Introducing Technology at Key Stage 2

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This article describes a school-based project undertaken when asked by a local school to assist them to introduce some aspects of technology as a part of the curriculum. The intention was that the project would provide some classroom-based staff development for the Key Stage 2 teachers, would extend the curriculum for the pupils involved and would enable me to develop ideas to use with our initial teacher training students at the university. The proposal was to work across seven classes and to use elements of technology that fitted in with their existing curriculum plans. In order that the teachers should maintain a sense of ownership over the activities, the details of the activities to be undertaken were negotiated and planned with them. I actually started working with the oldest pupils in the Year 5/6 classes and worked down the school, but in order to give a sense of development across the Key Stage, I will describe the work beginning with Year 3 pupils.

In Britain, the term technology is used in different ways in the context of education. Information Technology (IT) refers to the use of electronic, microprocessor or computer-based technology. Design and Technology refers to the processes of learning to design, make and evaluate artefacts. Both of these subjects are statutory parts of the National Curriculum (DfE, 1995) and have foundation subject status. Control Technology refers to the use of a computer or microprocessors to control machines, models or events, (such as a simple robot) by giving sets of instructions, often by means of the use of switches and sensors. Both design and technology and IT have been identified as having areas of weakness in British schools by the Office for Standards in Education (Ofsted). "The most disappointing feature at KS2, however, is the frequent lack of progress beyond KS1 levels of attainment ... Pupils are often not confident with control, which is often absent after KS1." (Ofsted, 1995) "The D&T subject knowledge and experience of teachers needs to be more extended, especially for those teaching Years 5 and 6." (Ofsted 1995).

My own observation from inspections and other school visits (running INSET courses and school based work supervision) has been that evidence of good practice in both design and technology and IT is patchy in many schools. Good teaching might be observed in isolated classes, but the schools frequently lacked continuity and development across the key stages. This gave impetus to the work, so that a framework might be developed for a school to introduce control technology across Key Stage 2 based on classroom practice. It was anticipated that this would then lead to a consequent development in broader aspects of both design and technology and IT.

The school I was working in had little expertise and few resources in this area, it was very restricted financially but had decided to order two floor robots (Pixie and Pip, manufactured by Swallow Systems) which are controlled by built in keypads using a subset of the Logo programming language. I agreed to loan a buffer box and software from the university for the period of the project, with the hope that the school could buy its own in the next financial year. The school was equipped with a range of Acorn A Series computers and BBC Master computers. The absence of User ports on the A Series computers rendered them unsuitable for control work, so it was decided to use a BBC computer together with software called "Contact" (from the National Council for Educational Technology). The buffer box was a Deltronics Controller box, complete with a built in power supply. This allowed control of up to eight devices at one time, and up to eight sensors. The software and equipment was simple, proven and robust, and most important, it was readily available. There was no need for software using multiple windows or sophisticated facilities. There were some materials and tools for construction, including glue guns and saws, wooden wheels, light bulbs, sockets, wire and batteries and 8mm by 8mm wooden strip. I took in flashing light bulbs, a soldering iron and solder.

The school told me they had purchased a curriculum planning package created by Cornwall LEA, but it provided little suitable for them in terms of IT and design and technology input. A theme of Survival had

been selected for the term. Because of this I was asked to plan work with the teachers which would augment their existing curriculum plans. The curriculum context varied across the years. In the Year 3 classes, I was asked to work in mathematics, developing work on estimating distance and angles using Pixie. In the Year 4 class, I was asked to do work on road safety, with the idea that the pupils would learn to program Pip and create a network of roads with junctions, road signs and buildings for Pip to navigate around. In the Year 5 class, we were to construct lighthouses and interface some of them to the computer, and in the Year 5/6 classes, we were to work on road safety again, but rather than using a floor robot, the pupils would build motorised vehicles and traffic lights. The traffic lights would then be interfaced to the computer and programmed to change in the normal sequence, with a sensor being used to start the sequence. They would also learn to use a soldering iron to make secure electrical joints.

Working with the Year 3 pupils, who had not used a floor robot before, I taught groups of four to six. The children sat in a circle and sent Pixie from one to another, estimating distances. They managed this quite well, so I then asked them to make the robot visit one person, turn (through 90 degrees) and visit another person. This was where some began to have difficulties. Some were unsure of left and right, others could estimate distances straight ahead, but found it very difficult in a different direction. I encouraged them to walk through the route they wanted the robot to take; this helped them. As they grew more familiar with the floor robot, I set them more difficult problems. We played robot skittles using unifix cubes as the skittles, and then made simple obstacle trails. They enjoyed this a great deal, particularly when the skittles were placed so that the robot had to turn to hit them all. Different groups adopted different strategies to help solve the problems. One group wrote down the steps as they went along. Another group tested each part of the obstacle trail before putting the commands together to make a complete program. Some of the groups had difficulty with working together, helping each other and taking turns, and I had to intervene to ensure all participated.

