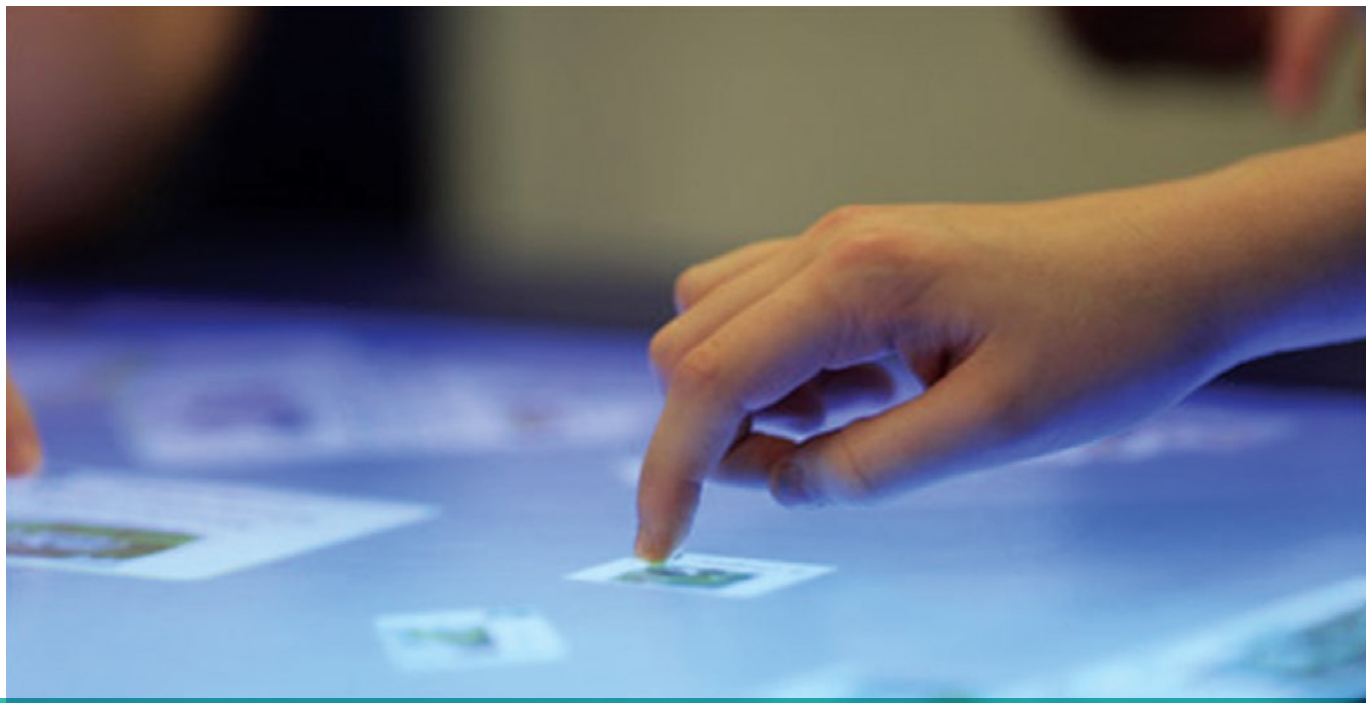

Digital thinking

A popular tool for improving dialogue and higher-level thinking skills for over twenty years, the paper sorting activity 'Mysteries' has now been given a digital makeover. **David Leat** and **Ahmed Kharrufa** describe the features of this new digital version, and explore the effect using it in the classroom has had on students' reasoning and thought processes.

Since the early 1990s, *Mysteries* have been a very popular teaching thinking strategy, offering a very open but challenging task with much promise in the development of metacognition and generalisation of learning. For those who are not familiar with the strategy, they started life as paper sorting activities with two to four pupils working together. Typically they would include:

- An open question, possibly with significant ambiguity - e.g. why a particular person is leaving their home and migrating to another country or region.
- 16-30 data items on separate pieces of paper.
- A narrative thread with characters and events or decisions to get students hooked.
- Background context which might indicate causes in relation to events or decisions.
- Some 'red herrings' to foster ambiguity and false trails.

The five stages of mystery solving

From the analysis of video evidence and photographs of pupils doing mysteries, as well as subsequent interviews with pupils about their thinking as they progressed through the task, five generalised stages were identified in how many students tackled mysteries[1]. Clearly, not all groups by any means, progressed through all stages.

The Display Stage – At the start, the group spread out the pieces of paper and read them. The main skill being demanded at this stage is comprehension of the data items.

