PUPIL CHOICE OF TOOL

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We examine a year 6 lesson where pupils were told to use paper and a calculator and also to use a spreadsheet. Pupils, in pairs used/chose different tools. We examine influences on their choices.

INTRODUCTION

It seems reasonable, in teaching and learning situations, that learners should experience using/selecting/choosing appropriate tool(s) for a given task. Such sentiments are often enshrined in curriculum documents, e.g. in England it is stated that learners should be taught mathematics through a number of activities including "choosing appropriate ICT tools ..." (DfEE, 1999, p.72). 'Choice' is a problematic term, however. When pupils 'choose' a tool, this is not completely free choice any more than it is completely determined. This paper examines choice of tool through the factors which influenced the actions of some pupils in one lesson.

In preparing this six page paper we had to make choices of our own in what to include and what to omit. We decided to focus mostly on lesson/student details and a discussion of their implications, and to leave out most of the academic background information (literature review, framework, rationale for methodology etc.). A longer paper on this work is being prepared, and hopefully will be published elsewhere.

The remainder of the paper is as follows: the lesson is described; data collection, analysis and interpretation is outlined; a map of influences is put forward and selected aspects are considered in greater depth; there is a brief discussion concerning choice of tool and use of tool; finally we consider implications.

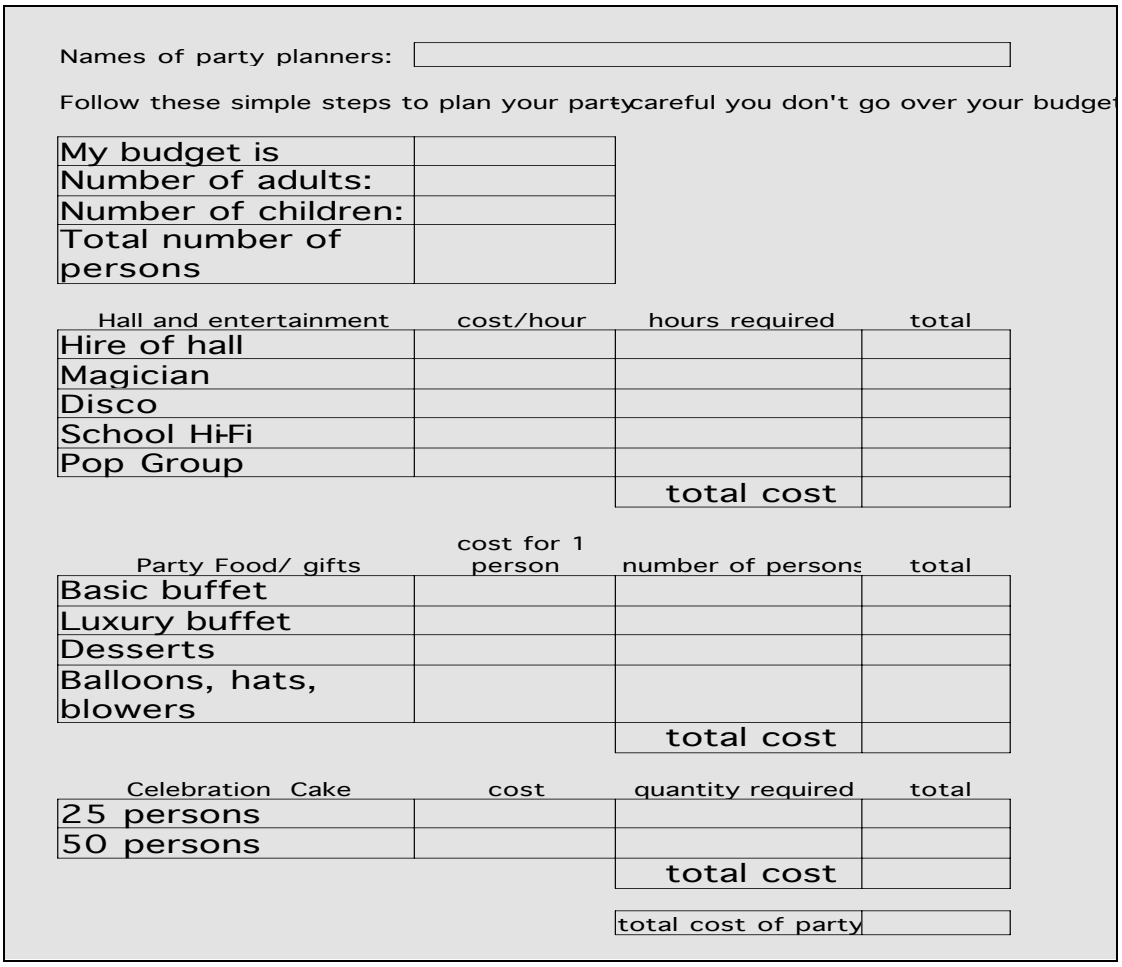
THE LESSON

The lesson we report on was with a year 6 group of 23 pupils in a pleasant working class area of Leeds. The lesson was one of a series of observed lessons in a project mainly focused on teacher professional development through mutual planning and observation on the use of spreadsheets to enhance pupils' mathematics subject knowledge. The pupils in this class had worked on spreadsheets in prior ICT lessons and had learnt to fill down, use formulas in cells and sum highlighted cells. The lesson was in the computer room and lasted 60 minutes. The task was to:

