Using ICTs to Support Numeracy Learning: The way of the future? Whose future?

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This paper discusses the approaches used by some of the teachers in a large project when using ICTs to support numeracy learning. It was found that many of the teachers used a traditional lock-step approach that has been widely criticised in the general mathematics education literature. These approaches are then compared with a more open-ended, student-centred approach adopted by one of the teachers. It is proposed that the different approaches offer potentially different learning outcomes for the participating students.

Within the mathematics education literature, there are two key distinctions made between ways of knowing – procedural knowledge and conceptual knowledge (LeFevre, 1993). In studying the ways in which students come to negotiate meaning in mathematics, the teacher is found to assume the most central role in classroom actions (Frid & Malone, 1995). The teacher, through his/her practice conveys subtle messages to students about what are valued attributes and ways of knowing. The practices implemented by teachers are heavily influenced by their own beliefs about learning (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997) and learners (Zevenbergen, 2003). More recently, the literature emerging on the use and adoption of ICTs in classrooms has identified teacher knowledge about computers to be an important factor in whether or not teachers use ICTs in their classrooms and the ways in which they use the ICTs to support learning. The implications of these literatures suggest that the most common approaches used in the teaching of school mathematics rely on the use of procedural knowledge. This paper explores the ways in which, in the large project, teachers' practice with the use of ICTs in mathematics classes employed procedural or conceptual foundations to their teaching.

When considering ways of understanding and ways of teaching, there are two distinct approaches identified with mathematics. The first adopts terms such as procedural, rote, instrumental, algorithmic, and functional to refer to practices in teaching and ways of understanding that relate to lock step approaches and are typically devoid of deep understandings. In contrast, a second approach is typified by terms such as conceptual or relational and are used to convey as a sense of deep understanding and the linking of ideas to form interconnections or networks. While these are often seen as oppositional and the latter is a preferred model, Mousley (2003) argues that there is a need for skills and algorithmic understandings and that collectively both procedural and conceptual approaches can build to deeper understandings. However, critical educators (Anyon, 1997; Delpit, 1995) argue that the procedural approaches dominate socially, culturally and linguistically disadvantaged classrooms, while the more open-ended, conceptual approaches are evident in dominant classrooms.

The Project

Drawing on examples from two classrooms, observations of two teachers are triangulated with video data. It is argued that in these two examples, the teachers adopt very different approaches to teaching numeracy through ICTs. The pedagogical approaches

align with the distinction between procedural understandings and conceptual understandings. The implications for these two approaches to students learning about ICT and mathematics are discussed. Often procedural understanding is seen to be inferior to conceptual understand but this is not the case that is argued here. Rather, the teaching approaches offered by the teachers could be seen to favour one approach over the other, the ramifications of which potentially create different learning opportunities for the students.

The Case of Liam

Liam's class occurs in a withdrawal section of the library where a bank of computers are located. Students work in pairs on the computers. The school serves a low socio-economic clientele and is based in a major urban area. The class has collected data prior to coming to the computer session. The data were collected in small groups and based on class interests Each group collected data across the class in one area such as sports, favourite food, and favourite television programs. Prior to data collection, the class had identified common themes in each category so that data collection was limited to set options (and an 'other' category). The objective of the observed lesson was for the students to use spreadsheets to input their data and then to construct graphs. Liam sat at the front of the group and worked his computer which was connected to a data projector so that his work was displayed to the class. Students needed to log into their files in order to save their work. Once this was completed and all systems were working, Liam began the lesson.

Liam: Right, eyes this way. You need to double click on this icon "spreadsheets' and open it up

[students open up spreadsheets]

Liam: Everyone ready…. OK, we need to label our spreadsheet. See these boxes, they are called 'cells'. We need to label these so that we can see what we are doing. In the column going down the side here (moves mouse over the far left column}, in here we have to put the types of data we collected. Anyone tell me what they were?

[students call out the different types of data collected]

Liam: OK what you have to do is, in here, in the first box or cell, you have to put in what the first type of information we collected was. So let's type in the favourite foods you had. [types in icecream in A1] Then move the mouse to the next one down and the next type in food [types in hot dogs in A2]. Now keep going until you have done them all. Each you have to type in the information you collected on.

[Students type in data, teacher walks around checking]

Liam: [returns to computer] Everyone finished?… hands up if you need more time. [some boys talking at back, not finished but do not put hands up]. OK what we have to do now is to put in how many people said they liked the different things you collected information on. OK, people in favourite foods, what numbers did you get?

