely interested in it now and feel more confident in approaching maths education"*. Finally, feedback from PSTs indicated that weekly access to the convenor (in workshops and for consultations) was a critical aspect for positive engagement and engendered a positive experience of mathematics for the vast majority of them e.g. *"I enjoyed having online lecture, workshops and tutorials. I felt this utilised the contact time between teacher and students."* and *"I think this course is particularly well structured with the online/face2face components"*.

Iteration Three (Semester 2, 2014)

Iteration Two was particularly successful at Campus A in terms of positive changes to PST attitudes towards mathematics education and an increased engagement with learning likely to engender improved MCK and MPK. Despite the improvements, I again used the design-experiment model and reflected on the course ahead of the final iteration discussed below. Key components of the final iteration in relation to its success (See Table 3) were less to do with structure and PST autonomy, and almost solely related to dialogue (in terms of consistency of mathematical language) and then to dialogue more broadly in terms of relationships between the learners, the tutors, the convenor and other mathematics staff. In relation to the PST profile, tutorials again contained between 25-28 PSTs and, as with Iteration One and Two, these PST's were in their second year and had completed an introductory mathematics education course focussing mainly on Number. The effect of this improved dialogue on PSTs developing MPK is discussed below.

TABLE 3: PST feedback scores from Campus A. Semester 2, 2014

SEC Statement	Score	SET Statement	Score
This course was well-organised.	4.8	This staff member presented material in a clearly organised way.	4.9
The assessment was clear and fair.	4.7	This staff member presented material in an interesting way.	4.9
I received helpful feedback on my assessment work.	4.7	This staff member treated students with respect.	4.9
This course engaged me in learning.	4.5	This staff member showed a good knowledge of the subject matter.	4.9
The teaching (lecturers, tutors, online etc.) on this course was effective in helping me to learn.	4.8	Overall I am satisfied with the teaching of this staff member.	4.9
Overall I am satisfied with the quality of this course.	4.7		

As was the case between Iterations One and Two, PST feedback indicated an improved level of satisfaction for Iteration Three when compared to both Iteration One and Iteration Two. Again, although there was a different cohort, they shared many similarities with those PSTs in the initial and second iteration. Overall scores on a five-point Likert scale for the end-of-course university feedback question "I am satisfied with the quality of this course" was 4.7 with positive changes of 0.7 when compared to Iteration Two and 2.1 when compared against Iteration One. When compared to Iteration Two, the improvements at Campus A were reasonably consistent across the range of the criteria (mostly 0.4 - 0.6). As indicated, structural elements were not modified; hence, these improvements are likely due to a number of changes in the type of dialogue occurring in and around the course. Indicative of the types of changes to dialogue made were regular announcements regarding student engagement, student assignment tasks and exam preparation; and consistent language use by lecturer and tutors across the campuses with shared PowerPoint presentations for use at the tutorials. In addition, I was much more explicit in my use of appropriate mathematical language in the workshops and tutorials and more demanding in the assessment tasks that students use correct mathematical language. Consequently, in this iteration, this was one of the key criteria for success in their major assignment. PST feedback indicated a high degree of satisfaction with the level of consistency between course aims and course assessment (at a structural level) but also course convenor and course tutors (at a dialogue level) and indicated that this was instrumental in improved learning. PST feedback on consistency of message include "*Both Kevin the lecturer and Rebekah the tutor were fantastic educators who provided us with ample opportunities to learn, engage and succeed and the standout aspect was the organisation of workshops and tutorials*" and "*the lecturer ensured that all content is consistent*". Iteration Three was more successful than both previous iterations as it maintained the structural modifications from Iteration Two and also initiated consistent mathematics language. PSTs thus received a coherent experience, which again translated into noticeable improvements in their engagement and self-confidence with the anticipated increase in their MPK.

CONCLUSION

The process of course redesign discussed in this article occurred both within strict university procedures and policies and also within the constraints of what I consider to be core methodological principles in relation to best practice in mathematics education. The non-negotiable university policies were limited time (three hours available per week) and the one convenor (with the clear expectation that online lectures would be used and that the focus would be on pedagogy). The self-imposed, non-negotiable principles were the necessity of providing an experience of mathematics which thoroughly explored the theoretical underpinnings of mathematics education; modelled exemplary mathematics teaching in order to increase PST engagement and self-confidence with a likely flow on to improved MPK; and a course that challenged pre-conceived notions of mathematics teaching. The markedly improved formal end-of-course PST feedback (Iterations Two and Three), informal PST feedback, and my own reflections on the course offerings, indicate that this has been a successful experience of reflection, course redesign, and implementation with subsequent improved outcomes in terms of non-negotiable principles outlined above. As a consequence of this positive experience, PSTs reported an improvement in their self-confidence to teach mathematics, and more specifically in some cases noted, identified improvements in their MPK such that they feel confident that they can teach mathematics effectively in the future. Further developments in Semester 2, 2015 will include continual fine-tuning of the lectures, workshops and tutorials; minor changes to the scope of content to be covered; and a modified assessment task to more clearly emphasise the importance of developing MPK. It is a common problem in education, and fully acknowledged here, that the veracity of the outcomes claimed in any teaching intervention (in this case with 2nd year PSTs) take many years to bear fruit. As they are developing initial mathematics pedagogy in this course, I think it is reasonable to claim, based on SET and SEC scores and student feedback received at the conclusion of their practical experience that the course had a positive effect on the pedagogy they used during their practical experience and will therefore likely use when they commence teaching.

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