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An Evaluation of a Pilot CPD Activity to Support the Development of D&T Subject Networks in Secondary Schools

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Abstract

This paper summarises the key findings of an evaluation of a pilot CPD project to support the development of innovative curriculum materials and CPD activities. It explores how the technologies available through CAD/CAM and EISS can be mutually supportive and help teachers to develop KS3 activities that involve designing and making a functional electronic product to a high standard using CAD/CAM and PIC technologies. The paper introduces the pilot project and outlines the methodology used for both the project and for the evaluation of the project. An outline of events is presented along with a short description of the four schemes of work that were developed and trialled. A summary of the findings from the evaluation is then presented. These are divided into.

- Development of subject knowledge;
- Development of pedagogic knowledge;
- Adaptation based on school centred knowledge;
- Outcomes of student interaction, and;
- Discussion on integrating CAD/CAM and electronics.

Key words

CPD, Key Stage 3, CAD/CAM, ECT

Introduction

The resources and manufacturing technologies developed through the CAD/CAM in Schools (2008) and Electronics in Schools (2008) programmes have significantly enhanced teaching and learning in the subject. However, the Design and Technology Association believes that there is an opportunity to build on the success of these curriculum and professional development programmes and to utilise their support networks to help in the dissemination of the outcomes. This belief is shared with a number of authors who also believe there is a need for innovative new approaches to professional development (see Fullen, 2001). The aims of the project on which this paper reports, were:

- to develop innovative curriculum materials and CPD activities which explore how the technologies available through CAD/CAM and EISS can be mutually supportive, and

- help teachers to develop KS3 activities that involve designing and making a functional electronic product to a high standard using CAD/CAM and PIC technologies (Barlex and Steeg, 2007).

A key part of the project was that it was independently evaluated by an experienced researcher. This report summarises the key findings of that evaluation.

Overview of the methodology

The project was based on a four stage model which can be seen in Figure 1.

1.	11-12 January 2008 Teacher 2 day CPD event
2.	In school development
3.1	8 March 2008 Student day
Further work in schools during E&E time	
3.2	15 March 2008 Student day
4.	1 May 2008 Celebration event

Figure 1: Overview of the project methodology

The evaluation of the project took place throughout all activities. The researchers were involved in all stages of the project and they carried out structured and informal interviews with both teachers and students. Questionnaires regarding the project were also sent via email to all participating teachers.

Stage 1

Stage 1 consisted of a two day event attended by eight teachers and four teaching assistant from four different schools. The delegates were supported by EISS curriculum advisers, and tutor/mentors from each of the local EISS Hub and CAD/CAM Support Centres.

The event kicked off with an introduction followed by a brainstorming activity (see Figure 2) which became the basis from which teachers developed schemes of work for the development of electronic products at Key Stage 3.

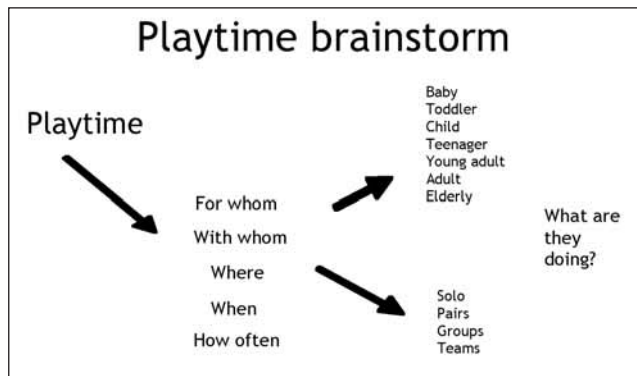


Figure 2: Example brainstorm (Barlex, 2008)

Teachers then developed, trialled and tested their project ideas during the two days. Figure 3 shows an overview of the activities.

