The design principles of an online professional development short course for mentors of mathematics teachers

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This paper describes the design principles and content of an online asynchronous short course contributing to the professional development of prospective Mentors of Mathematics Teachers. We aimed at bringing together the participating teachers' expertise and wisdom of practice, and the evidence from relevant research and professional literature in mathematics education through carefully designed online activities and 'lightly' orchestrated peer collaborations. We expect our course to develop the participating teachers' appreciation of how their gained knowledge from research and literature empowers them to critically reflect on their own teaching practices and on how they support the practices of teachers they mentor.

Keywords: professional development, research-informed mentoring, online community, online learning, subject specific mentoring.

INTRODUCTION

Practicing mathematics teachers in schools in England, UK and all over the world (e.g. Australia, Ireland, Germany) are expected to contribute to the professional development (PD) of less-experienced colleagues. Repeated government calls in the UK require that all school-based mentors are experienced in delivering high quality PD of colleagues, have a deep understanding of the specialist subject required for high quality teaching of the subject and understanding of how teachers develop this knowledge (Cordingley, Greany, Crisp, Seleznyov, Bradbury & Perry, 2018).

However, nationally and internationally support for mentors is sparse and rather generic, at the expense of subject specific support (ACME 2015, Barrera-Pedemonte, 2016). Currently in England, in schools that work in partnership with teacher training institutions, mentors are offered subject specific PD support. This training though is limited to one or two twilight sessions in a year. Furthermore, the mentoring issues discussed and reported in the literature are mostly of a generic nature, i.e. more concerned with general teaching situations rather than with subject-specific teaching or teaching after initial training (e.g. Martin, 1996). According to the findings of the *Developing Great Teachers* review (2018), subject-specific Continuous Professional Development (CPD) that focuses on enhancing teachers' understanding of the subjects they teach; how pupils learn in those subjects; and how to teach them, is more effective in terms of its impact on pupil outcomes, than generic pedagogic CPD.

Additional factors such as time constraints, workload issues, caring responsibilities, costs of PD courses, prevent teachers accessing PD support. In particular, when the PD support is run at specific times in a year and physical attendance is required, teachers may be unable to take advantage of such support. Similar factors also account for a lack of engagement of teachers with the research. Despite an increasing recognition in the UK of the need for teaching to be a research-literate profession, teachers repeatedly indicate that their working conditions do not enable them to spend time reading research to improve their understanding or to determine how to use it to adapt their practice *(*Royal Society and British Academy, 2018).

To address some of the above factors and in particular accessibility issues, using modern technologies to support distance, life-long and online learning has become a common trend (e.g. Chen, 2007). Massive Open Online Courses (MOOCs) and Short Online Courses have made their appearance in the educational field worldwide (e.g. Laurillard, 2014). Laurillard and her colleagues have offered great insights into how best to design such online courses that "provide access to key materials and resources, and the opportunity to exchange ideas and experiences from [participants'] own institutional and national contexts" (p.5) and subsequently enable participants to co-construct knowledge. This opportunity to exchange ideas and experiences and network with peers is of great importance in online learning environments, especially those relying on asynchronous mode of delivery, since it is viewed as a way to compensate for the lack of teacher presence (e.g. Liyanagunawardena, Kennedy & Cuffe, 2015). Murphy and Laferrière (2003) argued that the success of online teacher communities for PD happens when the course materials are high quality interactive instructional materials, valuing what participants experience and contribute to the learning of others. As expected, though, online learning brings a number of challenges. For example, participants' online learning depends on the quantity as well as the quality of their peers' postings (e.g. Geraniou & Crisan, 2019). Building a mutual trust between participants and working together to reach a successful learning outcome takes longer in an online asynchronous course compared to face-to-face learning opportunities (e.g. Haythornthwaite, 2002). Such challenges need to be carefully considered when designing online courses and deciding upon the pedagogical strategies for providing an effective learning experience.

Our aim in this paper is to share our learning design and facilitation strategies adopted for an online asynchronous CPD course that offers a functional learning space with appropriate activities for critical self-reflection, meaningful discussions and where appropriate, co-construction of knowledge to take place. We begin by presenting the design of our 'Key Ideas in Mentoring Mathematics Teachers' (KIMMT) course that allows participants to learn from the course content and from each other while enrolled on an online asynchronous CPD course.

THE RESEARCH-INFORMED COURSE DESIGN

As mentioned above, our review of the mentor provision in England, but also worldwide, highlighted that there is an ever increased demand of new mentors in schools, a demand for support for mentors that is subject specific, and according to the recommendation of the *Harnessing educational research report (*Royal Society and British Academy, 2018)*,* a need of support for *all* teachers to use evidence and insights from research to develop their practice.

Our aim was thus to design a PD course, with the following learning goals for prospective mentors: to be informed by the subject specific maths education research; to engage with the evidence from such research in their own teaching; and to consistently draw on such knowledge in their conversations with the mentees, hence promoting a research-informed teaching practice of their mentees.

