AN AUTHENTIC PACKAGING TASK IN THE CLASSROOM

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We describe the work of one Year 9 class who undertook a two week long activity around designing packaging for shelf-ready tea as part of a project on linking school mathematics to out-of-school mathematical activities. We describe the project and the classwork and discuss issues arising from the work.

INTRODUCTION

We report on the work of one class in a project concerned with linking school mathematics to out-of-school mathematical activities. In the next section we describe the project from each of our perspectives. We then describe the task, the class and what happened. The third and final section raises four themes that we feel merit consideration.

THE PROJECT FROM EACH OF OUR PERSEPCTIVES

The *Linking School Mathematics* project[1] is looking into ways that secondary school mathematics can be done in a manner similar to how it might be done in out-of-school activities. It aims to:

- understand problems in linking school mathematics to out-of-school activities;
- understand how learning activities can be designed to make these links;
- to understand the role of the teacher and of resources in making these links;
- to understand how learning is affected in such endeavours.

Well, that's John's account. Tony's view of the project is somewhat different. He is involved as a teacher-researcher because he wants his pupils to see how useful mathematics can be outside the classroom. He believes that by presenting pupils with a real life problem from industry that pupils can appreciate when and where specific mathematical topics are used in the workplace. He also views the project as a way to establish links with industry and a way of sharing ideas and good practice with the other teachers involved in the project.

THE TASK, THE CLASS AND WHAT HAPPENED

Tony made contact with a local Tea and Coffee company in Harrogate. The design brief for the project class was a real life problem faced by the packaging department of the company. There has been recent pressure from a large supermarket chain for the Tea and Coffee company to introduce *shelf-ready* packaging. At that time tea cartons were packed in a outer box containing six cartons (3 rows of 2 cartons) and, to stack the tea cartons on the shelves, it was necessary for supermarket staff to completely open the outer boxes and then stack the cartons one-by-one onto the shelves. The purpose of *shelf-ready* packaging is to enable supermarket staff to remove part of the outer packaging by using a perforated tear strip. The remaining

packaging has the cartons of tea left in place and the box is lifted onto the shelf ready for sale. Pupils were given the task of designing this new type of packaging. The company's design brief was to make changes only to the existing packaging and not make wholesale changes to the nets of the boxes. The pupils would have to give a final presentation which would include all necessary calculations and drawings as well as a prototype of their final design. Figure 1 shows the given net and the 'torn off' box of one group of pupils (with one carton of tea inside).

