The Impact of Weekly Formative Video Feedback on Pre-Service Teachers' Experiences in Online Mathematics Education

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This paper investigates, using a case study methodology, the impact of formative video feedback on the educational experiences of early childhood and primary preservice teachers (PST) completing a pedagogically focused mathematics education unit in a fully online mode. Given the trend over the past 10 years towards the delivery of university mathematics education courses online, this research is important. It is particularly timely given the current world health crisis, where universities are hurriedly rolling out online courses. We argue, based on the findings of this initial pilot, that the use of regular, formative video feedback has a positive effect on PST learning, and on the way PSTs perceive and engage with the feedback provided in video form, and on the affective connection this platform provides between the PST and the lecturer. We suggest that these themes have the potential to positively impact on PSTs' knowledge of content and pedagogy in the context of university mathematics education.

Keywords · Formative Assessment · Pre-Service Teacher Mathematics Education · Video feedback,

Introduction

Feedback is one component of a broad range of formative assessment strategies. Formative assessment is designed to monitor the development of student learning and to provide feedback and support for such learning. Formative assessment should be part of "everyday practice by students, teachers and peers that seeks, reflects upon, and responds to information from dialogue, demonstration and observation in ways that enhance ongoing learning" (Baron, 2016, p. 2). Formative assessment can assist students in identifying strengths and weaknesses as a course of learning unfolds and, at the same time, can provide information to teachers to tailor future learning. It includes a range of design and assessment procedures, which are utilised by teachers during the learning process in order to enhance student achievements (Henderson et al., 2019). Importantly for this research, it typically involves qualitative feedback, which focuses on the details of a student's current understandings through their learning artefacts and in-class performance and provides an opportunity to further develop and improve the submission (Wiliam & Black, 1996).

As experienced mathematics educators, we acknowledge that formative assessment is nothing new, since sustained successful teaching requires us to adapt our teaching in the light of evidence about the success or otherwise of previous teaching. However, formative feedback in

the Higher Education (HE) context is often difficult to implement or sustain, due to the nature of teaching workloads, large cohort sizes etc. In addition, the move to online delivery of courses initially designed for face to face mode places pressure on academics to modify the types of feedback they deliver. This study is concerned with exploring a less common formative feedback strategy for PSTs completing a course in fully online mode; that is, weekly video feedback posted to the course site. The video feedback provides formative assessment to the online PSTs on their engagement with the course materials and on their responses and artefacts they have produced each week. This video feedback does not replace all written communication with the PSTs (such as forum responses from the lecturer), but its implementation reduces the amount of written weekly feedback often required in online courses.

Our perspective on the role of the preservice teachers (PSTs), and of ourselves as teaching academics, is very much grounded in constructivism and we flesh out the role that feedback plays in a constructivist approach to learning and teaching in the conclusion and implications section of this article. The overarching research question driving this study is: *How does formative video feedback contribute to PST's experiences in a pedagogical mathematics education course?*

Exploring Video Feedback

We commence by defining what we mean by video feedback and then discuss formative video feedback. Video feedback incorporates images and sound, thereby mimicking face to face interaction and utilises "other forms of communication they [students] are used to in their technology enriched lives" (Johnson & Cooke, 2014, p. 112). The use of screencast video as a tool for the delivery of in-depth explanatory feedback, creates rapport and a sense of support for students, and has proven highly effective in a number of instructional contexts (Johnson & Cooke, 2014) for both student-student and teacher-student formative assessment (see Balzaretti et al., 2019). In the context of this study, formative video feedback was used to communicate more than just written feedback in visual and audio form. The formative feedback was provided to small groups (rather than individually) and incorporated micro teaching sessions, which gave the PSTs the opportunity to see and observe a range of mathematical problem-solving strategies in real time. For example, one task required the early childhood and primary PSTs to explore a cube that was created from 1cm cubes, in a 3 x 3 x 3 structure. The PSTs had to visualise and reason how they may change the surface area of the cube (by a defined measurement), via the removal of different 1cm cubes. The PSTs needed to find patterns and explain their reasoning in the removal of cubes and the effect this would have on the overall surface area of the new object. As this was a visualisation task and working on the assumption that the PSTs would not have access to classroom materials at home, Author 1 used the micro teaching session to model, with concrete materials, a range of problem solving strategies. The strategies modelled in the feedback were based on the PSTs prior engagement and submissions, and Author 1 would anonymously share different examples of PSTs' work, critiquing the strengths and areas for development required in each example.

