

Electronics and Communications Technology in the Design and Technology Secondary School Curriculum

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Abstract

The purpose of this study was to determine the depth and breadth of Electronics and Communications Technology (ECT) provision currently on offer within the 11-16 age phase in Design and Technology departments in secondary schools within Yorkshire and the surrounding regions.

The report presents an analysis of data resulting from a quantitative research study undertaken across a range of secondary schools in the region. Findings from the study with regard to curriculum content, resources and teacher expertise have been used as a basis for developing In-Service Training (INSET) and Continuing Professional Development (CPD) opportunities for teachers.

Background

We only have to take a look around us to witness the staggering developments that have taken place within the field of ECT during the last few decades and to witness the impact this has had on almost every aspect of modern life.

Building on this premise, it is somewhat worrying to note that in many of our secondary schools there still appears to be little or no emphasis placed on the delivery of a relevant, contemporary ECT curriculum within the design and technology subject area (Breckon & Branson 2001).

The National ECT Initiative

The ECT initiative, so called because the name "better reflects the work in this digital era where communications are a crucial part of electronic communications" (Breckon and Branson 2001), was initially set up in conjunction with the Institution of Electrical Engineers with funding provided by Marconi plc. It was intended as a means of improving the quality of electronics and control teaching in secondary schools and was augmented in order to address the following issues:

- At the present time less than 18% of secondary schools offer a GCSE course of study in Electronics or a course that contains a significant amount of electronics, a subject area which must be considered as one of the key technologies of the 21st century.
- Only 2.7% of all secondary school pupils undertake a GCSE course of study in Electronic Products.

- Of all pupils undertaking courses within the Design and Technology subject area at secondary school level, only 8.4% study the disciplines of Electronics and/or Control. Branson (2001), ECT Trainers Training Course, Marconi ECT website (2002)

The first phase of the Marconi ECT project resulted in a series of trials being undertaken in the Stafford, Salford, Coventry and North Wales regions during the period 1997–1999. When this first tranche of funding came to an end, the IEE approached DATA with a view to broadening the scope of the programme. The Design and Technology Association (DATA) has since obtained further funding from a range of sources including Marconi plc, the DfES and DATA Trustees.

In the current (second) phase of the ECT initiative, groups of prospective 'trainers' are being offered the opportunity to undertake a course of study that will allow them to acquire high levels of skills, knowledge and understanding of ECT and its applications within the school environment and society at large. On completion of their training, it is intended that the trainers will, in turn, cascade their knowledge and understanding of ECT to practising teachers of design and technology through funded INSET provision.

Initial ECT trainer accredited training takes the form of two four-day residential courses; assessment is assignment based. On completion of the assignments, participants obtain certification provided by DATA/IEE and endorsed by the DfES and the DTI, and a licence to deliver ECT training to teachers.

The primary aim of this second phase of the ECT initiative is a bold one. DATA's vision is that within five years, 100% of secondary schools will offer all pupils the opportunity to undertake courses of study in Electronics and/or Control. (Breckon, ECT Trainers Training Course, 2001)

Research Methodology

To inform the planning of ECT INSET and to identify CPD opportunities for secondary design and technology teachers, an investigation was undertaken to determine the current state of ECT provision in secondary schools. Through the use of questionnaires and interviews, a disciplined collection of

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information was obtained from twenty-two secondary schools in Yorkshire and the surrounding regions.

To ensure objectivity, trainee Design and Technology teachers from the Centre for Design and Technology Education at Sheffield Hallam University (SHU) were asked to complete the questionnaires whilst in the schools on teaching placement. Those volunteering to participate were briefed as to the nature and purpose of the study and given an overview of the ECT in Schools Initiative. The questionnaire was provided in paper format and took approximately twenty minutes to complete; observational evidence as well as discussion with members of the department was required. Completed questionnaires were obtained from twenty-two of the thirty schools used.

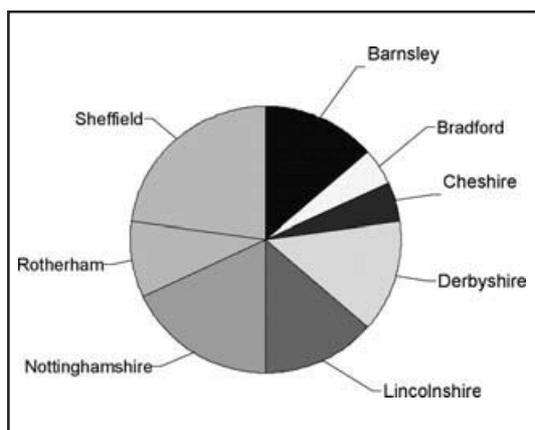


Figure 1: Breakdown of schools involved in the study (by LEA)

Results and findings from the data obtained are analysed in relation to discussions undertaken with teachers, teacher educators and LEA advisors for design and technology as well as in the context of the author's own teaching and teacher training experience.

Current ECT Provision in Schools – Key Stage 3

Number of schools delivering an ECT curriculum at Key Stage 3:

Although a compulsory element of the design and technology National Curriculum (NC), 27% of design and technology departments involved in the research offered no ECT experience for pupils within the Key Stage 3 curriculum (Figure 2) and were therefore failing to comply with the statutory National Curriculum 2000 requirements for Design and Technology at this level.