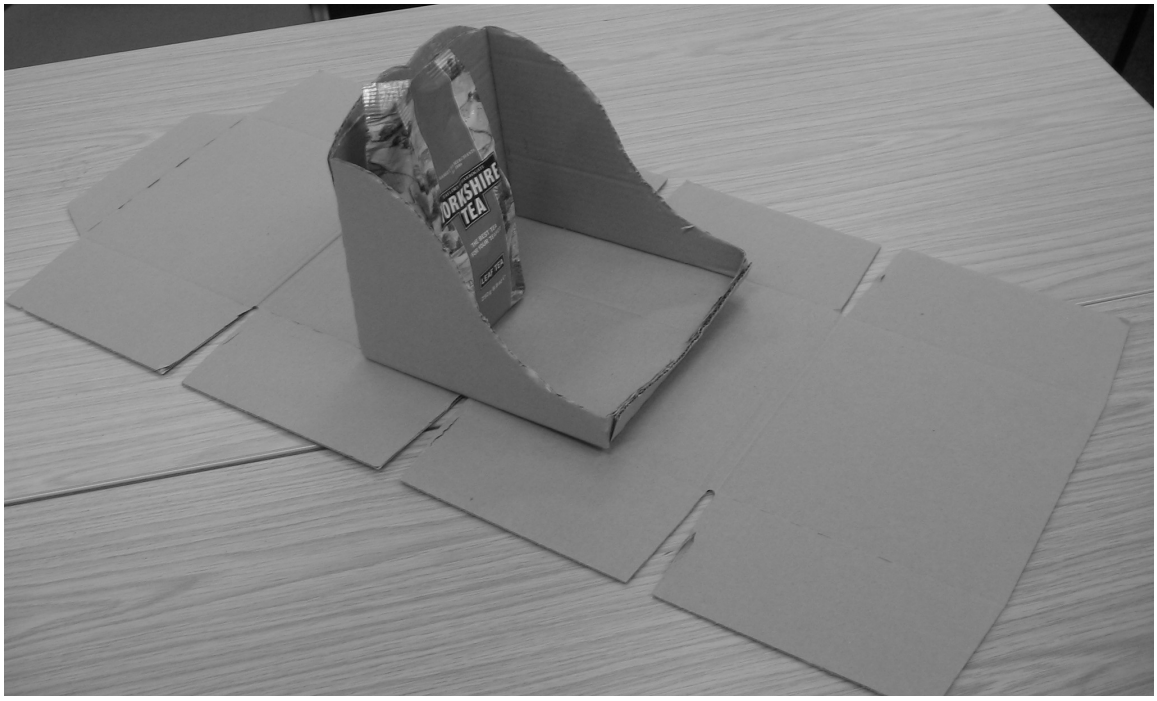

Figure 1 The net, a box and the tea

The group involved in the project were a 'top set' Year 9 class selected because it was felt they could afford time off from 'normal' mathematics lessons; these pupils are all likely to comfortably achieve a level 8 in their SATS at KS3 and will be accelerated to complete their GCSE mathematics qualification at the end of the Y10. The time frame for the project was 2-3 weeks (6 to 8 lessons). Pupils were given the full design brief, i.e. identical to that given to the company by the supermarket chain. Tony included several extra 'mathematical' problems, e.g. find the surface area of the box, to help justify the task as suitable for use in mathematics lessons.

The company donated a large number of the actual cardboard nets for pupils to work with. A company representative, the packaging department supervisor, introduced the class to the problem. The initial work was judged, in retrospect, to be very important: pupils coming up with ideas through trial and error. Using craft knives pupils made modifications to the net of the packaging. They made perforated strips around the packaging at various angles, decided on how much of the packaging would be left and how large a lip would be needed to ensure the tea cartons did not fall out of the box. The majority of groups made many early designs before taking one design further and making improvements to it.

During the design process the packaging department supervisor visited the pupils in class and was impressed with many of the designs. Although there were 10 groups of pupils working on the task, all of the designs differed from each other. Some pupils had decided to make the packaging more aesthetically pleasing by using curves constructed with compasses (such as the one shown in Figure 1) while others decided to make changes to the lip. One group changed the net to make it 'eco-friendly' (see Figure 2) so that it "sort of tessellates" to save cardboard.

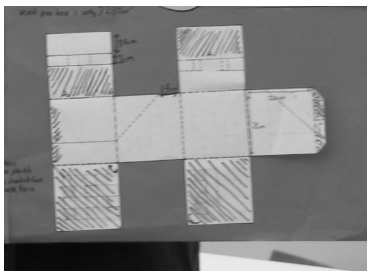

Figure 2 Eco-friendly net

By the end of the second week all pupils/groups had produced a final design and they began work on their presentation. On the final day of the project pupils, in groups, presented their work. We two, along with the company representative, were to be the judges. Unfortunately the company representative was unable to attend (an emergency at work). This was a great pity as we expected him to have different judgement criteria (see Monaghan, 2004). The pupils' presentations (see Figure 3 for one poster) were all very good and we decided not to assign a winning team. In terms of student engagement and motivation and in terms of setting a realistic task we thought the project was very successful.