Written feedback does not offer this range of affordances, as the PSTs cannot effectively "see" the activity or strategy in action in their written feedback. Furthermore, affective components such as tone and rapport cannot as easily be built or communicated using written feedback methods. As many PSTs experience high levels of anxiety and a lack of confidence in their mathematics education courses (Larkin, 2016; 2017a; 2017b; Larkin & Jamieson-Proctor, 2015), more so than other courses within their degree (Sanders et al., 2019), the use of formative feedback that includes an affective dimension was an important driver in the decision to use formative video feedback (Larkin, 2017a) in this course. Kuntze (2006) indicates that video offers the

possibility to provide feedback on instructional situations, with the added advantage that PSTs can engage in multiple viewings to maximise learning benefits.

Literature Review

In this article, we take as assumed the positive outcomes presented in the literature in regard to formative assessment. Thus, our focus narrows to the impact of weekly video feedback provided to early childhood and primary PSTs studying a mathematics pedagogy unit fully online in an Australian university. This short review of the literature synthesises a range of issues concerning the provision of feedback, including the role of assessment in mathematics education; the positive outcomes associated with feedback and its impact on student affect; and the use of a range of online feedback tools. We then look more closely at the important contribution online video feedback can make in relation to developing PSTs' experiences as they learn how to teach mathematics.

Formative Feedback

As indicated earlier, a core component of formative assessment is feedback, acknowledged as crucial to student learning in higher education (Biggs, 1999; McCarthy, 2017), with quality feedback regarded as one of the most powerful influences on student achievement in higher education (Robinson et al., 2015). As a great deal of research exists regarding feedback, here we provide just a brief synthesis. Feedback can be defined as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p. 81). Robinson et al. (2015) argue that effective feedback enables students to understand what is required; helps students to make an accurate comparison between the required work and their own performance; and prompts some action which will help students to close the gap between their work and the expected standard. To these requirements, as important conditions under which feedback supports learning, can be added an emphasis on timing of feedback, content and quality of feedback, and student engagement with feedback (Robinson et al., 2015). As was the case more broadly with formative assessment, to qualify as feedback the information provided must be useful in closing the gap between actual and desired levels of performance (Wiliam & Black, 1996).

Unfortunately, in many higher education mathematics courses, teacher feedback solely involves written comments on student assignments, and, in the case of content knowledge courses, students may only receive summative feedback as exam results. Added to these limitation is the observation that PSTs often do not engage with teacher written feedback beyond ascertaining the overall grade, and it has been argued that corrective written feedback does not improve students' written competencies (see Robinson et al., 2015). Johnson and Cooke (2014) report on research indicating that only 35% of first-year Australian university students perceived that the feedback they received was helpful to their learning; and a UK National Student Survey reported that students consistently rate both the quality and timeliness of the feedback they receive as poor, when compared to other aspects of their student experience (Robinson et al., 2015). Thus, PSTs rarely experience, during their formation as teachers, the formative assessment practices we hope they will use in their future classrooms (Larkin et al., 2016). Timely and informative assessment feedback is a critical factor in developing teacher-student and peer-peer relationships because the use of feedback by teachers provides the foundation for learner autonomy and for self-regulation (Zimmerman, 1989), as well as serving as a framework for high

achievement (McCarthy, 2017). These factors form part of our motivation for trialing a different form of feedback for the PSTs in our context.

Iannone and Simpson (2013) argue, at least in the case of mathematics, that students' beliefs and attitudes tend to move towards their lecturer's beliefs and attitudes during their studies, and that this likely includes messages about the role of assessment and feedback in mathematics. In light of this research, it appears that mathematics educators who are able to (a) utilise a range of information gathered from students to adjust the mathematics content they cover and the methods by which they teach, and (b) provide formative feedback during the process, are more likely to help students succeed at high-quality work (Gotwals et al., 2015).

Affect and Mathematics Education

An important aspect of feedback is its influence on PSTs' affective experience and also on their perceptions of the value of feedback, as both of these aspects are strong influences on student learning (Iannone & Simpson, 2013) and their own feeling towards mathematics education. Investigating PSTs' attitudes is important as attitudes formed during their formative professional years have a lasting impact on their professional practice (Larkin & Trakulphadetkrai, 2019). This is especially important in the context of mathematics education, as Brown, Westenskow and Moyer-Packenham (2011) found that PSTs typically experience higher levels of mathematics anxiety, a general lack of confidence for teaching the discipline, and can also demonstrate negative attitudes towards mathematics (Itter & Myers, 2017; Sanders et al., 2019), each of which will impact on their professional identities.