To orchestrate learning in such ways, we engaged with a research-informed framework for implementation of active learning practices into an asynchronous online environment, referred to in literature as 'An Architecture of Engagement' (Riggs & Linder, 2016) consisting of: Element 1: Syllabus Communication and Engagement Policy, Element 2: Course Orientation and Element 3: Modular Course Structure. Below we explain how this framework influenced the design of our course.

According to Riggs and Linder (2016), a modular course structure helps to frame the architecture of engagement throughout the course. *As such,* our KIMMT course is designed as a short online course, with activities that spread over five weeks. An orientation for an online asynchronous course introduces participants to the structure of the course (Element 2: Course Orientation, Riggs & Linder 2016), with each week requiring on average about four hours study time, as this is an amount of time manageable by teaching professionals, an argument supported by Laurillard (2014).

The first week focuses on welcoming participants by sharing expectations for online meaningful engagement on this course, informing participants of communication policies and the course schedule (Element 1: Syllabus Communication and Engagement Policy, Riggs & Linder, 2016) and asking them to introduce themselves to the course's online community. The other four weeks focus on powerful pedagogical inter-connected mathematics themes titled as "Fostering Algebraic/Geometric/Numerical/Functional Reasoning". Every themed week consists of an 'Introduction' to the week and the learning goals, followed by three main activities relevant to the respective theme, and finally a 'Concluding' section focusing on "Reflections, Learning Live and Concluding Remarks" (Element 3: Modular Course Structure, Riggs & Linder, 2016).

Our short five-week course (https://www.futurelearn.com/courses/key-ideas-in-mentoring-mathematics-teachers) is available on the FutureLearn platform and was first launched in January 2020. FutureLearn is a MOOC learning digital education platform jointly owned by the Open University, UK and SEEK Ltd, extending thus the access to our course resources to teachers in schools located in the UK and abroad, hence promoting principles of inclusivity in education.

The mode of delivery of this course is online and asynchronous, with ongoing online forum discussions between the participants and supported by us, aimed at promoting an **O**nline **Co**mmunity of practice (Goos, 2014) for prospective **M**athematics **M**entors (OCoMM). This delivery mode facilitates self-paced studying that accommodates more flexibly the various needs of practicing mathematics teachers.

As Laurillard (2014) reported about the design of a MOOC for Teacher CPD, such a course "has an audience who can benefit from each other's knowledge and experience, in addition to the information, ideas and research evidence the team could provide. The approach therefore was to 'orchestrate peer collaborative learning' as well as 'curate the key resources'" (p.12). As such, creating opportunities for participants to share insights from their own teaching practices, to learn about research evidence, and how to apply the newly acquired knowledge to their own practices, were of paramount importance in the design of our course. We achieved these by organizing the content of the course in two main strands, which we refer to as 'The Pedagogical strand' and 'The Research strand', while 'The OCoMM' provided the online space for learning throughout the course.

COURSE CONTENT

The two main interweaving strands of this course, namely the pedagogical and the research strands, are not context specific and as such the course offers learning opportunities to mathematics teachers who hold a variety of views about mathematics, its teaching and learning. Moreover, the research strand of this course draws from international mathematics education sources (handbooks, journals, conference proceedings, book chapters, etc.). We have selected descriptive and experimental research from relevant quantitative and qualitative studies recognised as influential in the mathematics education community worldwide, hence not adhering to a particular theoretical stance or view of mathematics teaching and learning.

The Pedagogical strand

For the *main activities* within each theme, we needed to choose which three pedagogical aspects of the teaching and learning of the maths topics to focus on. Considering the 'Fostering Geometric Reasoning' theme for example, our maths education research background enabled us to choose the most salient aspects of research in the teaching and learning of geometry, namely that geometric thinking and reasoning involve developing, attending to, and learning how to work with geometric images. So, one of the three activities is 'Visualising' and is designed to support participants to learn about the role visualisation plays in one's geometric reasoning and the importance of being pedagogically aware of what pupils 'see' when they 'look' at diagrams.

On the other hand, our experience as classroom teachers and teacher educators informed our design of the activities, each consisting of a number of tasks, called 'steps' in FutureLearn. The first step is **'A Mathematical Problem'**, usually related to a concept or a challenging topic to teach and is presented as a fictional scenario inspired from real life classroom situations that we experience ourselves as teachers, teacher educators, or read about in mathematics education literature. Biza, Nardi and Zachariades (2007) refer to such scenarios they used in the teacher education contexts "as tools for the identification and exploration of mathematically, didactically and pedagogically specific issues regarding teacher knowledge" (p. 308). In this first step we ask the participants to 'think about and suggest a solution to the 'problem' posed' and share their thoughts in the Comments section of each step. We included prompts such as '*What difficulties do you envisage pupils might have in tackling this question and communicating their solution both orally and in writing? When you have posted your response, consider that of another learner and offer your views and opinions on their answer'*. The next step of each activity focuses on reviewing and synthesising maths education research related to the specific maths topic under consideration.