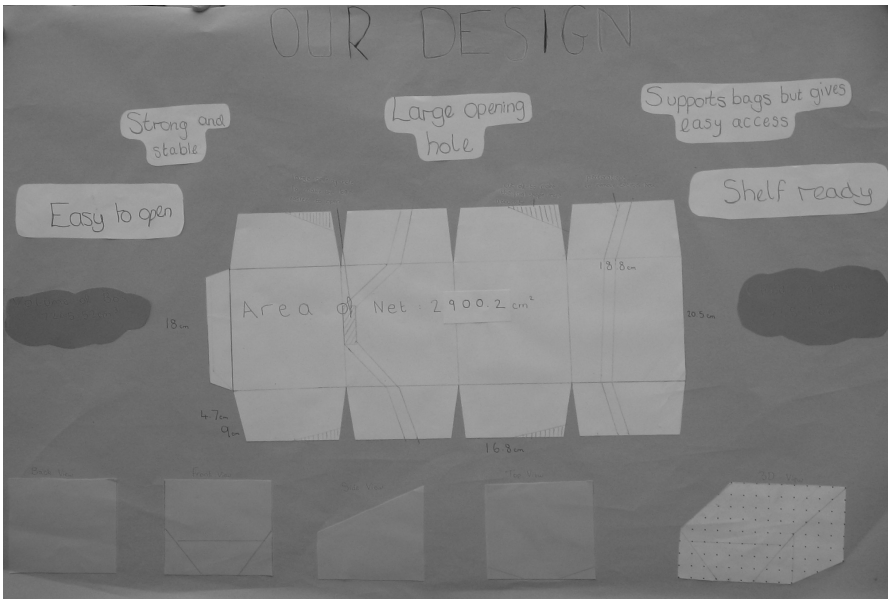

Figure 3 One group's presentation poster

DISCUSSION

We discuss four issues that appear, to us, as important in attempts to link school mathematics to out-of-school activities: the importance of 'outside people'; the role of tools; learning and assessment issues; lessons learnt (what we will do next time).

The importance of 'outside people'

We judged that the packaging department supervisor was very important for the success of this work. He gave us a real life problem. Indeed it could not be more 'real life' – the pupils worked on the exact same problem he had recently been given by a supermarket chain. There is no way we would have thought of this problem without him. Apart from the problem there were aspects of packaging that we simply had no idea about until he informed us. Further to this he motivated the pupils to work on this task in a way that we think we could not do simply because he was 'knew his stuff' and the pupils realised this – there was no pupil suspicion that Tony was giving them a pseudo-problem, here was something real to get in to.

Although the original project suggested that workers-in-the-field might be important with regard to assessing pupils' work we did not initially realise how important they would be in our/teachers' learning, in setting tasks and in motivating pupils. A bonus is appreciating how much goodwill there is out there for collaborating in educational ventures. We came to understand, however, that these are busy people who cannot always arrange their lives around a school timetable.

The role of tools

Tools are omnipresent in our lives and there are many things that can be said about the role of tools in linking school mathematics to out-of-school activities. In this subsection, however, we attend to just one aspect of tools in this work where we made an interesting mistake – locating the bottom of the box! We invite the reader to look at the net (and the box) in Figure 1 and think which part of the net will be the bottom of the box. When you are doing this by hand in a classroom it does not seem to matter a great deal which one of the four larger rectangles is the base. We told the class to take a specific larger rectangle as the base, but we were wrong. The packaging department supervisor was clearly surprised when he saw what we had done and he explained how the packaging machinery (which folds and glues the net, then puts six tea cartons in the box and then glues the final part of the box) works. We cannot explain this in the space available in this paper but, believe us, once you know what the machinery does there is only one of the rectangles which can be the base. As Pozzi et al. (1998) note "workers rarely think mathematically without an artefact to help them organise or compute the data". The lesson for us (and others who may try to link school mathematics to out-of-school activities) is *know the tools used in the out-of-school activities you emulate in the classroom.*

Learning and assessment issues

What did the pupils learn in these two weeks? This is a good question for which we do not have a definitive answer. With regard to content we do not think they learnt any new mathematics They did, however, use a number of mathematical skills: nets of 3D shapes, calculations, measures, compass constructions. The use of these skills varied over the groups, e.g. the 'eco-friendly' group were the only group which explored nets in any depth, only groups who wanted aesthetically pleasing curves

explored various compass constructions. It is extremely hard (and it may be pointless) to attempt to map, prior to classroom work, school curriculum mathematical content onto project work such as this. This 'content mapping difficulty' may present teachers with certain tensions – "Is this legitimate work for my class?". This tension was one reason why Tony asked the class to find the surface area of the box. We discussed this subtask between ourselves several times during the classwork (whether it was a useful thing to have set or not). In the end a pupil answered this for us: during her group's presentation, and quite unprompted, she said "I don't see why we had to calculate the surface area." She was, in our opinion, correct but this will not make the tension for teachers go away.