In regard to the impact of online feedback and affect, online formative assessment has been shown to reduce the level of anxiety among students (Orange et al., 2018). Due to the asynchronous nature of online learning contexts, instructors can use video as formative assessment to further develop rapport with students studying in online or blended mode (Dixson, 2010; Larkin, 2017a; McLoughlin & Lee, 2010). Formative assessment can enhance student motivation and foster feelings of competence (Faber et al., 2017); however, such outcomes can only be achieved if online instructors deliver prompt feedback to students, packaged in a manner that makes sense and that allows students to correct their misconceptions in order to facilitate meaningful learning (Orange et al., 2018). With regard to mathematics education, this tool for delivering formative feedback has the potential to mitigate some of the affective issues that are persistent in the discipline of mathematics, by providing a context in which rapport and support is built with students, to help develop their confidence and competence for teaching mathematics.

Video Feedback

Due to either the total absence of, or limited nature of, face-to-face interaction with PSTs, online mathematics educators are required to use a range of diverse, digitally supported techniques. Fortunately, online learning platforms offer a variety of asynchronous and synchronous Web 2.0 affordances including wikis, discussion forums, blogs, e-portfolios, and online chats to facilitate such informal instructional transactions (Orange et al., 2018). A key advantage of using e-assessment tools for educators is efficiency, whilst a key advantage for students is that online feedback provides them with prompt feedback that can be used by them in real time to remedy weaknesses in their learning (McLaughlin & Yan, 2017).

The evidence presented in the previous section indicates the positive aspects of online feedback. In this section we look particularly at how video feedback can support PSTs mathematics education learning.

A range of research has reported on positive outcomes following the use of video feedback. Kay and Kletskin (2012) provided a detailed account of some of the research findings regarding the use of video feedback in mathematics higher education contexts. These findings include students describing video feedback as enjoyable to watch; motivating and intellectually stimulating; and effective with respect to improving learning. Furthermore, students particularly enjoyed control over when and where they learn; what they need to learn; and the pace at which they were to learn, resulting in improvements in their study habits. Similarly, Robinson et al. (2015) reported that video feedback on assessments is seen as more personal, creating a teacher presence as students review feedback; easier to understand than handwritten or typed comments; not necessarily more time consuming than providing traditional feedback; and of a higher quality than written feedback. Johnson and Cooke (2014) indicated that key advantages of digital feedback include improved student access to teacher feedback; increased sense of personalisation between teacher and student; increased potential for student learning; improved reflective practice by students; time savings for teachers; and increased quantity of teacher feedback to students. Finally, regarding learning performance, Kay and Kletskin (2012) report on research indicating that the use of video resulted in significant gains in skills and overall grades.

In terms of broader educational implications, it appears that video feedback offers a chance for greater clarity of formative feedback, since information can be expressed in multi-media form, with a brief 2-minute video providing the equivalent of approximately 400 written words of feedback (Stannard, 2009). In addition to the potential time-saving advantages of this for academics, the actual medium allows for demonstration of concepts that would not be possible in written form. Finally, in relation to the educator's perspective, Stannard (2009) identified a number of positive outcomes from using video feedback. Firstly, the issue of time constraints in providing feedback are minimised, as an educator can create one video each week to provide global formative feedback, prior to more specific but shortened specific feedback post assessment submission. Secondly, the feedback videos become a useful future reference material for both educators and PSTs. For example, in future unit offerings the educator can review the feedback video from previous years and quickly remind himself/herself of some of the problems that had arisen. Thirdly, regular weekly video feedback minimises later PST complaints following individual assessment feedback, as students have previously received more generic, scaffolded advice related to the assessment tasks.

Methodology and Research Question

The present study was a pilot case study (Baxter & Jack, 2008) that involved a cohort of early childhood, primary, and primary/middle second-year undergraduate PSTs (n = 63). They were in their second year of a four-year degree, studying an online mathematics education unit centred on the strands of Measurement and Geometry.

Case studies provide the opportunity for in-depth description and analysis of a case, in this instance, an innovative, online pedagogical strategy. Here we use an instrumental case study, "where the case is selected for its ability to contribute to a general understanding of a phenomenon" (Pearson et al., 2015, p. 3). The unit chosen for this study was a pedagogical-focussed unit (as opposed to a content-focussed unit). As indicated in the introduction, the overarching research question driving this study was: *How does formative video feedback contribute to PST's experiences in a pedagogical mathematics education course?*

The unit provided differentiated content for early childhood and the primary/primary-middle specialisations, all residing on the same Moodle site. PSTs were required to engage in specified readings and/or video vignettes prior to commencing the activities for each week. They were given the option to work individually or collaboratively and each week were required to

upload the learning artefacts they had created. At the end of each week, every PSTs' submission was read, and themes were identified from each specialisation, for example, common misconceptions evident in PSTs' responses to the tasks. Author 1 then created two separate feedback videos, one for each specialisation, that discussed each of the tasks, the conceptual foci and intention of the learning experiences, and how the PSTs could interpret the video feedback to improve their own understandings for the upcoming week.

