The aims of and responses to a history of mathematics videoconferencing project for schools

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Researchers have long suggested a number of benefits to the integration of a historical dimension into mathematics education, yet there is little research into the effectiveness of such an approach. In this paper, I explore some of the issues at stake through a case study of a videoconferencing project on Babylonian mathematics.

History of mathematics, videoconferencing

Introduction

Mathematics has a long, rich history of which teachers and students are often unaware. As a result, they fail to appreciate that mathematics is constantly developing, a human endeavour and a subject that has varied in different times and cultures (Tzanakis & Arcavi 2000). For decades, researchers have suggested a number of benefits to the integration of the history of mathematics into mathematics education (Fauvel 1991). It is thought that an understanding of the history of mathematics and the context in which problems arose can lead to greater understanding of the content and nature of mathematics (Byers 1982, Furinghetti 1997). It is also believed that the history of the subject can humanise mathematics and thus be motivating to students who conceive of mathematics as 'dead', 'boring' or too abstract (Bidwell 1993). At present, however, there is very little empirical research into the effectiveness of the integration of history of mathematics into mathematics education. In particular, there is nothing that considers students' responses to the history of mathematics in their own words. This paper provides a modest contribution in that direction.

The case study

Barbin (2000) suggests that an appreciation of the effectiveness of a historical dimension in mathematics education will come through an analysis of case studies, using the observation of participants and interviews with teachers and students. It is such a study that I undertook for my MPhil thesis project. Specifically, this paper reports on a case study of a mathematics enrichment videoconferencing project through which students and teachers at four schools were introduced to Babylonian mathematics. The students were all around 10 years old. It was organised by Motivate (http://motivate.maths.org) and followed their standard format, namely two videoconferences, a month apart, with project work in-between. Hereafter, I shall use 'the Project' to refer to the case. The sessions were led by Eleanor Robson, an expert Assyriologist. During the first videoconference (VC1), Eleanor provided some historical, geographical and archeological background to the Babylonians. She then gave the schools a few activities involving Babylonian shapes and followed this by an introduction to the Babylonian numeral system, specifically the cuneiform notation and the fact they used base 60. The students then had a month to complete project work, for which Eleanor had given suggestions, although the choice rested with the schools. In the second videoconference (VC2), the students presented their work, received feedback from Eleanor and answered questions from the other schools.

Research questions and methodology

My research questions were developed both with an eye to the literature and with an appreciation of the specifics of the Project:

1. What are the aims and objectives of the organisers and teachers? Are these met?
2. How did the students respond to the topic and the ideas presented?
3. How did the nature of the Project support the learning of Babylonian mathematics?

The research was carried out in two stages. Pre-VC1, I interviewed the organisers of the Project (including Eleanor) and the teachers. Post-VC2, I interviewed Eleanor and the teachers again, as well as a group of three students from each school.

Results

Aims and objectives for the students

Barbin (2000) makes clear that any attempt to determine the effectiveness of the use of a historical dimension in the mathematics classroom must take into account the teacher's objectives. Thus, before considering the student responses to the material, it is important to be clear on what both Eleanor and the teachers hoped the students would gain from their participation in the project. In this case, consideration of objectives is particularly interesting because there was the potential for conflict between Eleanor's aims and those of the teachers. An example of conflicting aims will be discussed below.

For Eleanor, it was not important that the students should necessarily retain the content of the conference; rather, she hoped that they would, to use her own language during our interview, be able to 'absorb' the subtle 'messages' that underlined her presentation. The key idea was to engage the students in thinking about the nature of mathematics. In particular, she hoped that through discussion of the Babylonians, they would come to see that different societies and groups of people have different ways of thinking and talking about mathematics and that mathematics is a human endeavour. The activities featuring Babylonian shapes were designed to enable students to think about technical terminology, to challenge the notion of what a mathematical object is, to see that mathematics is a creative discipline and to realise that they can make their own mathematics. It is worth noting that the messages that Eleanor was hoping to convey are consistent with the literature on the benefits of incorporating a historical dimension into mathematics education (Fauvel and Van Maanen 2000). As well as hoping that at least some of the students absorbed some of these messages, Eleanor hoped more generally that all the students Would enjoy their participation in the Project and as a result would feel that mathematics can be exciting, inspiring and fun.

By contrast, the teachers did not have any clearly defined ideas about their objectives, especially relating to the topic of the conference. They had signed up to participate in the Project not because of any particular interest in the history of mathematics but because of their previous positive experience of Motivate, their ensuing belief in the benefits of this type of videoconferencing, and their desire to provide some kind of enrichment for their students. Broadly speaking, they hoped their students would enjoy it and that they should be inspired and stimulated. In contrast to Eleanor, for two of the three teachers, it was important that the students should gain content knowledge.