The girls collaborated very effectively when making their models

These observations surprised me, as the children were not of below average ability, were well motivated and appeared to be well integrated socially. I was particularly struck at the variations in ability, in visual conceptualisation as well as social co-operation. It also showed that at Year 3, many pupils found difficulties with the concepts of distance and angle. It confirmed the need for children to "Play Turtle" before doing formal work with Logo. This inclines me to think that before introducing floor robots at Key Stage 1 perhaps we should devise carefully constructed activities. I then made a treasure island map for them to drive the robot across, including hazards such as sharp rocks, sharks, marshes, jungle and snakes. This involved some complicated programming. I tried to encourage them to predict the sequence of movements in advance, and to write them down. Although they could program the robot to complete the course in single steps, they had great difficulty with programming and noting a sequence of actions. Finally, they used the ideas they had worked with to construct their own treasure island maps, and made and evaluated board games using cardboard models of the robot as counters. When I asked them to write down a set of instructions of how to find the treasure, they found this difficult, they could draw it in arrows, but not write it in

A finished buggy

directions. A number solved this problem by drawing sets of footprints across their maps – a novel solution to the problem of devising a form of notation.

Overall these activities were successful in that they had undertaken work with IT, maths, geography and design and technology. They had been highly motivated and enjoyed the activities, and I had learned a great deal about the limitations of conceptual development with Year 3 pupils.

The Year 4 class worked with Pip, which is more sophisticated than Pixie, allowing control of distance in centimetres and degrees (Pixie works in Pixie lengths and 90 degree units). It is also able to repeat parts of a program, and to play simple tunes. The teacher in this class had previously used a similar robot called Roamer (by Valiant Technology) whilst at college and found using Pip very simple. I introduced the children to Pip in a similar fashion to the Year 3 class. They proved to be much more able in dealing with the distances and angles. The teacher then got them to construct a large road map on the floor, and they made road signs and programmed Pip to travel around the map, stopping at various junctions and pedestrian crossings. This was very much a large scale design and make activity, only hampered by the fact that Pip was on temporary loan from the university, (the school was awaiting delivery of the one they ordered) and had to go back as it was needed for courses.

A floor robot makes an excellent focus for work, not just on Control Technology, but also for stimulating design and make activities in design and technology. It enables the pupils to create environments in which the robot can participate. When starting such work with floor robots the following points should be considered:

Firstly, group size is important – children need both to be able to interact with each other and the robot, and to take control. A group of six spent too much time waiting for a turn; groups of four were much more manageable. The use of an adult helper such as a classroom assistant or parent to oversee this work would also probably prevent a lot of wasted time.

Secondly, there is a very wide range of abilities among 7/8 year olds. While in the past I have quite happily recommended that floor robots should be used from Key Stage 1, I now question to what extent they can learn concepts from playing with them. It would appear that careful structure, support and direction are needed for effective learning to take place. From the groups of children I was working with, there certainly seems to be a significant growth in abstract conceptualisation between Year 3 and 4. This judgement is based on how the Year 4 pupils were able to function much more independently, use angles, cooperate and integrate the floor robot into other activities. This is an area where much more research is needed. Vaughan (1997) describes how she used floor robots with reception age pupils to develop their number ability. Although these children were only working with the concept of movement in one direction, they did not seem to find the difficulties I observed.

Thirdly, it is no good assuming that children will find out the more advanced features of the robots by accident. They had to be taught the syntax for programming Pip to repeat actions, to play tunes and to pause in its actions. At Year 3, children can describe individual steps in a program. They have difficulty putting sets of instructions into

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Programming the traffic lights

words, even when they are relatively simple like forward 5, turn left, forward 4, turn left, forward 2, stop. Even if they are able to correctly visualise the instruction in their heads, and give those instructions to the robot, they still have difficulty in turning these into written words. This suggests that we should spend more time in Year 3 getting children to sequence activities and write down those sequences, such as how to make a cup of tea, how to clean their teeth etc. By Year 4, these skills seem much more developed, and the pupils had much less problem with sequencing and writing down activities.

The Year 5 class constructed simple lighthouses using plastic bottles or Pringles containers. The children added lights using 2.5 volt MES flashing bulbs, making their own switches from paper clips and brass paper fasteners. Having successfully achieved this, we then took a number of the lighthouses, changed the bulbs for 6 volt normal bulbs, and connected the to the Deltronics buffer box, using its internal power supply. The Deltronics box was connected to the BBC computer via the Printer and User ports, and Contact was loaded from disc. First of all, I taught the children to use the software in direct mode to switch the light on and off. They saw the need for further instructions to make it flash, so we then added a repeat loop. They found that they could vary the length of the flash by changing the value of the Wait statements in the repeat loops. The final activity was to add a light sensor to the Input side of the Deltronics box, and undertake some programming to switch the light on when it was dark. This was quite difficult for them and they needed some direct instruction on how to achieve it.