The weekly videos were created using Panopto, the university's digital recording platform. When planning and creating the videos, seven well-researched design principles were followed. First, the mathematics problem type was selected and segmented into clear steps (e.g., Clark & Mayer, 2008) so that the end user (in this case, PSTs) were not overwhelmed. For example, if a common misconception became apparent, video feedback was then used as an opportunity to conduct micro-teaching on the relevant concept, and then link this to the pedagogical intent of the activity. Second, the context of the problem was explained and connected to previous mathematical knowledge (Bransford et al., 1999), modelling a constructivist perspective of learning. Third, key elements were presented in written form (e.g., simple slides) to reduce the cognitive load of users (e.g., Chandler & Sweller, 1991; Kester et al., 2006). Fourth, clear visuals were used to illustrate key aspects of problems (Clark & Mayer, 2008). In the present study, Author 1 also used concrete materials, created artefacts based on PSTs' responses, and used de-identified PST artefacts to illustrate a particular pedagogical or conceptual point. Fifth, important elements in problems were highlighted in order to focus student attention (e.g., Willingham, 2009). Sixth, a conversational, relaxed voice was used to engage PSTs and to create the impression that each PST was being addressed personally (e.g., Clark & Mayer, 2008). Importantly, the tone of these videos was always about building PSTs' capacity for teaching mathematics and recognising the strengths within the cohort first, before misconceptions or suggestions for improved understanding were addressed. Anecdotes were used from the lecturer's own teaching experience, humour, and enthusiasm in the delivery of the videos to demonstrate a personable and more connected persona than can be delivered via textual feedback only. Finally, the length of each clip was kept to a minimum to address issues of limited attention span (e.g., Kay & Kletskin, 2012; Tapscott, 2009). In this case, the videos were kept to 10-12 minutes each. The videos were also used to link immediate formative assessment with the overall summative assessment requirements of the unit.

Data collection was in the form of an online survey sent to each PST in Week 5 of the unit. This email consisted of questions regarding their experience with video feedback in online units and their perception of its value both for learning the required content and for affective components, such as feeling connected to the unit and lecturer and confidence in their own abilities. Online chat sessions (text based) were also used as a data collection tool, whereby the lecturer asked PSTs in general conversation to comment on the use of video feedback. End-of-semester student feedback was collected (with PST and university permission) and analysed for relevance to the use of video feedback. Data from these sources is presented in Table 2.

NVivo was used to support a thematic analysis of the data. The descriptive nature of thematic analysis allows the researcher to build a complex, holistic picture in a natural context of the educational setting – in this case, the online learning environment (Castleberry & Nolan, 2018). This approach supports the qualitative research design of a case study through the employment of several data collection tools to help explain the essence of a phenomenon. The data were initially analysed by Author 2, resulting in the generation of 21 themes. To maximise accuracy and relevance to the data, these themes were cross-checked by Author 1. As a result of this process, the following were identified as key themes: Affect, Electronic Assessment, Feedback, Online/Technology, and Screen casting (including Video and Audio).

It is important to note that there were other limited forms of formative feedback provided throughout this unit. The PSTs received an individual email in Weeks 4 and 7 of the (10-week) unit to give them an overview of how they were individually performing on the weekly tasks and to offer any specific feedback for improvement. The weekly videos in this unit study replaced the group written feedback provided in earlier versions of this course. However, as this paper is specifically concerned with the innovative use of formative video feedback, the analysis will focus on this aspect of the overall unit.

Findings

Quantitative findings

This research is largely based on the qualitative feedback provided in end-of-semester PST course evaluations. However, we also collected student experience data from bespoke, in course surveys and from synchronous chat sessions conducted during the course. Prior to presenting the findings that emerged from a themed analysis of the qualitative data, it is important to frame the upcoming discussion via the use of quantitative data gathered via an online survey (in Week 5) during Semester 2, 2019 (see Table 1). The 5-point Likert scale ranged from *strongly disagree* (SD) through to *strongly agree* (SA).

Table 1
PST Mid-Unit Survey Responses to 3 Question Prompts (*n* = 20 out of a possible 63)

The weekly video feedback has been helpful in developing my …	SD	D	N	A	SA
1. Understanding of assessment tasks and weekly requirements	2	5	5	5	3
2. Understanding of mathematics pedagogy for early/primary years	1	5	4	9	1
3. Confidence in my ability to teach mathematics in the early/primary years	1	8	2	9	0

Based on an analysis of the data, a number of observations can be made. Firstly, it is clear from the data that evaluations on the usefulness of video feedback were highly varied, with 14 of the 15 possible responses possible for the three questions completed by the PSTs. Secondly, the responses are relatively evenly split (but skewed towards the positive end) between positive views regarding the use of video feedback (8, 10, & 9 responses respectively) and negative views (7, 6, & 9 respectively). Thirdly, it was clear that the PSTs saw some value in the use of the video feedback for understanding the pedagogical approaches specific to their specialisation – i.e. either early childhood or primary education. Given that assessment relates more to the immediacy of their experience, and pedagogy relates more to how they will function as a future teacher, this is some endorsement for the value of the video feedback.