Student responses to the conference

Number

As a result of using clay tablets to practice writing cuneiform notation, the students identified a new-found appreciation of our own numeral system. As one group put it:

> Ed: to write fifty-nine you had to write like loads of stuff –
> Annie: - instead of just writing 5 and 9, you write the symbols –
> Ed: - yeah, you get like C C C C C, Y Y Y, Y Y Y, Y Y Y, instead of just doing 59.

The difficulty of writing Babylonian numerals was identified by all the students, although in some cases was related to the tedium of transcribing the symbols on paper (as instructed by their teacher and completely in contrast to what Eleanor would have had them do) rather than any inherent understanding of the relative efficiency of a base 60 system compared to a base 10 one. The students who did understand base 60 and the importance of place value were those who worked on it for their presentations, whilst those who had worked on shape had little to say on these topics. This goes to show the value of project work in reinforcing the topic of the conference and highlights the role of the teacher in picking the topic work and deciding what should be reinforced.

Shape

Although the students all seemed very excited by the shape activities during the videoconferences, they all talked about number before shape during the interview (despite the fact the Eleanor had prioritised the shape work during her presentations). This is possibly because I asked them to talk about Babylonian mathematics. They may not have seen the activities done with shape as being part of mathematics at all. For example, when asked how Babylonian mathematics was different to our own, they all talked about numbers but none mentioned the extensive discussion during the VCs that the Babylonians also had different shapes

That said, a number of students did later remark on the ‘strangeness’ of Babylonian shape names. The ‘cow’s nose’ seems to have made a particular impression (see Figure 1) – the students thought it odd that the Babylonians should have taken names for shapes from their environment and culture. Consideration of the cow’s nose led to the following discussion:

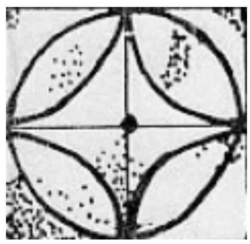

Figure 1: A cow's nose (the four-sided shape inside the circle)

> Ed: [pointing to a picture of a cow’s nose] I would call that a square.
> Researcher: Why would you call that a square?
> Ed: Because it’s like four-sided and all the sides are the same length.
> Josh: They’re all equal.

There is no doubt that Ed and Josh know what a square is. However, in the context of thinking about Babylonian shapes, in which he had previously learnt that triangles were allowed to have curved sides, it does not seem to great a leap to see this shape as a square. One of Eleanor's aims in introducing Babylonian shapes was, in a very subtle way, to challenge the notion of what a mathematical object is and to show that people decide as what counts as a shape. The above snippet suggests that to some extent, that is what Ed and Josh were doing.

Development and Diversity of Mathematics

As well as engaging directly with number and shape, Eleanor also hoped the Project would give students an opportunity to reflect on the nature of mathematics and history. There was plenty of interview evidence that the students had done just that:

> I thought that maths was just maths and was like all the same numbers. But when I did this conferencing, I realised that it's lots of types of maths and how we do things. (Harry, City Hill School)

Here, Harry has picked up on the key idea of Eleanor's presentation. One issue at stake in the incorporation of the history of mathematics into mathematics education is whether to view mathematics as a timeless set of value-free truths, or as a subject that develops through human endeavour within social contexts (Fauvel 1991). Harry's idea that "maths was just maths" suggests the former view, whilst now realising that there are "lots of types of maths" marks a shift to the latter. Some students went beyond simply noticing differences between then and now to positing a sense of continuity in the development of mathematics:

> If they [the Babylonians] didn't do maths, then we probably wouldn't do maths now, unless someone else invented it. [Beatrice, City Hill School]

At no point during the videoconferences was the development of mathematics discussed, so Beatrice's comment is indicative a relatively young children being able to engage with the idea of the historical development of mathematics, without much prompting.

The following comment may reveal an even deeper insight:

> They could go back to using Babylonian numbers, but probably not in our generation or the generation afterwards. [Ed, Village School]

In one sense, Ed is mistaken; the likelihood of Babylonian numbers coming back into use is negligible. But, moving past that, Ed seems to be showing an awareness at least of the possibility that the way we do mathematics might change in the future. Beatrice, on the other hand, only suggest the development of mathematics from the past to now, without explicitly showing a further understanding that the subject might continue to grow. Ed and Beatrice's comments show that exposure to the history of mathematics can indeed show that mathematics is not a finalised body of knowledge, as is claimed by Bidwell (1993). The use of the word "they" in Ed's comment is also interesting. Though not clear to whom "they" actually refers, it might suggest awareness on some level of the fact that mathematics is a cultural endeavour, in particular that people or cultures make decisions about what numbers we use.