The Setting Stage – Students usually begin to organise the data into groups so classification is a key process. Yet even at this early stage, a variety of strategies appear which may reflect cognitive ability or metacognitive skill and knowledge. Lower achieving groups frequently form sets on the basis of the names of characters or places. Many groups however, assemble more thematic sets, for example 'reasons for' or 'against' something. On the table, these sets are arranged as clusters, columns and blocks. Most groups form a 'reject' pile, which at this stage are not seen as relevant. Some lower attaining groups jump to conclusions and often make large reject piles as they fail to see linkages between data items.

The Sequencing and Webbing Stage – At this stage, most groups begin to identify links between sets or between single data items. In some instances, they construct lines representing the construction of a causal explanation (sequencing), while in others, groups of items are linked by other single data items indicating inter-relationships (webbing). This is essentially the point at which groups are generating their initial explanation and it reflects an ability to synthesise and hypothesise.

The Reworking Stage – This stage can be radical or modest and can take many forms. It may start with moving one slip from a set to another, but can go on to include reject slips being worked into the explanation, or even wholesale regrouping. These re-workings appear to represent new sets of relationships, which are increasingly abstract. In the process of being moved, data items are cumulatively taking on new meaning. As a generalisation, thinking is becoming more complex as the stages proceed.

The Abstract Stage – For a few groups, the physical manipulation ceases but the discussion continues. It is likely that they have internalised the data to a point where they can explore new relationships and hypotheses without recourse to the concrete format of the data slips.

Going digital

Mysteries were widely adapted into different subject contexts, notably in the 'Thinking Through' series of books (Primary, geography, history, MFL, RE, English, maths etc.) and even made an appearance in the secondary strategy materials 'Leading in Learning'. Some talented teachers understood the scope for moving thinking on in formative mode, but I was equally aware that some teachers turned mysteries into convergent activities with a right answer, which was not a complete disaster but this strips out much of the capacity for argument and dialogue. The world moved on and I had other things to do, so Mysteries have just been *out there*, cherished by some but not in the spotlight I believe that they deserved.

However in 2007, Ahmed Kharrufa – who was working on a doctorate focusing on the potential of tabletop computers – developed mysteries into a digital format and opened a whole new world of possibilities. Tabletop computers have reasonably large horizontal surfaces with touch screen technology that invite group work. Ahmed developed some new features which enhance mysteries in significant ways. Digital mysteries explicitly divide the task of solving a mystery into three stages only

– a reading stage which corresponds directly to the display stage, a grouping stage which corresponds to the setting stage and lastly, the sequencing/webbing stage. This last stage affords the students the opportunity to progress to the reworking and abstract stages.

In digital mysteries, all the slips appear in an iconic (minimised) mode and the text is only readable once the slip is magnified. The application only allows moving to the second stage if all the slips have been magnified to a readable size as they are assumed to have been read. In this grouping stage, the application provides three explicit externalisation tools the grouping tool, the post-it note tool, and the sticky tape relation tool (as shown in the middle commands menu in figure 1).The application only allows moving to the third stage if all the slips have been put in at least a specified number of groups (usually three or four depending on the teachers' setting). In the sequencing and webbing stage, an additional relation tool, the arrow shaped sticky tape, is provided to help make linkages between items more explicit. Students can indicate the end of this stage by selecting the next command. After the third stage, an explicit reflection stage is provided.

In summary, the mysteries software puts special emphasis on:

- Supporting face-to-face collaboration.
- Enforcing a structure on the task (through the stages).
- Enforcing a structure on the interaction (through switching between multiple and single input).
- Providing tools (grouping, sticky tape etc.) which emphasise important cognitive skills.
- Recording the activity, so that it can be played back for reflection.
- Providing relevant feedback to jump start reflection.

Figure 1

Adapting the technology to suit learning needs

We conducted whole class trials, using six tabletops in a local secondary school working in geography, history and English. One of the hard lessons we learned was that student disposition makes a considerable difference to how pupils engage with the technology and the task. Where pupils are very tuned into their next set of tests and are not particularly interested in their own learning processes, they do not readily engage and have a tendency to 'game' or beat the machine. By contrast, students who are interested in learning processes whatever their ability get very engrossed and interact with the task and the feedback.

The following are goals of current technical developments:

1. The class whiteboard and teacher screen should be set up to show some indication of the progress of each group and for monitoring and demonstration.
2. The teacher should be able to see on each table, not only the current 'state of play' but also the history of actions, such as what has been put in the recycle bin.
3. There needs to be flexibility for the teacher, so that they can increase or decrease

the level of challenge, based on observation of progress – perhaps by adding or reducing the number of data items or even changing the question.