Further descriptive data (see Table 2) regarding the unit were collected in end-of-semester unit evaluations and these were coded according to the themes that emerged from the literature. Only PST comments that relate to feedback are included below.

Table 2
Categories of Responses (*n* = 99 response *)

Categories of responses	Number of responses
Future pedagogical approaches to mathematics education	6
Future confidence to teach mathematics education	14
Regular and/or explicit nature of feedback	10
Positive impacts of video feedback	40
Preference for written feedback	15
Preference for individual feedback	23
Total responses	108

* Total coded responses 108 as some responses coded into two categories.

By far the largest number of the responses related to the positive impacts of video feedback. The second and third most common responses are in some ways two sides of the same coin, with preference for written feedback also indicating a preference for individual feedback; therefore, they will be considered together in the findings and the discussion. Very few PSTs made any comment on the impact of feedback on their pedagogical approach to mathematics education. This may be because these PSTs were not yet halfway through their degrees and had only experienced one practical placement at this time. As this initial placement was largely an observational experience, it is understandable that PSTs were still developing an understanding of pedagogical approaches to mathematics education.

Qualitative Findings

Given the relatively small number of responses in the quantitative data, and also the availability of a greater range of qualitative data, we will now turn to an analysis of the qualitative data. Initially we offer a summary of the key points raised by the PSTs, and then we discuss their responses and explore their implications in the final section of this paper.

There was minimal feedback specifically regarding the impact of the videos on how the PSTs perceived their development as future teachers of mathematics and we acknowledge this as a limitation of this pilot study. That being said, two types of views were reflected in the feedback from the PSTs (*n*=6) who commented on pedagogy. Firstly, from a negative perspective (and perhaps more about unit structure per se), they requested a weekly lecture to develop their practical competency via instruction on methods of teaching mathematics – for example,

> I think a lecture would have been helpful to assist with the explanation of … numeracy into practice.

Secondly, from a positive perspective, students could see the importance of weekly reflections in developing a teaching identity with practical connections to their future practice – for example,

> I found this style of feedback more beneficial to my learning and understandings, as I was able to apply the knowledge learnt in real life contexts.

A larger number of PSTs (*n* = 14) indicated that the course, which included the weekly video feedback as the main form of lecturer-PST communication, improved their confidence to teach

mathematics. Often this subset of comments related to affective components, such as the importance of the visual connection they could make with their lecturer (albeit in one direction) – for example,

> It was good seeing [the lecturer] though and her enthusiasm for teaching us,
>
> I enjoy the video feedback, I think it more meaningful when I can see and hear how passionate you are about mathematics and the feedback is constructive and authentic.
>
> Creating this online environment made me feel so comfortable in my learning.

We will discuss further the importance of communicating an interest in PSTs as learners and a commitment to sharing an enthusiasm for mathematics in the discussion and recommendations.

We now turn our attention to the major thrust of the comments from PSTs; namely, observations firstly about feedback in general, then more specifically those comments regarding the pros and cons of the use of video feedback in this unit. Notwithstanding the comments to follow that indicate a preference for individual or written feedback, all comments regarding the *regularity and/or amount* of feedback (n=10) were positive. As might be expected, a number of PSTs appreciated the regular feedback in relation to assignment completion. For example,

> The constant feedback was very helpful, especially for the assessment", "the formative assessment has been supportive and explicit.
>
> The continuous feedback is very good for me as an external student … it helps me to finish the assignment through the whole semester.

As indicated earlier, other forms of feedback were implemented, for example occasional individualised emails; however, as these forms of feedback were used sparingly through the course, we suggest that students are making reference specifically to the video feedback in these comments, as this form of feedback was used weekly throughout the course. Pleasingly, at least from our perspective, other PSTs noted the importance of feedback for future performance beyond the immediate assessment. For example,

> I believe that feedback can help produce high quality future work" and "feedback identified specific areas for improvement.

The largest set of responses received from PSTs related specifically to the perceived strengths of video feedback (n = 40) and then two types of perceived weaknesses; namely, the small group rather than individual feedback (n = 23) and a preference for written feedback (n = 15). In terms of positive aspects (n = 40), the following themes are evident: Accessibility (n = 8), Benefits beyond text (n = 4), Targeted (n = 8), Affect and Gesture (n = 5), and Generic positive affect (n = 15). As the generic comments merely indicated that the videos were "good" or "helpful" or "great" without articulating why, they will not be discussed further.