Conflicting aims

As mentioned above, the nature of the Project makes it possible for there to be conflicting aims between the expert presenter and the school teachers. The following example is illustrative of this. During a post-VC2 interview with a group of students, one said, "I think we have the same divide and take away signs, but just different signs for, like, number." The student is mistaken – the Babylonians had entirely different signs for these operations. It is only when one considers the exercise her teacher set for her project work that one can see how the misconception arose (see Figure 2)

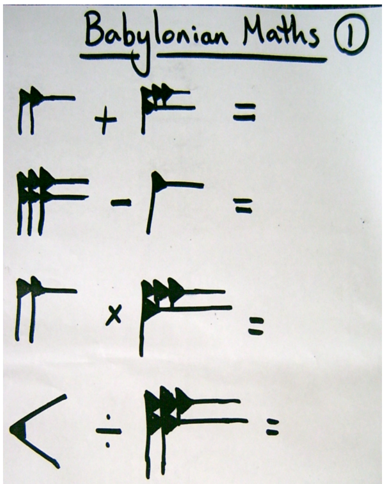

Figure 2: "Babylonian Maths"

One may ask 'why does this matter?' The answer depends on one's aims. If, as seems to have been the case, the teacher simply wanted to give the students the chance to familiarise themselves with Babylonian numerals by placing them in a recognisable context, then this level of historical accuracy is not an issue. However, this is entirely incompatible with Eleanor's aim of showing how mathematics was different in different societies and periods. In this case, such anachronistic use of these operation symbols is extremely problematic. This episode is suggestive of just how difficult it can be to incorporate history of mathematics into a culture of school mathematics with different sets of values and expectations.

Considerations due to the nature of the Project

The focus so far has been on the topic of the conference – Babylonian mathematics – and in particular the way the students responded to it. However, this cannot be separated from the way the material was presented. Interviews with the teachers and students revealed six ways in which the nature of the Project affected their grasp of the topic.

Firstly, the fact that it was a Motivate videoconference meant that the teachers and students were exposed to the topic when otherwise they probably would not have been. Secondly, the students were unanimously excited to have taken part, a feeling that arose at first from the novelty factor of videoconferencing and later extended to excitement about the knowledge they were obtaining. Thirdly, the videoconference provided an opportunity different than their usual classroom experience. As one student put it, "it makes it more interesting and it makes you want to learn about it". Fourthly, a valuable opportunity provided by this form of videoconferencing is that it provides the students with direct access to an expert. Eleanor's vast knowledge, plus the prestige of her attachment to the University of Cambridge, meant both the students and teachers took the information they were presented with seriously. Fifthly, the videoconferencing provided an opportunity for students from different schools to interact, an aspect of the Project that the students identified as being particularly enjoyable. Moreover, the students were able to learn from their peers in other schools. Finally, the project-work that the students completed allowed them to engage with the material more deeply than they would have done simply by taking part in the conference. The pressure to good give presentations in front of their peers and Eleanor meant that the students really did strive to understand the topic.

Discussion

Having discussed Eleanor and the teachers' aims as well as the student responses, I shall now consider the extent to which there was a correspondence between them.

As for the general aims, there is no doubt that the students unanimously enjoyed their participation in the Project, although it remains to be seen if and how it alters their feelings towards mathematics more generally. As mentioned above, remembering the content was deemed important by two of the teachers, but not by the third or Eleanor. As it happens, the student grasp on the actual content of the conference was shaky. In many cases, within two days of the Project the students had forgotten or misremembered a number of facts and episodes from the conference. On the plus side, the students did have the opportunity to develop their understanding of number systems and they were all able to compare the two systems. However, it is too great a leap to claim that it really did deepen their understanding of number systems more generally.

The majority of students interviewed were able to appreciate, as a result of their participation in the Project, that mathematics has developed over millennia and that there are culturally different but equally valid ways of doing mathematics. Moreover, by engaging with the lives of Babylonians, they were able to appreciate a human element to mathematics. The activities with shape allowed students to think about technical terminology, although there is little evidence (apart from Ed's comments discussed earlier) that students came to see mathematics as a creative discipline or appreciated that they could make their own mathematics.

Conclusion

Eleanor and the teachers all deemed the Project to be effective, in as much as it met their immediate aims. However, it is too early to tell the long-term impact and a number of its effects will be impossible to measure. One encouraging result is that the benefits suggested in the literature for the incorporation of the history of mathematics into the classroom can indeed be realised and that ten year-old children are capable of articulating those benefits. However, it is difficult to make any generalisations or recommendations about incorporating the history of mathematics into the classroom because of the particular nature of the Project, particularly the fact that it was delivered by an expert over a videoconference.

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