Promoting a research-informed mathematics teaching practice.

Cosette Crisan describes prospective mentors' learning in a professional development course.

Introduction

This article provides a brief description of a recently developed professional development course designed to support and promote a research-informed approach to mentoring mathematics teachers. I will be using specific examples lifted from the course content itself, together with past participants' own (anonymised) contributions to the course which account for their learning.

About the KIMMT course

The *Key Ideas in Mentoring Mathematics Teachers* (KIMMT) is offered as an online asynchronous professional development course. We feel the asynchronous delivery mode facilitates self-paced studying that accommodates, more flexibly, the various needs of the participants on this course, most of whom are envisaged to be practicing mathematics teachers. The course allows and encourages participants to dip into their wisdom of practice, to share and discuss the new ideas encountered by critically reflecting on both their teaching and mentoring practices. Such sharing of ideas and learning from each other is facilitated by the online collaborative spaces which are built in this course.

This course is 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. Moreover, as improved subject knowledge for teaching mathematics to 11-18 year old students is among the learning outcomes of this course, any mathematics teacher wishing to enrich their subject knowledge for teaching mathematics by engaging with relevant mathematics education research and by understanding how it can be applied to their own teaching practice also benefit from the learning on this course.

Why a focus on mentors and mentoring?

In their capacity, mentors are best place to promote and support less experienced colleagues in developing their teaching practice, including promoting engagement with research. Repeated government calls in the UK require that all school-based mentors are experienced in delivering high quality professional development 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). A review of the support for mentors nationally and internationally clearly indicated that such support is sparse and rather generic, at the expense of subject specific support (ACME 2015, Barrera-Pedemonte, 2016). According to the findings of the *Developing Great Teachers* review (Cordingley et al., 2018), subject-specific continuous professional development 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 professional development courses.

Why a research-informed focus?

Mentors are experienced mathematics teachers who draw on their wealth of knowledge about what works and is effective in teaching and learning of mathematics. They reflect upon this knowledge to consider how to best mentor less experienced mathematics teachers and colleagues. While their wisdom of practice is a rich source for supporting their mentees, a research aware and research informed mentor is empowered to share not just from their own experiences that worked or not in those particulars contexts they experienced. As such, mentors in schools play an important role in helping teachers see the relevance of research to classroom practice and supporting them develop of a deeper understanding of the role of research in mathematics education. Such mentor-mentee conversations could spill over into conversations with other mathematics colleagues, not just with their mentees, contributing to a research aware mathematics department.

The design consideration of the KIMMT course

The content of the KIMMT course is organised in two main strands, namely 'The Pedagogical strand' and 'The Research strand', while the third strand 'The Online Community of Mathematics Mentors (OCoMM)' provides the participants with an online space for collaborative learning throughout the course.

In the following, each of these strands is exemplified with some content lifted from the course itself. At the same time, data collected from the online written contributions of the past participants will be used to illustrate how the design of the course supported the participants to develop an appreciation of how their gained knowledge from research empowered them to critically reflect on their own teaching practices and on the practices of teachers they mentor.

The data used in this article is taken from the online contributions of the spring 2020 presentation of the KIMMT course. The 47 participants, from seven different countries, learned together over the five weeks of the course, with each week requiring on average about four hours of study time. The participants' consent for using their contributions for publications purposed was sought at the start of the course, and the names of participants quoted in this article are pseudonyms.

The Pedagogical Strand
The course is designed around four powerful pedagogical, inter-connected, mathematics themes:

1. Fostering algebraic reasoning.
2. Fostering geometric reasoning.
3. Fostering numerical reasoning.
4. Fostering functional reasoning.

Each themed week consists of an 'Introduction' to the week and the learning goals, followed by three main activities relevant to the respective theme. For example, within the Fostering Geometric reasoning theme, the big ideas in geometric reasoning as identified by mathematics education researchers over the years influenced the focus of the three main activities. The first activity, *Working with diagrams*, provides the stimulus for consideration of how to support students to talk about diagrams or geometric features and move beyond what 'it looks like it'. The importance of labelling diagrams and naming them, not just for the purpose of being able to talk about the diagrams, but also for drawing attention to properties which are of geometric interest, is emphasised in this activity. The second activity *Visualising* considers 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. Finally, the third activity *Invariance* models how to support students to progress in their geometric reasoning from 'because it looks like it' to producing convincing arguments for 'it always works'.