Many PSTs commented upon the accessibility (ease of use, easy to follow, easy to understand) of the weekly feedback video. For example,

> Easy to follow along, support and feedback provided through videos were really helpful.
>
> This was easier to understand rather than a post on the forum or an email.

Ease of access was seen as especially important given all of the PSTs in this unit are engaging fully online:

> I loved how [the tutor] did weekly overview videos! This was so helpful to me as an external student to know I was on the right track or where I needed to make some improvements.

Along these lines, other PSTs commented on the "value adding" of the video beyond what written feedback could provide. For example,

> To explain in a way that feels more natural than text.
>
> Sometimes you just can't get what you need from written feedback.

Two PSTs noted the extensive amount of reading required in the unit, with one indicating,

> It is nice to listen to feedback rather than read it.

Possibly related to the early discussion regarding developing pedagogy, but included here as the PSTs could also have been referring to assessment, is the notion that video feedback afforded development of a deeper level of understanding. For example,

> I believe video is a good way as it gives us a more in-depth onto what we did wrong … rather than messages to everyone.
>
> I like the videos better as they are easier to grasp what is being said as there is a deeper explanation.

Part of the explanation for the development of a deeper level of understanding relates to affect and embodiment, facilitated by the delivery of interesting, engaging, and challenging microteaching opportunities afforded by the videos, using mathematics materials. For example,

> I think it's more meaningful when I can see and hear how passionate you are about mathematics and the feedback is constructive and authentic.
>
> Seeing your body langue helps me a lot!

In terms of negative responses, they clustered around the themes of individual feedback (n = 23) and the desire for written feedback (n = 15). As we are of the view that a preference for written feedback is a subset of a broader preference for individual feedback, in this paper we will deal with both issues simultaneously and highlight where there may be something particularly pertinent in receiving written individual feedback rather than other forms of individual feedback (forums, videos, phone calls, etc.). The negative feedback regarding individual concerns relates to issues with group work in general and also with feeling isolated as individuals in particular. Some feedback was also of the generic type – for example, some students stated that they couldn't find the feedback videos, wanting other forms of feedback as found in other units, or problems with accessing the unit in general. In terms of group-level concerns, these reflect many of the concerns experienced by many PSTs in both online and face-to-face contexts. For example,

> It is important for future teachers to work together, however group work … can be frustrating when other students or members in a team do not communicate.
>
> I found this easier as it meant less work, but I don't think there was valuable critical nor reflective thinking with another external class.

One PST indicated that sometimes group feedback can be effective in face-to-face contexts where other mechanisms are available for individual feedback:

> We are external students so tasks would work well internal, but I found it did not work well for external.

This is because they did not have the luxury of staying behind after class to discuss things in an informal one-on-one format with [the tutor].

This last comment segues nicely into a range of feedback related more to the desire for individual feedback – often expressed in a desire for written feedback that would likely be

individual. A number of PSTs felt that they were not receiving what they perceived to be an appropriate level of support – often linked to completing the course in online mode. For example,

> I am a remote student. I feel like I am not getting personal feedback to help me get better.

Comments such as this often related to an insecurity in relation to understanding their own progress through the unit:

> I do wish at times having individual feedback (on weekly tasks) give me piece of mind that I'm on the right track. I tend to over think things then confuse myself,
>
> Group feedback is good, but I feel like I am in the dark about how I am personally going
>
> I feel like I am just guessing everything and the feedback doesn't really clarify if I am on the right track or not.

These latter comments indicate a lack of self-confidence about mathematics that is evident in much of the literature.

The final few comments presented below are again individual in orientation but specifically mention the desire for written feedback (as we have indicated, a likely proxy for the desire for more individualised attention) but still an indication of what sort of feedback some online PSTs are seeking. Several PSTs indicated that written feedback made assessment/revision easier. For example,

> I prefer written feedback, because I can look over it when needed for assessments.
>
> I can go through and highlight the page and refer back to it immediately.
>
> The information and relevant feedback can be sourced more rapidly and easily.

These PSTs indicated that this was a limitation of group video feedback as they,

> Had to review the videos numerous times and try to find out which section applies to me.
>
> There was no effective way to search out the most relevant part of a video other than watching the whole thing.

Other PSTs preferred written feedback, as it is both an acknowledgement of their work as individuals and also a means of providing more tailored individual feedback.

Regardless of whether they were reflecting on individual feedback or individual written feedback, many PSTs acknowledged the realities of higher education in terms of time constraints for academics. For example,

> I do prefer it [individual feedback] as it gives me an understanding of what I need to do to improve. I don't expect this for every single task obviously, but even an indication that I'm doing ok is better than nothing. Thank you.
>
> I do prefer written as it gives me an understanding of what I need to do to improve. I don't expect this for every single task obviously.

