Mentor-Mentees conversations: Making explicit the teaching and learning of Mathematics

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This paper describes the design of a short professional development course for prospective mentors of mathematics teachers. A vignette activity sequence approach that promoted the use of topic specific mathematics education research was employed, as a means of supporting the course participants to critically reflect on, and make explicit their own teaching practices. We present and discuss the various components of the course, and account for how such a design served the purpose of encouraging the participants to be introspective of their ability to provide explanations and examples that place the teaching of specific mathematics topics at the heart of mentor-mentees conversations.

Keywords: mentors; research informed mentoring; subject specific mentoring; mathematics mentors; online course design

Context

This paper reports on a short five-week professional development course 'Key Ideas in Mentoring Mathematics Teachers' (KIMMT) which is available on the FutureLearn, a MOOC learning digital education platform. The course was first launched in January 2020 and has since had three complete runs.

The mode of delivery of this course is online and asynchronous, as this delivery mode facilitates self-paced studying that accommodates more flexibly the various needs of practicing mathematics teachers. The design considerations that led to the decision to offer this course online, aimed at promoting learning as part of an **O**nline **Co**mmunity of practice for prospective **M**athematics **M**entors (OCoMM). have been reported elsewhere (e.g., Geraniou & Crisan, 2020), and hence *are not* the focus of this paper.

Instead, this paper describes how a vignette approach to designing the activities of the course supported the participants to not only delve into their own wisdom of practice and become explicitly aware of how and why they 'do things the way they do', but to also critically reflect on why 'things work the way they do' through reading about relevant topic-specific mathematics education research.

Introduction

A 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. According to the findings of the *Developing Great Teachers review* (Cordingley et al., 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. A similar requirement for school-based mentors has been put forward, namely to 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 et al., 2018).

However, even when mentor teachers are experts in mathematics teaching, they are not necessarily able to conceptualize their view of the knowledge required for mathematics teaching (Asikainen et al., 2013), and most frequently they do not articulate the principles that underlie their pedagogical reasoning to their preservice teachers (Hudson et al., 2013).

These research findings clearly suggest that there is a need to support mentors through professional development opportunities that offer subject specific support, which encourages a focus on the subject matter, its teaching and its relation to students, together with an awareness of the importance of explicitly sharing such insights with beginning teachers, who otherwise are led to focus (more) on generic rather than subject-specific pedagogy when teaching a specific subject content area.

Mentor-Mentees conversations with a focus on the content knowledge

The limited professional development afforded to experienced teachers who undertake the role of a subject-specific mentors has been recognized to be an obstacle to the quality of mentor preparation. Research has shown that the socio-emotional and socialization roles tend to be the predominant aspects of a mentoring repertoire (e.g. Ganser, 1996). The majority of the six mentors in Hudson et al., (2013) study were found to explore content knowledge implicitly, through conversations at the stage of lesson planning, and by reviewing their mentee's lessons plan and giving them feedback on what else needed to be done to improve it, but generally the mentors did not always discuss the specifics of the content knowledge, let alone doing so explicitly.

Our aim was thus to design a PD course that would support participants (prospective mathematics mentors) to familiarise themselves with topic-specific maths education research; draw on such knowledge when reflecting on their own experiences of teaching those topics; and become aware of the importance of subject specific focus of mentoring exchanges that make subject matter and its teaching explicit.

The participants on the KIMMT course

The KIMMT course was designed for mathematics teachers aspiring to become mentors, but also for existing mentors of mathematics teachers who are seeking research-informed professional development opportunities for their teaching and mentoring practices.

For each presentation of the KIMMT course, data were gathered according to ethical standards (e.g. informed consent, guaranteed anonymity and confidentiality) (Patton, 1990). Data consisted of the participants' written contributions to the online forums of the course, as well as the transcripts of the two live, one-hour online sessions, where the participants had the opportunity to interact in real-time with the course educators and the other learners on the course, to discuss any course content related aspects. The participants' consent for using their contributions for publications purposed was sought at the start of the course, therefore the names of participants quoted in this article are pseudonyms.

Using Vignettes as a Design Approach to the Course Content

The KIMMT course covers four carefully chosen, powerful pedagogical and inter-connected themes of the school mathematics curriculum titled as "Fostering Algebraic/Geometric/Numerical/Functional Reasoning", where each weekly theme requires on average about four hours study time of the three main activities.