The Research strand

One of our main goals for developing this course was to promote and empower prospective mentors with ideas, suggestions, advice, etc., which are informed by relevant mathematics education specific research. We wanted to offer them the means for reflecting on how such ideas can be applied to their own practice. In this respect, each mathematics-specific situation introduced in the activities of this course is either preceded or followed by a step titled **'What does the research say?'**. In each such step, we provide a selective summary of the research insights and results related to the specific mathematics topics under consideration. This summary consists of a very concise review of the research, where important details of the research studies themselves are left out (a deliberate decision), while references were included for participants to investigate deeper and further.

The review of research is then followed by a task that requires participants to engage with the research step and in the Comments section they are encouraged to reflect on how the reading could possibly help them gain an insight into the presented scenario. This step is important, as it precedes the step where we model for the participants how engagement with research could potentially support teachers in teaching the topic in a way that supports pupils' understanding of the particular concept or topic.

We have done this in a variety of ways. For example, participants are presented with a scenario in which a beginner teacher seeks advice from their mentor about how to address a particular misconception, or cognitive difficulty, or mistake, or flawed reasoning pupils propose. The participants are encouraged to act the role of a research-informed mentor: '*Reflect on your reading so far this week and imagine you are the mentor of the beginner teacher. In the Comments area, share your views on how you would advise them in this situation'*. We want the participants to make sense for themselves of the research and start thinking about ways in which such newly gained knowledge could be applicable to their real-life classroom situations.

In a final step, '**Using research to support pupils' learning'**, we model how the research reviewed could be used in mentor-mentee conversations. These are usually videos of mentors-mentees in conversations, where the mentor makes explicit references to the research reviewed when offering explanations or suggestions to her mentee. This step provides a 'solution' to the 'problem' given to participants in the previous step.

The OCoMM

When designing our course, one of the aims was to establish an online community to complement the learning on the course and ensure sustainability for our course goals. Our long-term goals were: (a) to empower mentors with research informed practice and instil in them a welcoming stance towards mathematics education research, and (b) to encourage peer collaborative learning and sharing good practice through a sustainable online mentors' community of practice.

The literature indicates that there is a need to facilitate and cultivate conditions that will nurture the development of the online community by community members. Learning in such communities does not just happen. As designers, we knew we had to create opportunities to purposefully foster the growth of our online community. Guided by Murphy and Laferrière (2003)'s finding that the success of online teacher communities for PD happens when there are opportunities for teachers to engage systematically and formally in this very process, we built in the design of our course such opportunities. Each activity has a number of online spaces for sharing and discussing ideas, allowing participants to dip into their wisdom of practice and feel that the experiences they bring to the learning on the course are valued.

Similarly, Laurillard (2014) suggested that they promoted engagement with their MOOC's resources by proposing discussions around "'to what extent they could implement a teaching idea shown in a video', and 'how they would overcome the barriers within their own school'" (p.13). The activities are designed such that the participants are regularly prompted to share their thoughts and ideas. Even though reviewing the output of their peers was not a requirement as per the advice by Laurillard (2014), we relied on the participants' own motivation in sharing their ideas and viewing this as an opportunity to reflect upon their own views and potentially reconsider and improve their current teaching and mentoring practice. It is the partnerships and interactions among the participants that define the learning community, and not the digital media, that are used (Riel, 1996). FutureLearn indeed provides the online space where participants 'come together' and interact as and when prompted by the activities of our course. Such interaction fosters the "process of building and rebuilding interpersonal relationships" (Di Petta, 1998, p. 62). We envisaged that our participants not only interact, but also "learn from each other's work, and provide knowledge and information resources to the group related to certain agree-upon topics of shared interest" (Hunter, 2002, p. 96).

CONCLUDING REMARKS IN LIGHT OF THE FIRST COURSE PRESENTATION

One of our main goals for developing this course was to promote and empower mentors with ideas, suggestions, advice on their mentoring and teaching practice, which are informed by relevant mathematics education research.

Reflecting upon the first course presentation and the participant feedback received via an end of course evaluation survey, we recognised that while FutureLearn provided the online platform where participants 'came together', it was the OCoMM that provided the online space where participants started building relationships and learned together.

In 2014 Laurillard claimed that engaging participants fully in online collaborative learning activities aimed at developing a research informed practice was still a challenge. In 2020, we found that the research-informed architecture of engagement framework supported us in establishing an OCoMM, where prospective mentors in particular, but also mathematics teachers in general from around the world, would network, contribute to each other's reflective comments, share experiences, seek advice, co-construct knowledge, and discuss research informed mathematics teaching practice and how it can be applied.

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