The issue of time constraints (administrative rather than pedagogical) is in many ways "the elephant in the room" in relation to the possibility of individual feedback, for example, large unit sizes and limited time allocations for assessment, and this will be a major discussion point in the following section.

Discussion

In coalescing the findings above, two main themes emerged: (a) the way in which these PSTs perceived feedback provided in video form, and (b) the added value video feedback provides in fostering a sense of connection with the lecturer-and thus the unit. We address these two themes below.

Engaging with Video Feedback

Whilst there were some concerns about the video feedback, overall, the data supports the role of video feedback as a tool that PSTs can use to reflect on their own learning experiences in an online learning environment. The real-life example, or microteaching episode, made available through the platform of video assisted students to develop self-reflection of their learning, and suggests that even though written feedback may have provided similar advice, the video format engaged them in a way where they potentially were able to synthesise the information more easily. This is consistent with Robinson et al.'s (2015) observation that PSTs do not necessarily engage with teacher written feedback effectively (especially beyond ascertaining whether they have successfully completed the task or not). In the online environment, self-reflection of learning is an important aspect to developing sound awareness of one's own learning performance. This theme suggests that the use of video feedback engaged PSTs in a manner not replicable via written format, which helped them unpack the conceptual and pedagogical aspects of the learning task.

Consistent with a constructivist perspective, the use of video feedback in this study suggests that this method of providing feedback has the potential to close the gap between the actual and desired levels of performance (Wiliam & Black, 1996). This is due in large part because the PSTs can experience, to help scaffold this learning, the lecturer modelling the delivery of formative feedback on their prior learning artefacts. Thus, we suggest that the use of video feedback enabled the PSTs to view the micro teaching episodes created by Author 1 and then to use these episodes as a benchmark against which they could critique their own actions during the specific learning tasks. This is evidenced in statements such as

> Viewing the videos was easier to understand rather than a post on the forum or an email.

The provision of video feedback again supported PSTs in easier self-analysis of their performance and their own understandings of the task or concept, as seen in PST responses that labelled video feedback as "explicit", "in depth", "helpful", and a "more natural" way of evaluating their own performance. Finally, the perceived value of video feedback was evident in the way PSTs said they were aware of the changes they needed to make in their work. Whilst this study did not have the scope to compare individual grades with their individual views on video feedback, these findings do suggest there is a potential for video feedback to have a more positive impact on PST learning. This is because they could immediately embed these changes in the short-term in completing the unit, as well as making a connection to how this feedback should be interpreted and enacted for their development as a future mathematics teacher in the long-term. These results indicate that there is a warrant for further exploration of the role of video feedback in such mathematics units more broadly.

Teacher Connectedness

The second theme emerging from these findings is the positive impact of video feedback on PSTs' affective outcomes due to the establishment and maintenance of "teacher presence". Establishing teacher presence online is fundamental to building a community of learners and developing a culture of connectedness (Dixson, 2010). As discussed in the literature review, many PSTs in online mathematics classes have preconceived ideas about the potential (and often unrealistic) difficultly a unit will present. There is often a heightened anxiety and lack of confidence in their own abilities, primarily due to damaging mathematical instruction during their own schooling (Sanders et al., 2019). The provision of formative video feedback allowed PSTs to see and experience the first author's positive modelling of teaching early childhood and primary mathematics. This suggests that video feedback is a useful tool for creating a positive learning environment and sense of connection with the lecturer, which is one of the core elements for promoting more successful learning outcomes for students – specifically in the discipline of mathematics (Johnson & Cooke (2014; Kay & Kletskin, 2012). For example, many PSTs noted how the microteaching opportunities presented in the video were used as a mechanism for feeding back a range of pedagogical approaches and/or mathematical solutions to the task. As stated in the introduction, the aim of this study was to investigate how weekly formative feedback videos may contribute to PST's experiences in a mathematics education unit. We argue that what also emerged regarding the use of technology was the influence video feedback had on (a) PSTs' mathematical content knowledge (MCK), and (b) PSTs' understanding of the ways they can implement this MCK when teaching mathematics for their targeted age group. This also enabled them to make connections with future teaching which, although not an initial intended outcome of the use of video, is likely to be an unintended benefit of the video feedback.