Each activity is designed using a vignette approach. There are many reasons educators use vignettes as a teaching tool, as they encourage professional development through self-reflection and critical analysis, as well as through group discussion since it has the benefit of being shared beyond own personal experience. Jeffries & Maeder (2011) highlight the key benefit of using vignettes, namely that they provide users with "incomplete short stories that are written to reflect, in a less complex way, real-life situations in order to encourage discussions and potential solutions to problems where multiple solutions are possible." (p. 163). Inspired by Wilkerson et al.'s (2018) vignette activity sequence (VAS) approach, we too employed VAS to structure each activity of the KIMMT course. This enabled us to design a sequence of steps within each activity that: starts by valuing the participants' wisdom of practice (step 1); builds on it with a knowledge base of research readings (step 2); supports critically reflection on their own teaching practice (step 3); raises awareness of the importance of explicitly sharing such insights with the beginning teachers (steps 4 and 5).

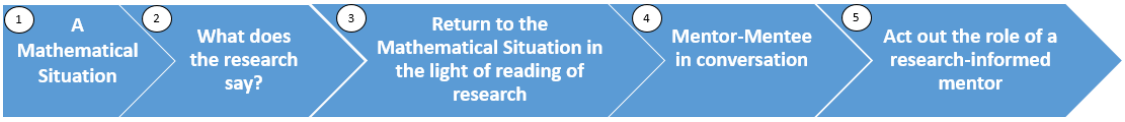

Figure 1: The VAS of the KIMMT course

In the following, each step in Figure 1 is described in some detail, and exemplified with data collected from the course participants.

Step 1: Each activity starts with **A Mathematical Situation,** 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 (designers of the course) experienced ourselves as teachers, teacher educators, or read about in mathematics education literature. To keep in tradition with the nature of vignettes, the mathematical situations are brief and narrowly focussed on a specific maths concept.

Example from KIMMT - In the activity Expressing mathematical relations, participants are invited to consider the following problem: Write an equation using the variables S and P to represent the following statement: There are six times as many students as professors at this university." (Clement (1982), as cited in Arcavi (1994; p. 27)).

When a vignette approach is used in education, participants are typically asked to comment on how they think the character/s in the story of the vignette would feel about or act in the given situation, or how they themselves would react and act in the given situation. In this step 1, the participants reflect on their own teaching practice encouraged by prompts such as *What difficulties do you envisage pupils might have in tackling this question and communicating their solution both orally and in writing?*, and then share their wisdom of practice by offering a 'solution' or a comment to the mathematical situation, which they upload as written text in the online discussion forums.

Carmina's comment indicates that this step, and the course in general, did help her become more explicit about her practice:

> "The course took me outside my comfort zone, as I had to type up my thoughts and I never had to do so before, so personally I benefitted. Because you have to think about what you are doing rather than you just saying it and not remembering what you said because it is gone. Whereas in writing you see it, then you constantly see it and revisit it to change it as a result of thinking about things more."

Step 2: In the step **What does research say?**, the framework for conceiving and presenting "solid findings" as put forward in the series of articles by the Education Committee of the European Mathematical Society (2011) was an instrumental first step in our selection of research on the teaching and learning of specific mathematics topics. The four criteria for identifying 'solid findings' are: 'results from trustworthy, disciplined inquiry'; which 'are generally recognised as important contributions that have significantly influenced and/or may significantly influence the research field'; which 'can be applied to circumstances and/or domains beyond those involved in this particular research', and most importantly for our KIMMT course, which 'can be summarised in a brief and comprehensible way to an interested but critical audience of non-specialists (especially mathematicians and mathematics teachers)' (EMS Newsletter September 2011, p. 46).

Example from KIMMT - In the 'Fostering Algebraic Reasoning' module, from the vast mathematics education research in algebra, we settled for three big ideas: *Mathematical Relations, Algebraic Language,* and *Solving Equations,* with the aim of providing the stimulus for considering how to support pupils in identifying mathematical relations and expressing them symbolically; manipulating algebraic expressions; and justifying the steps when solving equations, as opposed to just describing the method they are using.

In this step, our summary of research is followed by activities that aim to model how engagement with research could potentially support teachers in a number of ways, through offering: an insight into pupils' misconceptions, mistakes, and/or challenges in understanding a particular mathematics concepts; a better approach to teaching a particular topic; recommendations as evidenced in and derived from the relevant research reviewed.