Each activity introduces a 'mathematical situation', presented as a fictional scenario inspired from real life classroom situations that we experienced ourselves as teachers, teacher educators, or read about in mathematics education literature. Such 'situation' could be, for example, a scenario in which a beginner teacher seeks advice from their mentor about how to address the teaching of a specific mathematics concept or a challenging mathematics topic, as exemplified below:

> For example, considering the 'Fostering Numerical Reasoning' theme, one of the activities focuses on **'Working with negative numbers: language and notation'**, which is designed to support participants to reflect on the implications of language and notations used for negative numbers.
>
> Prior to engaging with each activity, participants are encouraged to share from their own pedagogical experiences related to the specific mathematics topic under scrutiny. Here is Mark's posting in the OCoMM: *Negative numbers is very confusing for students. The issue is understanding that minus, subtract and negative have the same meaning. It is better in my opinion to start with subtracting a negative number instead of minus minus. Only when they understand that we can move on to minus minus, then I will move on to rules: --=+, -+=-…*

The participants are asked to suggest a way to support the beginner teacher and share their thoughts in the OCoMM space. Very importantly for their learning, the participants are encouraged to reply to each other's posts, as shown below:

> For example, Samir responds to Marks' posting (from above), confirming that indeed, *Students struggle adding and subtracting negative numbers, especially when they see two operations next to each other (--, +-, -+). The challenge for students is figuring out what to do with the signs.*
>
> Similarly, Amos shares from his experience, adding to the ongoing online discussion: *Pupils will use a number of words and have numerous understandings of what they mean. So we have a mish-mass of minus, take away, less, remove, subtract, negative, less than etc. Students seem to be stuck with their previous learning as correct and struggle to move onto a wider understanding.*

The Research Strand
The next step within each activity is part of the research strand, which provides a selective summary of the research insights and results related to the specific mathematics topics under consideration. 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*?

For example, in the activity **Working with negative numbers: language and notation,** the participants are given the opportunity to familiarise themselves with a number of research findings (Vlassis, 2008 – about understanding the minus sign in three senses: unary, binary, and symmetric) and recommendations around implications of the language and notations around negative numbers (Bofferding, 2014).

This summary consists of a concise review of the research, where important details of the research studies themselves are left out, while references are included for participants to investigate deeper and further. After familiarising themselves with the summary of research, the participants are encouraged to act the role of a research-informed mentor by reflecting on the reading of research and thinking about ways in which such newly gained knowledge could be used to advising the beginner teacher. 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.

This step is important, as 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 real-life classroom situations.

For example, here is such a scenario: "A beginner teacher seeks your advice on how to tackle some frequently-occurring mistakes he has noticed his pupils make when checking the answers to the homework. Pupil A is surprised by the teacher's feedback on his incorrect answer. "But sir, I am right. -3 - 2 does equal 6 because minus and minus makes a plus and since there is nothing left between 3 and 2, you times them together."

Commenting on what they would do in such situation, Samir explains*: Pupil A is very confused, possibly using a combination of binary and symmetric understanding. I would suggest changing the language to Negative 3 Subtract 2 and displaying how this would work on a number line. I would suggest that the first number is your starting point*.[..]

The excerpt above indicates Samir's explicit engagement with research in order to analyse and interpret Pupil A work in a given scenario provided in the course. These few examples have been included in this article not only to illustrate the design of the course and its content, but just as importantly, to provide the reader with some snippets of evidence for the learning that is facilitated by this course. Analysis of the data collected from participants' online contributions, and also from the two optional live online discussions between designers of the course and the participants added to the evidence which accounts for how the design of the KIMMT course supported the participants to be introspective of their ability to provide explanations of and solutions to classroom-inspired scenarios, that are informed not only by their wisdom of practice, but also by the mathematics education research base of the course.

References

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Cosette Crisan and Eirini Geraniou, both former mathematics teachers, and currently mathematics teacher-educators and researchers at UCL Institute of Education, University College London, designed the KIMMT course. The course is available on the FutureLearn platform, with four online asynchronous presentations per year:

https://www.futurelearn.com/courses/key-ideas-in-mentoring-mathematics-teachers