To illustrate this point, it is important to note that the majority of PSTs in this cohort (n = *63*), experienced success, in some form or another, in achieving the goals of each of the set of weekly activities. The responses within our data indicate that PSTs appreciated "seeing" the alternative strategies or methods presented in the feedback. These were strategies that perhaps they did not consider, or that they may have otherwise overlooked, if simply reviewing written feedback or the written work of their peers. Many comments expressed nuanced views of this aspect, characterised by comments that described how the video format could provide information that is not possible to convey through text only. This resulted in the PSTs feeling supported whilst learning challenging and unfamiliar content, because they regarded this form of feedback as "*targeted*", "*explicit*", and "*easier [than text] to understand*". To ensure feedback is useful, it must close the gap between the learner's performance and the expected level of achievement (McLaughlin & Yan, 2017). Based on our data, we argue that weekly video feedback has, along with other aspects of the course present before and alongside the intervention, contributed to this aspect of learning, as illustrated by the number of positive responses to this medium (*n* = 40), and exemplified in comments that described how many PST's felt connected to the tutor and thus supported in their learning.

Conclusions and Implications

The overarching emphasis of the videos (made explicit to the PSTs) was for them to be *forward looking*, that is, facilitating future learning opportunities, for example, where and why PSTs could explore these concepts and use them in their future teaching, rather than a narrow focus on what the tutor was saying merely to pass the course. The intent here was to understand how formative video feedback could contribute to PSTs learning experiences in mathematics education and the

role it can play in supporting learning behaviours to maximise PSTs' opportunities for success. As we indicated in the introduction, our perspective on the role of the PSTs and of the teaching academic is very much grounded in constructivism. This strong empirical learning theory demands that an academic is both transparent and reflective about their teaching (Biggs, 1999); however, it also positions both teacher and student (in this case PST) as co-constructors of learning. Constructivism is very much foundational to Biggs' (1999) third level of teaching competence, whereby the focus is on how a student understands, interprets, reflects on, and enacts the concepts and principles in focus, not on the content the teacher has "taught", with the former far more important when determining the level and quality of learning that is, or is not, occurring (Shuell, 1996). This is especially vital in the online learning context as there are very different challenges and affordances than present in face-to-face teaching. As McLoughlin and Lee (2010) describe, the role of online educators in higher education institutions demands "a move from the delivery of content to a focus on designing experiences that facilitate personal learning, capability building and skills development, combined with a renewed emphasis on curriculum design that values the student's voice and needs in shaping decision making" (p. 37).

The results from this study are limited; therefore, the implications that we have drawn from this study are conservative. Despite this, we suggest that they are multifaceted and indicate a number of factors which need to be considered in implementing formative video feedback into online teaching and learning pedagogy. One implication relates to time management of lecturers and their role as online tutors in online teaching. As discussed earlier, university teaching is neither well conceptualised nor well-resourced for the provision of formative feedback, despite the vast body of research highlighting its importance for learning. This study was undertaken as a pilot and with only one cohort of PSTs; therefore, the lecturer (Author 1) needed to adjust and modify her normal teaching practice to facilitate the use of video feedback. This resulted in a "hybrid" approach to her pedagogy which included the preparation, filming, and delivery of the formative videos, involved individualised written feedback/online chat groups (although less frequent), the preparation of tasks and "normal" contact between tutor and students on a daily basis to scaffold students through each week, and the summative components of assessing and giving extensive written individualised feedback. With the addition of the use of video feedback, this initiative exceeded Author 1's allocated time commitment for the preparation, teaching, and assessment components of the unit. However, given the positive results gleaned from this small study, a key implication for moving forward with this research is the need for changing the way stakeholders such as universities and PSTs view the value of formative feedback (and in this case, via the medium of video) to help support its affordances for deeper learning, and for increasing the level of resourcing to implement this initiative on a larger scale to assess the true potential of this strategy for learning.

A second implication from this study is the importance of appropriate of technology to deploy video formative feedback. In this study, Panopto was the recording technology used, as it easily enables Desktop screensharing, and the use of images within the recording, to illustrate key points to PSTs. Whilst not proposing that Panopto is the only solution, it is important that universities support academics with access to, and training in appropriate digital programs such as this. Without this investment, it is unlikely that academics will use innovative digital assessment strategies.

In summary, a pedagogical approach incorporating formative video feedback, based on data from one online cohort and the experiences of the tutor who has taught the unit several times, suggests that the use of formative video feedback may help to create a sense of connectedness to the learning environment, which, in some cases resulted in an increase in self-reflection and connection to the lecturer and the unit, due to the affordances of the visual communication methods. This supports Iannone and Simpson's (2013) constructivist perspective that students'

beliefs and attitudes towards mathematics are a reflection of their teacher's beliefs, attitudes, and dispositions. However, further investigation is required to assess if, and then how, pedagogical competency for teaching mathematics is influenced by the use of formative video feedback. At the time of writing this article, a global health crisis was emerging (and unfortunately continuing), and a significant shift to online learning for extended periods of time, including in primary and secondary education, is underway. Given this setting, this research is not only timely, but has great potential to be further developed, beyond mathematics education, to a range of different online educational contexts.

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