> Plan a party for your 11th birthday. You have £300 to spend and you MUST NOT go over budget! Work in pairs to work out your costs. You should work out the calculations on paper, using a calculator and also using a spreadsheet.

The pupils were given a sheet with costs including: hire of hall, food prices and prices of disco, magician, pop group, etc., and asked to record their decisions about

the party on a grid (Figure 1), which was available as a paper worksheet and as a spreadsheet workbook.



Names of party planners:

Follow these simple steps to plan your party careful you don't go over your budget

My budget is	
Number of adults:	
Number of children:	
Total number of persons	

Hall and entertainment	cost/hour	hours required	total
Hire of hall			
Magician			
Disco			
School Hi-Fi			
Pop Group			
		total cost	

Party Food/ gifts	cost for 1 person	number of persons	total
Basic buffet			
Luxury buffet			
Desserts			
Balloons, hats, blowers			
		total cost	

Celebration Cake	cost	quantity required	total
25 persons			
50 persons			
		total cost	

total cost of party	

Figure 1: Grid provided as hard copy and as a workbook

As a planned part of the teaching, there was an amendment to the task 42 minutes into the lesson, when they were told of a telephone call from ‘Auntie Mary’:

> How wonderful to hear you’re having a birthday party! Just a quick call to say that I’d love to come and join in the fun! I’m sending you £50 towards your party. Hannah and Jacob your cousins were really excited when they heard that they were invited too!!

The structure of the lesson (in minutes) was as follows: (1) lesson starts, Intro/plenary, problem set (using Powerpoint); (8) end of Intro, pupils move to computers to log on; (12) second plenary – teacher asks ‘how are you going to do this?’ and later ‘how might you do it on a spreadsheet?’; (19) pupils settle in pairs at computers; (42) Auntie Mary message, pupils resume work; (52) assemble for final plenary; (60) end. The adults present during the lesson were: the teacher; two researchers and a local secondary teacher as participant observers; and two volunteer computer technicians. The teacher instructed the pupils, verbally and through the Powerpoint slides, to “work out the calculations on paper, using a calculator and also using a spreadsheet”. Pupils clearly enjoyed the lesson.

Data collection, analysis and interpretation

The table below summarises data collected (column 1) and analysed (column 2).

Video-recording of the lesson	Description to record structure of lesson
Teacher interview prior/after lesson Pupil interviews 2 days after lesson	Transcripts 'scrutinised' Transcripts subjected to open coding
Screen capture of 3 pupil pairs	Descriptive notes with 'memos'
Pupils'	
Paper work	Scrutinised/memos made
Final Excel worksheets	Examined for correctness
Records of attainment	Global mathematics attainment noted

Interviews were semi-structured and pupil interviews were in small groups (usually four pupils). Pupils were asked about the work they did and about home use of computers. The screen capture data provided full records of pupils' key strokes and discourse at the computer for three pairs of pupils (we could also tell when an adult assisted). Our interpretation was informed by constant comparison of data analysed with ongoing 'storyboards' of pupils' task development in the lesson.

One outcome of our interpretation was a description of the tools pupils used in this lesson. We focus on four tools: (i) the grid (Figure 1); (ii) the use of paper and pencil with calculators; (iii) the use of the spreadsheet as a means to display work; and (iv) the use of the spreadsheet as a calculation tool. Of the 11 pupil pairs in the class, one pair did not use a computer at all, one did not use paper and pencil at all and nine used all four tools. We comment briefly on these four tools.

(i) All pupils used the grid (on paper or in electronic form), as it was implicitly part of the task rather than an optional means to do the task. When for example one pair of pupils started to work on a blank spreadsheet, an adult came over and loaded the spreadsheet version of the grid. Choice on this was effectively denied to the pupils.

(ii) The use of paper and pencil with a calculator also included the use of 'mental algorithms'. These formed a unified set of tools in practice in this lesson.