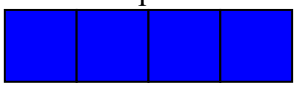
[student call out their numbers]

Liam: OK, so click on B1 and then type in how many people liked ice-cream. Click on B2 and then the number you had. You now have to do the same for your information. Any questions? … OK, off you go.

The rest of the lesson continued in this vein with Liam talking the students through the process they needed to undertake in order to construct their table of information. He adopted the same method as they then went on to construct pie graphs. What was obvious in observing the lesson was that Liam modelled the steps that students needed to take and then they were allowed to undertake the same procedures. The questions posed related to the process to undertake. There was no evidence of exploratory talk, even when students were to construct the graphs. There was no discussion in the graph construction as to which graph would be used, or why pie graphs were the preferred option (i.e. as in the purposes of graphs). The lesson was very focused on learning the steps to undertake in order to enter data in order to construct a pie graph.

The Case of Cristo

Cristo's class is a multi-age dual teaching area. The class is a 5-6-7 grouping with approximately 50 students. The class breaks into smaller working groups, and Cristo takes the ICT work in a curtained off section of the classroom where a bank of computers are located. Students work in pairs on the computers. The school serves a middle socio-economic clientele and is based in a major urban area. The students were working on a unit related to the solar system. Cristo's approach is to progressively build on work so that scaffolding is central to how curriculum is organised. He models thinking and concepts using a range of media of which ICTs is only one part. There is a strong integration between the modes of representations so that students are able to make links between various representations. Cristo has been trained and actively employs a 'philosophy in the classroom' approach where students are encouraged to debate ideas, question each other (and the teacher) and develop protocols for interaction. This approach fostered a classroom ethos where students and teachers engaged in considerable questioning (rather than statements). In using ICTs and the multiple modes of representation, Cristo assumed a position often at the front of the group where students could see him model objects. At the back of the classroom, two students would be working on the computer connected to a data projector that was beamed to the board behind Cristo. Students could then see the links between Cristo's talk and explanation and the computer events. Cristo would prompt the students at the computer to explain what they were doing and more often than not, why they did it in that way.

In the following extract, Cristo is wanting the students to develop a map where the turtle moves around the grid such that when the turtle hits different coloured squares it will hop in particular directions (forward, right, left). In order for the students to do this Cristo has taken the students through programming with colours and the basic movements. In this lead-in activity, Cristo is scaffolding the students so that they can get the turtle to "hop" rather than just move. This is to create the impression of the turtle jumping from square to square. On the board, he has  drawn four boxes:

Christo: So how would I get the turtle to move from here to here [points to first box then last box]? Each box is 40 units square.
Stud 1: Well, it would be forward 40, forward 40 to the third square and then another forward 40.
Cristo: That may work, has anyone got another idea?
Stud 2: You could do a repeat so that it is repeat 3 and then the square bracket, fd 40.
Stud 3 That would be better because you don't have to type so much
Cristo Can you visualise what this will look like?
[students offer suggestions about the forward movement being smooth}
Cristo: OK, Steve, can you show us what it looks like
[Boy at computer programs the turtle so that it moves in a straight line]
Cristo: OK, what I am going to do now is to make it a little more difficult for you. Let's see if we can get the turtle to hop from square to square. Steve, can you show the class how that turtle can hop around that map
[boy clicks on a program where the turtle moves around a grid in a stilted motion.]
Cristo: OK, now what you have to do is to think about how you get the turtle to 'jump' from square to square. If you're not sure of how to do it, remember to check the help menu for the different commands to see if there is something in there that might be useful.

At this point the students work in pairs on their computers. Most go to the help menu and scroll down the command options. What was needed is a 'wait' command so that they would tell the turtle to jump forward and then wait so that it gave the appearance of

jumping. Cristo moved around the class, posing questions to students to prompt their thinking. When some students had success, they were willing to share with peers who asked.

Summary

The two teacher extracts illustrate very different approaches being employed by the teachers. In the case of Liam, his approach can be seen to be quite procedural whereas Cristo's is more open-ended so that students have an opportunity to develop their understandings. The implications for these different approaches to using ICTs to support numeracy learning can be quite different. In Liam's class, the students followed the teacher's lead whereas in Cristo's class, the teacher used questioning and problem posing to scaffold the students to 'discover' the knowledge they needed. This demanded considerable input and planning from the teacher. What is perhaps a significant observation from the project is that the approach adopted by Cristo was observed by another teacher in the Independent school, whereas the approach adopted by Liam was observed in the other settings where the students were from socially-disadvantaged backgrounds. This observation begs the question to be posed as to the approaches being used by the teachers and the differential impact this has on the learning of students.

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