Friday 11th January	
9:00	PowerPoint introduction including brainstorming activity with teachers (start point for later activities)
9:45:	Presentation outlining available facilities followed by a brief discussion around two separate subjects being taught separately – trying to pull them together – aim of the package – money available for CAD/CAM/Electronics kit.
10:15	Planning
11:30	Reporting back
12:30	Lunch
1:00	Trying out ideas/ design development – electronics
4:30	Report back
Saturday 12th January	
8:30:	Introduction
9:30:	Design development (CAD/CAM)
12:30	Lunch
1:30	Continued development
2:30	Reporting back- discussion regarding student days
3:00:	Evaluation

Figure 3. An overview of Stage 1 activities

Stage 2

Working in their schools the teachers developed the schemes of work supported by distance guidance (email and telephone) from the EISS Hub and CAD/CAM Support Centres. Teachers from two schools used this time to develop a 'workbook' for their students. This could be handed out to the students involved in Stage 3 (see below) and would provide the basis of working through the project. Two schools developed and produced the circuit boards that the students would use during Stage 3 and one school ordered pre-made circuit boards for their students. One school stated that they had not found any time to further develop the scheme of work and had not given it any attention since the two day teacher event.

Stage 3 (shown as 3.1 and 3.2 on Figure 1)

This comprised of a two day 'Digital D&T Workshop' at which a selection of Year 8 and Year 9 pupils from each of the four schools tackled the units of work. The event took place across two Saturdays separated by two weeks. Figure 4 shows an overview of activities.

Saturday 8th March	
9:20	Schools start to arrive
9:40	Introduction
10:00	Teachers introduce activities and work starts
12:30	Lunch
1:30	Feedback session
1:45	Students continue to work on projects
3:45	Tidy up
3:55	Debrief
4:00	Finish
Saturday 15th March	
9:20	Schools start to arrive
9:45	Welcome (very brief) & demonstration on how to send work to the laser cutter.
10:00	All groups resumed work
10:55	Dissemination demonstration
12:20	Lunch
3:45	Tidy up
3:55	Debrief
4:00	Finish

Figure 4. an overview of stage 3 events

Separating the two practical days by a week gave the students and teachers the opportunity to use Enhancement and Enrichment (E&E) time at school to work further on their projects under the distance guidance of the EISS Hub and CAD/CAM Support Centre mentors.

Stage 4

A twilight celebration event at which the four schools will display their accomplishments.

Aims and objectives of the initiative

At the end of Stage 1 the teachers should have acquired knowledge and skills which will enable them to develop short curriculum units suitable for pupils at KS3 (Barlex and Steeg, 2007). It was hoped that at the end of the event the teachers would have acquired the subject knowledge required for teaching an integrated electronics and CAD/CAM project, that they will have the pedagogical knowledge to allow them to teach the schemes of work effectively, and that they will have applied their own school knowledge, in order to ensure the schemes can be implemented successfully (see Figure 5).

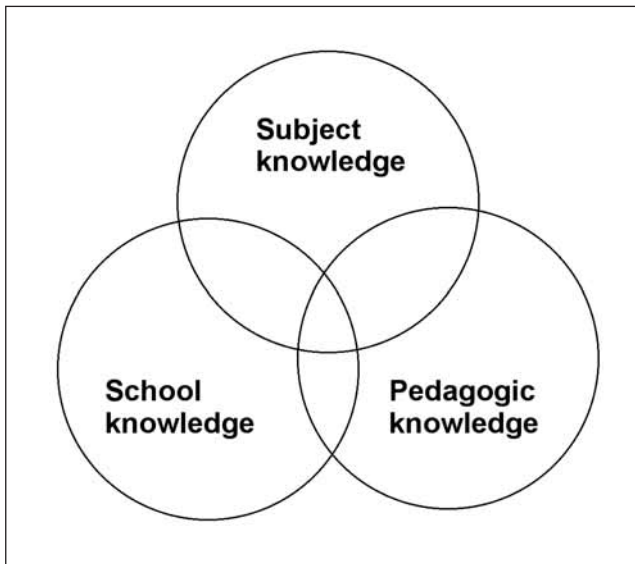


Figure 5: The subject construct approach (Adapted from Banks et al, 2001)

Outcomes from the two-day event

Four products (one per school) which integrated electronics and CAD/CAM production were developed.