Pupils worked well in their groups (of three or four) and small group learning has many potential benefits. Sahlberg & Berry (2003) note that it may: bring about equal academic achievement; be effective in learning mathematics; be particularly useful in mathematical problem solving situations; have a positive effect on pupils' meta-cognitive development. Further to this, and with regard to Sahlberg & Berry's (taken from Cohen) typology of tasks, this task encouraged *rich equal exchange* in that all could contribute and the group outcome is likely to be much better than any one pupil could have done. This, coupled with the high motivation of the pupils as they engaged in a realistic task, is where we feel the real learning in work like this lies.

With regard to assessment we were very disappointed that the packaging department supervisor was not able to attend the pupil presentations because assessing such work is highly likely to depend on the assessors's viewpoint and we were particularly interested in his viewpoint. A few weeks prior to these presentations John had attended the presentations of pupils from another school. The project teacher-researcher in this school had enlisted the help of an NHS data analyst. Two presentations stood out: one where the mathematics (statistics) was highly developed, the other where the group had not developed the mathematics in as much depth but had attended to contextual issues in depth. The mathematics teacher thought the former should win but the NHS data analyst thought the latter should win. Their argument was pointedly 'mathematics vs context'. Is there a *correct point of view*? Probably not but this seems to be a debate worth extending in discussions of linking school mathematics to out-of-school activities.

Lessons learnt (what we will do next time)

This activity will be repeated by Tony in the next school year. He hopes to get a collegue in the mathematics department to do it as well. From both of our positions (university and teacher-researcher) it will be interesting to note similarities and differences that different teachers bring to this activity. The initial experiment was a *step into the unknown* for both of us. Tony was understandably cautious and this was one reason he conducted it with a high attaining group who had covered the curriculum content for the year. Having seen that it has many benefits for the pupils he feels he can do it with a lower attaining group. John is very keen on this because, in the course of work on this project, he has come across the following teacher

dilemma (for vocational curriculum classes): I want to do 'real' real world project work with them because it will motivate them but I need to help them get the best possible grades; their projected grades are not high, so I need to focus on mathematics which will be in the examination (rather than real world mathematics) but this will not motivate them.

Apart from another teacher and a different class there are several things Tony will change when he does it again. He will not ask the class to calculate the surface area – the activity is rewarding in itself and it does not need extraneous sub-tasks to justify it's legitimacy. He will get a video-recording of the machinery in action so that the pupils can get a 'feel' for what is happening in the actual packaging. He also hopes that the packaging department supervisor is able to attend the pupil presentations.

One of John's tasks is to find ways to gather data on learning. There is an interesting lesson for researchers in his plans for the project and what materialised in practice. He set the project up as a two year project in the belief that *teachers' classroom activities will work better the second time around*. He had specific ideas on how learning in realsitic activities might be measured. These were informed by activity theory (Leont'ev, 1978) and included: are students' motives consistent with the intended learning outcomes?; does the mathematics employed by the students in realising specific goals assist them in realising the overall aim(s) of the activity? When he was in the classroom, however, the directions that pupils were taking their work was not what he expected and he felt he had to suspend many of his data collection plans. While the second year of the project will almost certainly help teachers to refine their work, it will also give John a second opportunity to collect the data he planned to get in the first year.

ACKNOWLEDGEMENTS

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NOTES

See http://www.education.leeds.ac.uk/research/cssme/outofschool.php for a fuller project