4. The technology needs to be integrated with other aspects of lesson planning, so that the digital mystery is part of learning activities and some groups who work particularly quickly, might move on to other tasks.
5. The technology must allow the teacher control over the classroom (for example, override conditions, start, pause, resume and end the process).
6. The technology should allow for transition between the individual, group, and classroom planes.
7. The technology should allow the outcome of the process to extend beyond the session (for example, it should be possible to email a summary of the process and answer to the students).

Dialogue, demonstration and observation

Another recent development is a suite of 'authoring' tools so that teachers can write their own mysteries or edit existing ones to suit the needs of their students and the content being studied. This also opens up the option of students themselves constructing mysteries based on their own enquiries or fieldwork, as this provides a diagnostic assessment of understanding of an issue. We have also become very interested in the general formative assessment potential of digital mysteries. The underlying premise here is that formative assessment is grounded in talk about thinking and ideas, therefore any serious discussion generated by the mystery or during the reflection phase is formative, as it helps shape ideas and scaffold the sense making process. This is underlined by a 'second generation' definition of 'Assessment for Learning' by Klenowski[2]:

'Assessment for Learning is 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.'

Dialogue, demonstration and observation are available in abundance generated by digital mysteries. There follow three examples of very formative assessment stemming from digital mysteries.

Example 1

Deciding whether to put a slip in the 'for' or 'against' (staying) categories during the grouping stage.

This occurred during the grouping stage of a mystery (*Annie Schmidt leaves Windy Creek)* which asks whether a young female graduate should leave her small home town in the foothills of the Rocky Mountains.

The students' conversation was as follows:

Student 1: Put that one in 'red herrings'?
Student 2: What does that one say, I don't remember.
(Student 1 makes the slip larger. Student 1 and student 2 read the slip content aloud.)
Student 3: It's kind of a reason to go, because she doesn't want to waste her education but she loves her family.
Student 1: It could be for staying.
Student 2: It's kind of in the middle.

Student 3: Or make another group like for I don't know.
Student 2: Like pie, like overlapped and it goes in the middle *(makes circular gestures with the pen)*.
Student 3: Let's make a group and put it in the middle. What shall we call it?
Student 2: For and against.

Not only are these students demonstrating problem solving behaviours, but they are also generating new ideas in this context by introducing the idea of a Venn diagram to accommodate data items which do not fall cleanly into a *for* or *against* category. The grouping tool is vital here as it forces their attention towards the process of classification and forming concepts. Exploratory talk is very much in evidence as student 3 leads them into a discussion of data items that are ambiguous. The reflection is 'part of the activity' and stimulated by the need to have at least four groups, as they have only two data groups initially.

Example 2
Using the sticky tape to show linkage between two slips in the webbing and sequencing stage.

Student 1 creates a sticky tape and links two slips together.
(After a little more than a minute)
Student 2: Why are they related? *(asking student 1 while pointing to the two related slips)*
Student 1: Because she can go and do, she can go canoeing and the … It's a winter sport, isn't it? And she can go canoeing in winter, you know.
Student 3: How, if the water is frozen?
Student 1: Not necessarily, like she can do it in the autumn.

This is a relatively short extract, but even here there is 'part-of the-activity' reflection and productive talk stimulated by the use of the sticky tape tool. Feedback to student 1 is embedded in their talk as student 2 asks why the two slips are related. There is

no teacher involvement and no obvious scaffolding. However, it is important not to disregard such small episodes as they are part of a cumulative process of building a climate in which students are inducted into exploratory talk, in which questions and explanations are commonplace, and the power to reason develops. Of particular significance is that the physical, visible act of using the tape to make a link prompts student 2 to ask: "Why are they related?"

Example 3

Effects of reflective prompts at the sequencing/webbing stage. This occurs after all the data items have been moved.

On some occasions, groups selected the finish command with either a number of grouped slips or very simple linear sequences of slips. With the use of evaluation prompt, (see Figure 2) students in all cases successfully identified the layout that most closely resembled their structure and constructed more complicated representations. In one extreme case, a group selected finish command with the slips still in their original grouping with only a few added notes. Once the prompt was displayed, one of the students said: "Oh my God, so we've done it totally wrong." They selected the grouped layout and resumed working and talking. The students pulled out the slips from the groups, put them in piles and put a number of sticky tapes on them and on their existing notes, and selected finish again. Upon seeing the sequence dialogue, the students realised that they had not improved on their answer and started to feel a bit frustrated. The teacher, noticing the students struggle, provided some scaffolding and more detailed hints on how to start building a reasoned sequence. Only then were the students able to think clearly in terms of causality and linkages and build a sequence that reflected their level of understanding of the problem.