Projection project (Year 8)

This project consists of a large product casing manufactured via producing a mould with the CAM router over which plastic is then formed (see Figure 6). The casing holds a PCB and a number of LED light sources. The casing also has space in which laser cut lettering is slotted. PICAXE is used to program the lights so as they come on they project the lettering in a series of colours and/or positions.

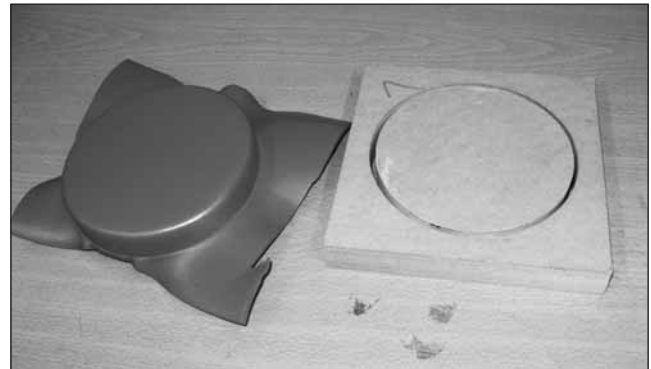


Figure 6: MDF mould using CNC router used to produce the casing for the projection product

Light band project (Year 8)

This involved the development of a core light circuit (see Figure 7) which uses a number of light sources within a Rapid Prototyped (RP) casing. PICAXE is used to control the movement of the lights so they produce a variety of colours and/or patterns. The light product is then attached to a band or casing of the students choice (for example see Figure 8).



Figure 7: Development of the PCB for the light band product



Figure 8: A flashing shoulder bag produced by one student

5.3 MP3 light project (Year 9)

This product is designed to connect to a source of music via a standard jack. It consists of a number of lights. The students used PICAXE to develop a PCB through which the lights are controlled by the music (see Figure 9).

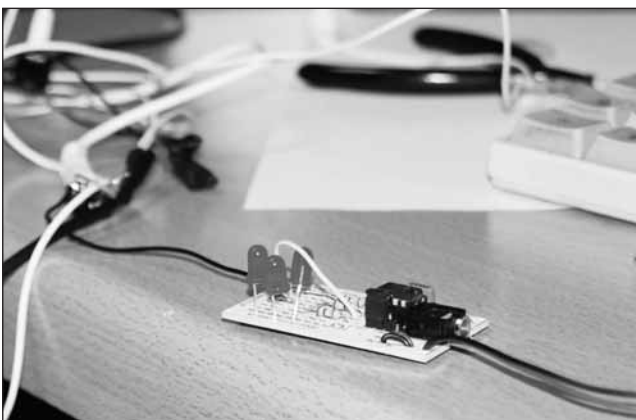


Figure 9: Testing the PCB via PICAXE

The PCB is contained within a hard casing developed built from layers of laser cut plastic (see Figure 10).

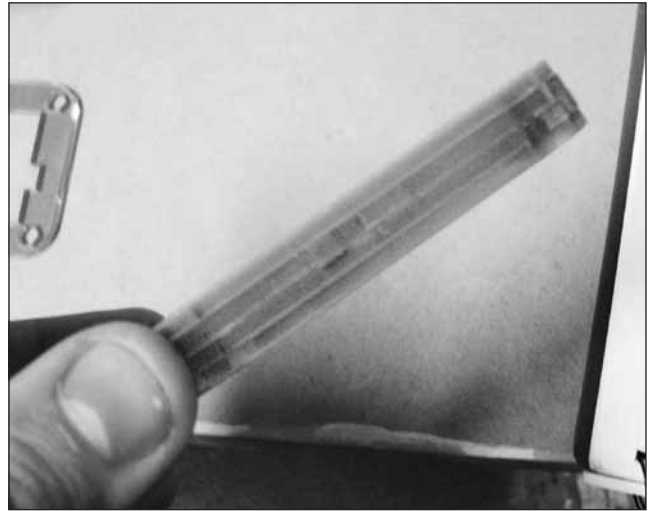


Figure 10: Casing built from layers of laser cut plastic

5.4 Cyberpet project (Year 9)

This project was developed by a school who were new to PICAXE and based it on an existing 'kit' project. The electronics component is a pre-bought kit whereby PICAXE is used to programme the brightness of two LED 'eyes'. The PCB is incorporated into a casing made by laser cutting a net from thin plastic sheet (see Figure 11).