(iii) and (iv) The use of the spreadsheet as a display tool or as a calculation tool are 'pole categories of use', and in practice the pupils often used the spreadsheet in different ways at different times. It is important, however, to distinguish between these uses – between on the one hand inputting cell contents manually, and on the other using the calculation functions of the spreadsheet, such as formulas, fill down and sum (Σ). These options represented a critical 'choice' in tool use during this lesson, partly because the use of the spreadsheet as a display tool is not mathematical in the way that was intended for the lesson. The 'Auntie Mary' intervention was designed to provoke awareness of this critical distinction in the pupils.

A map of influences (on choice of tool)

Through the various kinds of analysis undertaken on the data from the lesson, a picture emerged of influences on pupils' choices of tool, shown in Figure 2.

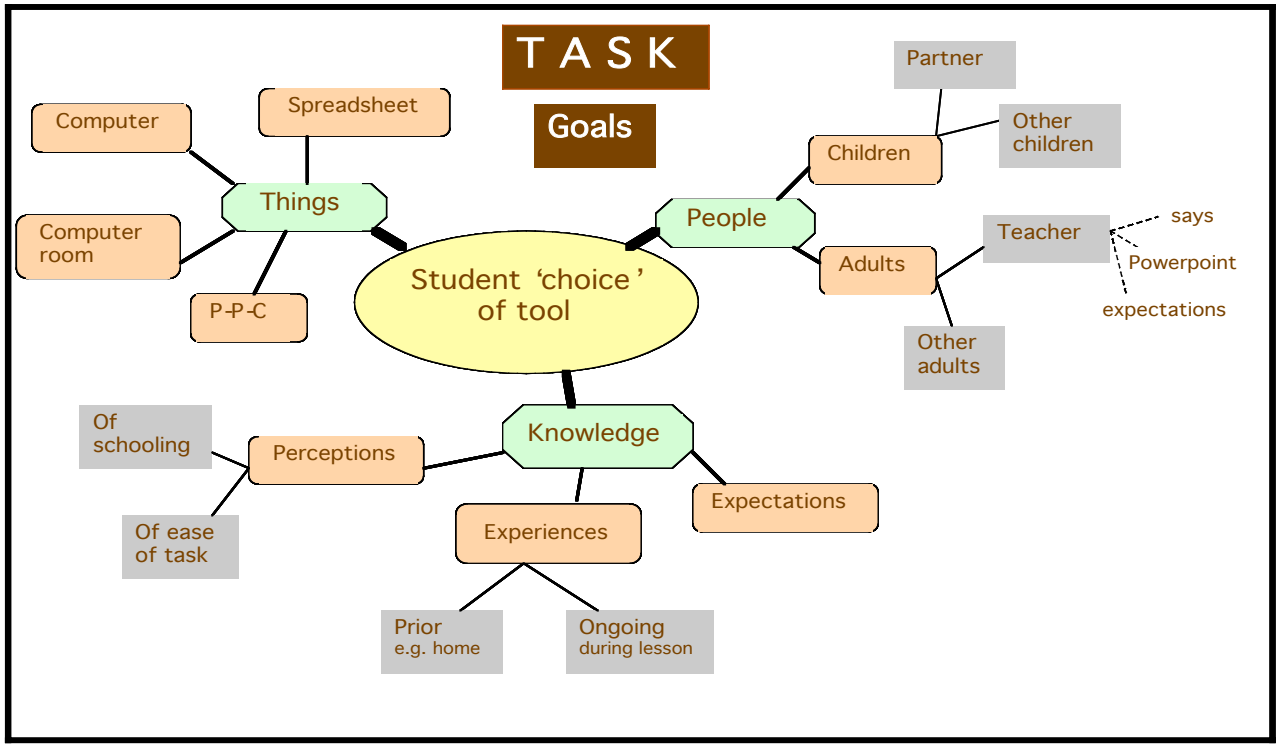


Figure 2: A map of influences on choice of tool

The three aspects of influence shown in Figure 2 – people, things and knowledge – emerged in the analysis as distinct in their characteristics, despite their clear interrelatedness. Space does not permit a full examination of all parts of this map and so we merely give an example from within each of these three 'zones' to illustrate their nature, influence and interrelatedness. 'Task' and 'goals' are highlighted in the map to emphasise their overarching importance – choice of tool in any mathematics lesson is going to depend on the task and on people's goals.