Jane shared with her peers on the course how this step impacted on her thinking about her own teaching practice:

> "I read the research and it made sense, but to me I needed to try things out, to go with the experiment."

Jane went on to test out a mathematics question suggested by the literature she read, which was very similar to the *Expressing mathematical relations* activity she herself did on the KIMMT course. She was surprised by the results of this experiment, as only 9% of her 'top set' pupils answered correctly the question: How many days are there in a week?', with w = 7d being the most popular answer. Jane commented on this experiment:

> "I think I kind of was aware of it…I am not sure…but now I am definitely aware of this being a big misconception, and reading the papers which explained why students make these mistakes…so I will be teaching this better from now and support my mentees better with this topic."

Step 3: The next step of each activity consisted of a **Return to the Mathematical Situation in the light of reading of research,** where the participants are asked to

read the selected research and critically reflect on how such reading could possibly help them gain an(other) insight into why 'things worked the way they did' for them. This step is very important in providing the incentive and supporting the prospective mentors delve into their own wisdom of practice and become explicitly aware of their pedagogical reasoning.

Example from KIMMT – In this step, we would like you to consider how to engage with the research review presented in the previous step to help a beginner teacher who is asking you for advice on how to plan for a lesson on solving linear equations and, in particular, how to teach the 'Balancing Method' approach.

Step 4: The next step models engagement with research in **Mentor-Mentee conversations**. This is a video vignette scripted by the designers, with the purpose of making explicit references to the topic-specific mathematics educations research presented in earlier steps in order to address the **Mathematical Situation** proposed in Step 1 of the VAS.

Example from KIMMT - This video shows a conversation between a mentor and a mentee, where the mentor, informed by the research reviewed so far, is helping her mentee plan a lesson on solving linear equations using the 'Balance Method'**.**

In this step the participants' attention is drawn to how the research-informed mentor advises the mentee to consider various aspects, such as the concept of equivalence, how and when to deviate from using the 'balance method' approach, and how best to justify the solving steps and method overall. Together, the mentor and mentee discuss the crucial steps in a solution and reflect upon the mathematical justifications.

Samira reflects on her learning from the video vignette:

> "I think it is important that the mentor start[ed] the discussion by asking the trainee to model the approach they plan to use. This allow[ed] [for] a very beneficial discussion to follow. The mentor correctly explain[ed] the importance of the language used and how poor choices [of language such as] 'get rid of' can lead to misconceptions. The mentor was able to support the trainee how to further scaffold the learning, using pictures to emphasise the importance the equivalence. You can see evidence of research based mentoring as the mentor talk[ed] about the key misconceptions identified in research, such as the importance of equivalence and the language used in algebra."

Step 5: Finally, the 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. Through prompts such as: *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',* the participants are encouraged to **Act out the role of a research-informed mentor**. Our aim with including such a vignette in the last step of each activity was to encourage the participants to make sense for themselves of the research they read, and start thinking about ways in which such newly gained knowledge could be applicable to the teaching practice.

Tom's comment seems to confirm the desired impact:

> "I [too] enjoyed thinking about things more deeply. I sometimes done things that I came across in this course, but not necessarily know what have been called [referring to understanding the minus sign in three senses: unary, binary, and symmetric]. It was good to be able to read more about it and pass this on to the beginning teachers, not just the techniques, but why and how it works or it doesn't."

Discussion and concluding remarks

The motivation for our KIMMT course came from consistent recommendations of the body of research we reviewed, namely that in their role, it is vital that mentors are explicit about and are able to articulate their teaching practices. We designed the KIMMT course in order to support the participants (prospective mathematics mentors) in this respect.

The steps of the vignette activity sequence (VAS) of each activity require teachers to explicitly engage with research, to reflect and deconstruct their teaching practices, while the design of the course ensured that the content knowledge was put forward as the focus of mentor-mentees conversations.

The asynchronous online delivery of this course meant that the participants shared their views and justifications for the choices of pedagogical approaches in writing, in the OCoMM spaces of the course, often after reading contributions of other participants on similar issues. At the end of the five-week course, the participants commented on how the activities created habits of them being explicit about their own teaching practice and bringing into their awareness the need to do the same with their mentees, as modelled by the video vignettes where sharing own practice, and research-informed teaching approaches was the focus of the mentor-mentees conversations.

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