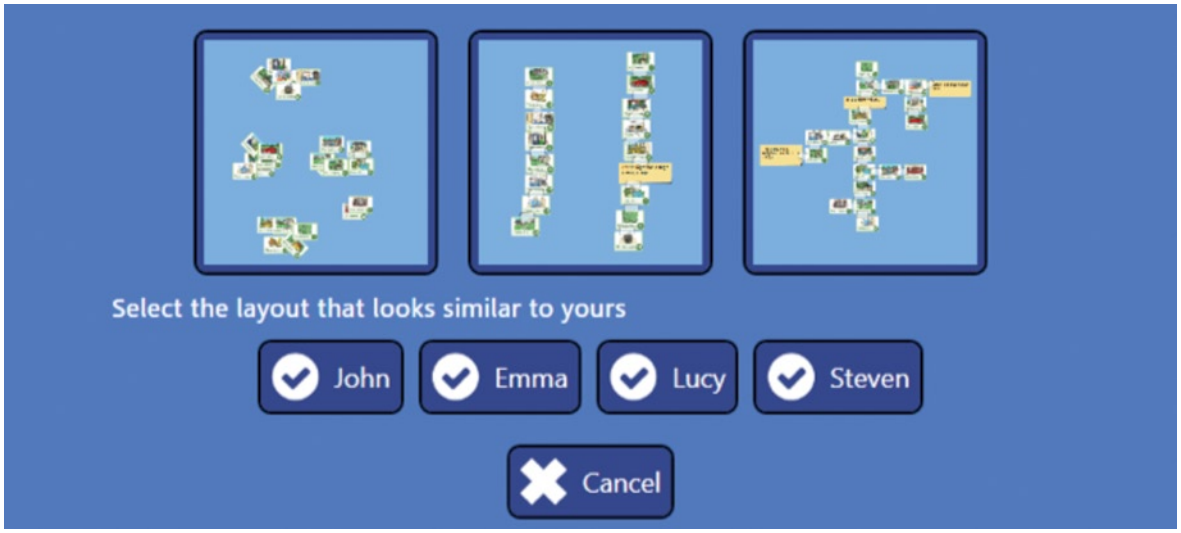

Figure 2

This example illustrates the importance of feedback from the tabletop which prompts inter-activity reflection. The feedback from the tabletop tool is depersonalised and comes at a stage when the students are open to rethinking, which is less the case when they have committed to a personal written outcome. Furthermore, this is a critical intervention as the students are approximately at the present limit of what they can achieve, and the graphical/written feedback induces bouts of exploratory talk and occasionally a little panic. This panic is a trigger for the teacher to intervene and provide scaffolding, and she did much to control the building frustration, particularly by suggesting how to achieve goals – doing just enough to get students past a particular difficulty. We are aware that the tabletop prompts tread a fine line between scaffolding and imposing constraints through suggesting that there is a 'rightish' answer.

References

1. Leat D, Nichols A. (2000) Brains on the table : diagnostic and formative assessment through observation, Assessment in Education: Principles, Policy and Practice, Vol. 7(1), pp. 103-121.
2. Klenowski, V. (2009) Assessment for Learning revisited: An Asia-Pacific perspective. Assessment in Education: Principles, Policy & Practice, Vol. 16 (3), pp. 263–268.
3. Torrance, H. & Pryor, J. (2001) Developing Formative Assessment in the Classroom: Using action research to explore and modify theory, British Educational Research Association, Vol. 27 (5), pp. 615-631.

Knowledge trails

1. **Mysteries** – David Leat provides an example mystery and describes how he used it in one KS4 classroom. http://library.teachingtimes.com/articles/mysteries
2. **Thinking for learning** – Mel Rockett explains why so many schools in Northumberland have been inspired to adopt thinking skills strategies such as Mysteries to raise standards. http://library.teachingtimes.com/articles/thinkingforlearning

We think it is particularly important that conceptions of formative assessment for practice go beyond instruction, as this limits teachers to thinking about the process as one driven exclusively by them. This approach is reflected in the work of Torrance and Pryor[3]:

"(They) should be encouraged to engage in this dialogue with each other as well as with the teacher. A variety of questions should be used to elicit understanding and guide progress. This is crucial for communicating quality criteria and realising 'scaffolding' in action. Particularly useful forms of such questioning are elicitations which invite students to clarify and to reflect on their own thinking."

Digital mysteries provide a significant opportunity to promote dialogue and thinking, and with the aid of current tools and future embellishments, avenues of both group and individual progress can be mapped. The tools mean that a great deal can be achieved even where teachers do not have a refined insight into thinking generated by the task and its tools, or indeed a repertoire of scaffolding moves. However we contend that digital mysteries will be more powerful where they are mediated by a skilful teacher.

For more details of the use of digital mysteries go to: www.reflectivethinking.com/

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