Things

From their screen capture, it was clear that Cathy and Mark primarily used paper and pencil with a calculator for their calculations, with the spreadsheet used only to offer a neat record of their work. However, 27 minutes into the lesson they did attempt to use the spreadsheet for calculation, highlighting relevant cells in order to use Σ to find the total for 'hall and entertainment' (see Figure 1). The screen capture data makes it clear that they know that Σ is in the top right corner of the spreadsheet. However, the top right corner also contains other commands, including 'fill down', and Cathy and Mark accidentally activated 'fill down' so that their highlighted cells are all changed to 40. The audio recording on the screen capture data shows instant recognition of the problem, with Cathy saying "oops". The influence of the 'thing' (the spreadsheet) on Cathy and Mark's choice of tool is in their abandonment of the attempt to use the spreadsheet as a calculation tool, and their reversion back to using

it as a display tool. Of course the 'thing' in this episode did not influence Cathy and Mark in isolation from other factors. 'People' and 'knowledge' also clearly interact with it: 'people' in the form of adults encouraging them to use the spreadsheet in that new way; and 'knowledge' in knowing that the use of Σ was expected, knowing that Σ was somewhere in the top right of the screen, knowing that the 'slip' occurred, and knowing that they could not use the sum operation reliably.

People

The teacher had an obvious influence on choices when she said, for example "I've also set up a spreadsheet for you to use. You don't have to use it if you don't want to" and "I want you to have a go at it on paper so you can see what you're doing" and "One of you can do it one method, one of you can do it another method". Children also influenced each other in the choice of tool. For example, one said to another "Do the sum thing, the sum thing that you did". But people as an influence do not always determine choices. For example, in one case when the observing teacher said "Put the formula in" a pupil responded "No, because if you do it this way [on paper with a calculator] you are positive that it's right." The pupil's response here seems more influenced by her knowledge than by the other person.

Knowledge

Knowledge has many aspects and, as well as the types of knowledge commented on immediately above, a seemingly influential kind of knowledge in this lesson was knowledge about what computers are for. As one boy said in the lesson to explain why his pair did not use the computer to do the work: "computers are for YouTube".

DISCUSSION

(i) Map of influences

We have identified three 'distinct but inter-related' areas of influence on tool use: things, people and knowledge. While it is possible to view each as a separate influence, and think of the eventual choice as arising from which of them is the most 'powerful', our analysis suggests an interrelatedness relating to pupils' personal perspectives. This can be illustrated with extracts from an interview involving Keith.

> K: […] we decided to do it on paper because we thought it might be easier, because I didn't, I don't like computers […] I do like them but […] I don't like spreadsheets, I just can't do it, I get confused
>
> K: I like computers, like in my house I just want to go on games and internet and stuff but I don't like using the spreadsheets, I can't do it
>
> K: […] we had two of us but where it was one of us was doing it it would be real hard …because we'd have the calculator to control […] but he did the calculator and I did, I wrote it down and worked out some of them in my head

Things, knowledge and people are there in these extracts but they are tied up with who the pupil is. Keith likes being in control – as suggested by his reference to

‘easier’, ‘confused’, ‘can’t do it’, and ‘calculator to control’. He likes computers but not spreadsheets. Where we value a mathematical use of ICT, he values computers for other reasons, and would rather, in this case, use ‘old fashioned’ technology to achieve the mathematical ends. What seems to be most important about things, people and knowledge as influences on Keith’s actions is how he views them. In other words, this pupil’s perspectives and values are the key to his choice of tool.

(ii) Two levels of ‘choice’: choice of artefact and choice of tool

The difference between ‘artefact’ and ‘tool’ is that an artefact is a thing which becomes a tool when it is used to do something. Using this distinction it could be said that we both choose an artefact and also choose a tool as a use of that artefact. This can be considered through the use of spreadsheets in this lesson. A spreadsheet is just an artefact until it is used, and in this lesson it was used in two distinct ways – for display, and to calculate. Not all pupils chose to use the artefact, but those that did made a further choice – a choice of tool.

IMPLICATIONS

As choice is situated, and choice of tool is essentially interrelated to task, it would be inappropriate to presume generalisation from the observed lesson. However, the analysis outlined above does raise some questions about how best to develop mathematical subject knowledge in pupils through the use of ICT. Since learning generally occurs as a by-product of goal-directed activity, the issue of tool-choice is critically important to it. Reflection on this lesson has indicated that pupil values are key to this, and that an investment in developing helpful pupil perspectives on computers and other relevant ‘things’, on teachers and other relevant people, and on software functionality and other relevant knowledge, may be an essential adjunct to the conventional pedagogical focus on what to do and on what is being taught.

The lesson also offered a reminder that ‘choosing’ to use an ICT artefact (eg because the teacher has set a task requiring the use of it) is not enough for mathematical learning – it requires a further choice in how the artefact is used, in effect choosing to use it as a mathematical tool. When designing lessons using ICT in the belief that its use promotes mathematical learning, it needs to be remembered that how it is used is vital, and achieving appropriate tool use requires careful consideration. This might be said to be acknowledged in curriculum documents which recommend that learners “choose appropriate tools”, but the subtleties of the meaning of this expression are not usually articulated.

ACKNOWLEDGEMENTS

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REFERENCES

DfEE (1999) *Mathematics: The National Curriculum for England*. London: HMSO.