The Year 5/6 classes also initiated their work through creating models. First of all, they created wheeled buggies using cardboard boxes, dowel and card wheels. This involved them in some careful measurement – they found that if the axles were not exactly parallel, the buggy would not run true. They then decorated their buggies, adding body work and colour to make attractive vehicles. The next stage was to make a buggy based on a rectangular chassis of 8 by 8 wood strip and MDF (medium density fibreboard) wheels. Although most of the children had made electric circuits in the past, this work reinforced it as some had forgotten, they had also not had the opportunity to make switches or to do soldering. There were also

some who had recently come from the private sector, and had no experience of either National Curriculum Science or design and technology. The buggy chassis was then motorised using an electric motor and a simple gearing mechanism (an elastic band driving a cotton reel). They found here that it was necessary to have the motor carefully aligned or the elastic band would slip off the motor shaft. It was also necessary to ensure the vehicle was well balanced – all the weight on one axle meant it would not drive properly. Some children then added headlights to their vehicles and made switch boxes on a length of wire so they could be remote controlled. They found that by reversing the wiring they could change direction of the vehicle, so one group experimented with two way switches so it could go forwards and backwards.

All wire joints were soldered. I showed them how to tin the wire and make simple soldered joints, pointing out the health and safety implications (solder is poisonous, being made from lead and tin, and the bit of the iron can easily melt the electric flex). Body work was then added to the vehicles which ended up looking like sports cars, lorries and jeeps. Two groups then constructed simple traffic lights using bulbs and holders hot glued onto 8 by 8 strip. Making a stable base caused some a few problems – they tended to make the base too small or to fix the light onto one edge. These design and technology activities provided the curriculum context for use of the computer, and the problem-solving skills the children were using in wiring up their vehicles were similar to the problems they would have to solve using the buffer box and computer. Once the lights were made, we then connected them to the Deltronics box and went through a similar programming process to the group which made the lighthouses. I then gave them a simple worksheet so they could work through the rest themselves. There was plenty of discussion about the traffic light sequence, eventually they found a sequence they were happy with. They were able to program it to repeat, change the timing and save it as a procedure. During the process, they had to solve a number of problems, they had to make the lights come on in the correct order, they forgot to switch lights off so that red, green and amber were all showing at once.

The next stage was to add external control to the traffic lights. We didn't have a pressure pad to sense cars passing, so it was decided to use an ordinary push switch, so that pedestrians could stop the sequence and change the lights to red. This required more sophisticated programming as the computer needs to continually scan the input to see if the switch is being pushed, and then the program has to be stopped long enough for the pedestrians to cross the road. Eventually, with a little help, the children solved the problem. A push on the button and the lights would stop on red for a while, then the sequence would restart when there had been enough time for the pedestrians to cross. Unfortunately, we could not add a buzzer as we didn't have one, or a flashing green man as there were no spare 6 volt bulbs.

Back at the university, I developed these ideas to reinforce work with the Initial Teacher Training students on their Foundation Studies IT and design and technology courses. In IT, work with floor robots was developed in terms of the students developing their own maps and games for the children to play, this was then transferred onto the use of Logo on the computer. The students with more advanced IT skills were asked to create and program their own sets of traffic lights. I hope to develop these aspects of the work further this year. In design and technology they were shown the buggies and vehicles the children had made, and then created their own models, added some form of propulsion evaluated them and then created a 2 dimensional display showing how they would use these ideas in a classroom context.

If you want to start working with Control Technology in your school, I suggest you consider the following steps:

- Work out how to integrate it into the curriculum. There are opportunities in Science, Geography, Maths and Design Technology.

- Decide what equipment you need to buy. Depending on the size of the school, I would suggest that two floor robots are needed (Pixie and Pip or Roamer), a control box (such as the Deltronics Box) with some switches, sensors and components such as lights and buzzers, and some software such as Contact or Coco, depending on the computer you wish to use. This is an excellent role for an old BBC. If you want to use a newer computer, you may need to add extra sockets to it. Before using a package like Contact, prior work with Logo should help to give the children a lot of transferable skills in programming and problem solving.

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Equipment Suppliers:

Swallow Systems (Pip and Pixie)
32 High St., High Wycombe, Bucks, HP11 2AQ

Valiant Technology Ltd (Roamer)
Myrtle House, 69 Salcott Rd, London SW11 6DQ

Deltronics Ltd (Control It buffer box)
Church Rd Industrial Estate, Gorslas, llanelli, Dyfed, SA14 7BF

Commotion (Coco)
Unit 11, Tannery Rd, Tonbridge, Kent, TN9 1RF

Data Harvest (Contact)
Woburn Lodge, Waterloo Rd, Linslade, Leighton Buzzard, Beds, LU7 7NR

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