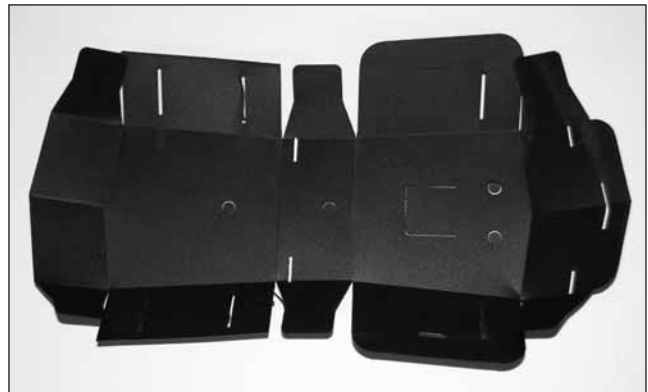


Figure 11: The laser cut net for an example casing

Findings

Presented below is a summary of findings from the project. These are divided into:

- Development of subject knowledge;
- Development of pedagogic knowledge;
- Adaptation based on school centred knowledge;
- Outcomes of student interaction;
- Discussion on integrating CAD/CAM and electronics.

4.1 Development of subject knowledge

The subject knowledge to engage with the CPD initiative required a knowledge of PICAXE, and a knowledge of CAD/CAM. Some of the teachers had already had involvement with the project team, with a number of them having visited the host school to take part in training through the EISS hub. The teachers also had varying levels of confidence of both electronics and/or CAD/CAM. Some schools had one expert in CAD/CAM and one in electronics. Two of the schools felt a general weakness in electronics.

The feedback during the evaluation session at the end of Stage 1 suggested the need for an optional tutorial for everyone in PICAXE at the beginning of the first day as many of the teachers were in a position where it was new to them and this may have got them off to a quicker and more structured start. It was agreed that a number of short, optional tutorials in the various options (cad/cam/electronics) would have been beneficial.

It was also suggested that those teachers that want to engage with the initiative take part in some pre-training events. Teachers suggested the courses offered by the EISS and CAD/CAM centres. The four day ECT course was specifically mentioned.

4.2 Development of pedagogic knowledge

Although the teachers devoted much of the two day event (Stage 1) to developing and producing an electronic and CAD/CAM product, significant attention was paid to how this project would be taught to students and the learning gains of the approach. One of the key drivers for the schools taking part in the event was the belief that an integrated approach to teaching electronics and CAD/CAM would lead to improvements in students abilities to retain and transfer skills between subjects and years.

Teachers devoted time at the outset of the two days, when they were at the initial stages of developing product ideas, to think about their students and what qualities the schemes of work would have to possess in order for effective learning to occur. The outcomes of these discussions were similar across the schools attending the two day event:

- The scheme of work needed to be made up of short, sharp activities to keep students with short attention spans engaged.
- The project had to be appealing and directly relevant to students in order for them to be interested to learn how to make them.
- The project had to appeal to both boys and girls.

The teachers also used time to ensure that the knowledge and skills taught as part of this scheme of work would build upon previous issues and lead onto knowledge and skills that would be taught in subsequent years. For example teachers in one school took the decision to use non-musical programmable interface controllers (PICs) during this scheme of work, which would be introduced to Year 8. This would then lead to a project in Year 9 where the more advanced features of the microcontroller (PIC) would be used.

Differentiation

The aims and objectives of the CPD activity includes the need to ensure the scheme of work can be made appropriate for all age ranges and abilities. Teachers all stated that the integrated scheme of work lent itself to differentiation as there were many levels of expertise that could be brought to the project, however every student should end up with a working product that they could take home and be proud of.

The consensus among the staff was that differentiation would build on prior knowledge of students via language used and detail of explanation and demonstration given. Any handouts developed for use during the pilot study would also be trialled and re-written for different levels. It was also brought up that differentiation would occur naturally in the outcomes that each of the students produce, with some students producing high quality, inventive products and others simply following instructions.

