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Design and redesign: Investigating mathematics teacher efficacy in primary initial teacher education

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Introduction

This research was initiated as a proactive response to a major reform of the structures of initial teacher education (ITE) in Ireland to support best practice (Teaching Council, 2017). We are undergoing an iterative process of design research with the intention of investigating and refining the mathematics education modules undertaken by students on our undergraduate Bachelor of Education programme (Borko, Liston & Whitcomb, 2007).The first phase of the research involved the design of a module on Measures for 460 first year ITE students. Students' perceptions of the module and their mathematics teacher efficacy beliefs were investigated using an online questionnaire based on Enochs, Smith and Huinker's (2000) Mathematics Teacher Efficacy Beliefs Instrument (MTEBI). The second phase of data collection will commence soon. This involves inviting the same cohort to participate in focus group interviews.

Conceptual Framework

The conceptual framework underpinning this research is teacher efficacy. Self-efficacy considers how we perceive our ability to accomplish certain levels of performance and self-efficacy beliefs influence how we think, feel, and motivate ourselves (Bandura, 1997). The related concept of teacher efficacy has been defined as the belief that one can successfully bring about desired outcomes in one's students and is conceived as having two distinct components: personal teacher efficacy and teaching outcome expectancy (Enochs et al., 2000).

Personal teacher efficacy describes a teacher's perception of his/her personal effectiveness and ability to teach. Researchers have demonstrated links between effective teaching and teachers' self-efficacy beliefs and confidence in their own mathematical competency. The concept has been the focus of research in European contexts (e.g., Capara, Barbaranelli, Steca & Malone, 2006) and Klassen, Tze, Betts and Gordon (2011) highlight the internationalisation of teacher efficacy research in recent years. Teacher efficacy is pertinent to our programme design as teachers with high levels of efficacy have been shown to be more likely to employ inclusive teaching strategies with flexible goals, methodologies, resources and assessment practices that promote mathematical understanding (Enochs et al., 2000; Swars, Smith, Smith, & Hart, 2009; CAST, n.d.). Similarly, the self-efficacy of ITE students has been shown to be highly correlated to confidence in teaching mathematics (Bates, Kim, & Latham, 2011).

The second construct which contributes to teacher efficacy is teaching outcome expectancy. This relates to whether a teacher believes that effective teaching can result in quality learning outcomes

for all children regardless of a child's background, aptitude or disposition (Enochs et al., 2000). This construct has particular relevance in mathematics education where mathematics has been recognised as a 'gatekeeper' and notions of fixed ability and related pedagogical practices such as ability grouping have long been identified as problematic (Boaler, Wiliam & Brown, 2000). This strongly resonates with the ECER conference theme of inclusion and exclusion.

Our aim is more than simply an evaluation of our ITE programme (Adler, Ball, Krainer, Lin, & Novotna, 2005). We expect that the questions and conjectures which will arise at various points during our longitudinal research will inform theories of teacher learning as well as improvements in our teaching practice (Borko et al., 2007). Currently, we have designed and taught the first module of a four-module programme. The questions that guide us at present relate to students' current efficacy beliefs, students' perceptions of the module and how prepared they felt to teach Measures on School Placement (SP). Interrogation of students' perceptions of SP was included because early career experience has been shown to have a powerful influence on perceptions of efficacy and efficacy levels have been shown to be malleable at this career stage (Woolfolk Hoy & Burke Spero, 2005).

Methodology and Methods

The methodology employed was design research. This encompasses four discrete stages; design, enactment, analysis and redesign (Borko et al., 2007). In this section, we briefly discuss our course design, module enactment, and data collection strategy.

The initial focus on Measures aims to address children's lower attainment in this area in comparison to other mathematics topics, as revealed by national studies (Shiel, Kavanagh & Millar, 2014). The course consisted of two plenary lectures followed by nine two-hour seminars. Consideration was given to the subject matter knowledge (SMK) and pedagogical content knowledge (PCK) (Shulman, 1986) needed for the teaching of Measures. Content was designed to engage students in problem solving and to support them in interrogating their own SMK, pedagogical approaches and their preconceptions of mathematics. Identification of the attribute, units of measurement, instruments of measurement, accuracy and comparison were presented as core concepts of measurement (Haylock, 2011). Each seminar featured sample classroom activities and opportunities were created for students to experience multiple, progressive methods of supporting mathematics learning (Kennedy, 1997). A central component of the module involved students' collaborative planning and teaching of a Measures lesson in class. Constructive feedback was provided by lecturers, and sought from peers for this activity.

The first element of data collected was an online questionnaire based on the MTEBI (Enochs et al., 2000) with a small number of open questions pertaining to the Measures module and experiences of SP. All 430 students were invited to complete the questionnaire but only 40 did so. Despite the low uptake, the analysis gives insight into the experience of some students and offers future potential for scaling up. We will also soon invite all students who taught Measures lessons on SP to attend semi-structured focus group interviews (Freebody, 2003). Should the uptake be large, we will choose a

random sample of 12 students to make three, four-person groups. In these interviews, we propose to discuss issues arising from the MTEBI analysis as well as students' experiences of teaching mathematics on SP and their perceptions of the research module using an adapted interview protocol by Savage (2005). It is intended that thematic analysis (Braun & Clarke, 2006) of transcripts will be undertaken with results prepared in time for presentation at the conference. Participation was/will be on a voluntary basis with the option to opt in or out at any stage, with no impact for students' grades.

Preliminary Results

The MTEBI is well validated and has been used in multiple cohorts internationally (Swars et al., 2009). It consists of two independent subscales; the Personal Mathematics Teaching Efficacy (PMTE) subscale and the Mathematics Teaching Outcome Expectancy (MTOE) subscale. Each item has five possible responses on a Likert Scale ranging from strongly agree to strongly disagree. Overall, average students' scores tended towards the midpoint of the Likert Scale for both subscales but while the responses to the five positively worded PMTE items generally exhibited a high level of self-efficacy, responses to three of the eight negatively worded statements appear to contradict this. Nearly three-quarters of respondents reported believing that they may not possess the skills necessary to teach mathematics. Only 20% of responses indicated that they would not find it difficult to use manipulatives to support the teaching of mathematics with understanding and half reported that they have difficulty making mathematics engaging for learners. Some contradictory results also arose on the MTOE subscale. Students responses appear to suggest that they believe increases in pupils' mathematics achievement are due to the effectiveness of the teacher but pupil underachievement is not a reflection on teachers' effectiveness. Responses also suggest that the majority of respondents did not believe that the teacher is responsible for a child's interest or performance at school. In total, 32 respondents stated that they drew from the course content in at least a few SP lessons.

While caution is necessary regarding interpretations of these findings, they raise important issues for programme design. We plan to investigate further in our forthcoming focus group interviews. We hope to explore, for example, whether students' outcome expectancy beliefs are different for different school subjects. We also hope to explore sources of teacher efficacy (Klassen et al., 2011) and (dis)connections with the taught module.

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