4.3 Adaptation based on school centred knowledge

The schools taking part in the pilot CPD event had varying levels of facilities from very good to quite poor. Staffing levels were also quite varied with some running large departments with a small number of staff.

Practical implications of running an integrated activity with students back in schools were discussed at every stage of developing the new projects. A number of schools had to 'rein in' their ideas based on limits of what they can do both technically and due to resources.

During the event there the teachers had to make the decision of whether to use their time at the host school as an opportunity for excitement and to do some different things using the myriad of equipment and expertise available. Or to use the time to develop and trial a scheme of work that could be done back in their schools. The decision was eventually made to run their schemes of work that could be run back at school.

Outcomes of student interaction

The students and teachers from all four schools seemed enthusiastic and engaged throughout the two Saturdays (see, for example Figure 12), and three schools even turned up early on the second day in order to get on with their projects. This enthusiasm was also reflected between the two days, as all pupils gave up their lunchtimes and stayed after school to continue working on their products.



Figure 12: A student learns how to solder

The students all showed delight in their work as they were developing products for themselves, that could be customised as they wanted. The excitement of high-tech equipment such as laser cutters and sublimation machines, which the students could use to print high quality images from personal photographs onto their product casings was also a key element of maintaining interest. Many students, however commented that the equipment they had access to during the two days at the host school was not available back at their own school, which they felt was very unfair.

The project work undertaken by the students was very intensive, and even though there were three teachers to six students from each school (with some schools only having three students), the curriculum advisors and tutor/mentors were still called upon to provide expertise at a constant rate.

Discussion on integrating CAD/CAM and electronics

There were two clear approaches observed during the student days (Stage 3). One approach was to view the electronic and CAD/CAM elements of the project as two distinct and separate elements of a product that would become integrated at the end of the project. Teachers guided students through the

development of a circuit board, and then moved onto the development of a product casing. The two items were then assembled into a final product. Indeed one school did not introduce the context into which the circuit would fit until after its completion. The remaining two schools took the approach of using workbooks to organise activities. The context and aim of the project was introduced to the students at the beginning of day 1 by 'skimming' the workbook. Both the electronic circuits and the casings were designed together, therefore teaching both elements in an integrated manner.

6. Conclusions

The overriding opinion of the participating teachers and students was that the pilot CPD event was a resounding success. All teachers were of the opinion that an integrated approach to teaching electronics and CAM/CAD in design and technology had a number of pedagogical advantages and that the schemes of work could be adapted for a number of students. The set up of the initiative allowed time for teachers to devote significant attention to how the schemes of work would be taught and what qualities projects would have to possess for effective learning to occur.

One criticism of the CPD event is in the area of 'development of subject knowledge'. Although all schools developed schemes of work that they were confident in teaching back at schools, it was suggested that a more significant 'base' of knowledge would be beneficial before taking part in the CPD activity. One suggestion for this was for all schools taking part in the scheme to send at least one teacher on the four day ECT course offered by the Electronics in Schools Programme.

One of the more unusual aspects of the CPD event was the freedom assigned to teachers to develop their own schemes of work, within a supportive and constructive environment. One school came to the event hoping to get a pre-designed scheme of work to take home, and were initially quite disappointed that the event was so open-ended. However, it was felt by many teachers that coming to the event with no parameters or initial information was a positive thing. At the end of the event all teachers agreed that it would have been harder to adapt a prescribed project back at school, based on resources and facilities. The development of bespoke projects allowed these aspects to be considered early on and decisions made accordingly. Schemes of work could also be developed to build upon previous work and lead up to subsequent work done in each school. This approach also allowed teachers to request support from experts as and when required, but also provided space for learning from one another both within and between schools.

The trialling of the schemes of work with students was very

successful, with the enthusiasm and pride from students completing their electronic products very clear. It would, however, be interesting to see how these projects would fair in schools, with reduced levels of technical equipment, larger numbers of students, and without experts on hand to help. This would also highlight more practical, 'in-house' issues that need to be addressed.

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