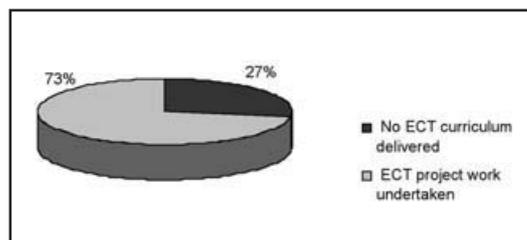


Figure 2: Schools offering ECT component within the design and technology curriculum at Key Stage 3

It is interesting to note that there was only minimal variation in the number of schools undertaking ECT work in Years 7 and 8, however there was a marked increase in those including work in this area in Year 9 (Figure 3). This is probably to be expected considering the nature of the work, the level of resources required and the difficulty factor involved for both staff and pupils with this element of the curriculum.

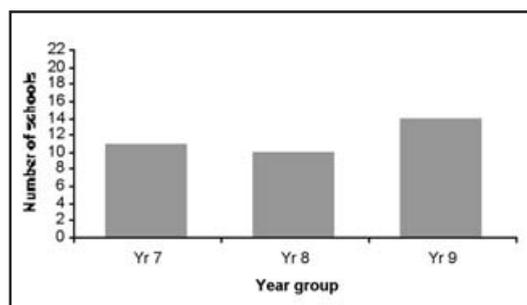


Figure 3: Number of schools offering ECT curriculum at Key Stage 3 (by year)

Nature of the ECT curriculum currently delivered at Key Stage 3:

73% of the schools involved in the research offered some form of ECT study for pupils in design and technology during Key Stage 3. As would be expected given the flexibility of the Design and Technology National Curriculum at Key Stage 3 and the autonomy it offers to Design and Technology departments and individual teachers, ECT projects delivered to pupils varied considerably in both nature and content from school to school and year to year.

In Year 7, 50% of the schools researched included an ECT element within the design and technology curriculum. In all but one of these schools, ECT knowledge taught focused on issues of circuit continuity, the interaction between voltage, resistance and current and discrete component

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Sch	Hrs	Projects	Skills	Knowledge	Software
1	16	Penny push game	Soldering	Component theory	Croc clips
2	0	None	None	None	None
3	*	Mini light	Soldering	Continuity	None
4	*	Pic chip buggy control	None	Pic tech & programming Systems design	Chip factory
5	11	Money box (tracktronics)	Soldering	Simple pcb design Resistors, output devices	Croc clips
6	0	None	None	None	None
7	0	None	None	None	None
8	*	Bedroom doorbell (led, buzzer, push to make)	Soldering	Led, buzzer, switch theory	None
9	0	None	None	None	None
10	?	Steady hand game	Soldering	Continuity	None
11	5	Battery tester	Soldering	Volts, current, resistance	None
12	*	Buzzer	Soldering	Continuity	None
13	15	Intro to electronics	Soldering	Led, resistor, capacitor, led and switch theory	Croc clips
14	0	None	None	None	None
15	0	None	None	None	None
16	0	None	None	None	None
17	0	None	None	None	None
18	0	None	None	None	None
19	0	None	None	None	None
20	*	Steady hand game	Soldering	Continuity	None
21	0	None	None	None	None
22	*	Transistor light circuit	Circuit manufacture (copper on paper)	Current flow Transistor theory	None

Figure 4: ECT curriculum content at Year 7

* Insufficient data to determine curriculum time spent on projects undertaken in these schools.

theory, for example the function of capacitors, switches, light emitting diodes and transistors (Figure 4). The main skill developed by pupils was soldering and in two cases circuit manufacture (use of copper strip on paper and printed circuit board (pcb) design and production).

In Year 8, ten of the twenty-two schools undertook some form of ECT-based project work within Design and Technology. All but two of the schools were building on foundation ECT work undertaken in Year 7. In these schools, there was clear evidence of progression with the majority of projects

involving knowledge and understanding of systems design, pcb design, discrete component theory and simple chip technology. Three (almost one third) of the projects focused on the use of peripheral interface control (pic) chips where pupils were introduced to simple programming techniques. As was the case in Year 7, the main practical skill developed was soldering, although in almost half the schools delivering ECT it was taught within the context of pcb manufacture (Figure 5).

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Sch	Hrs	Projects	Skills	Knowledge	Software
1	16	LDR Alarm Pcb Manufacture	Soldering	Component theory Pcb design, Systems design	Croc clips Pcb wizard
2	*	Electronic game	Soldering	Systems design Component theory	None
3	0	None	None	None	None
4	*	Memo (transistor astable)	Soldering	Pcb production Transistor switch theory C R timer theory	Omega electronics
5	16	Steady hand game (latching thyristor)	Soldering	Pcb manufacture More complex pcb design Comp theory thyristor latch	Croc clips
6	0	None	None	None	None
7	0	None	None	None	None
8	*	Bedroom alarm (Darlington pair)	Soldering	Pcb manufacture Pcb design, Transistor theory	Croc clips
9	0	None	None	None	None
10	*	Jitterbug	Soldering	Systems design, Programming	None
11	*	Jitterbug (IQ Controller)	Soldering	Systems design Programming	None
12	0	None	None	None	None
13	15	1) Adv elect flashing badge 2) Computer control	Soldering	Component theory Systems design Industrial practice	Programming Lego control lab
14	*	Door buzzer	Soldering	Switches	Croc clips
15	0	None	None	None	None
16	0	None	None	None	None
17	0	None	None	None	None
18	0	None	None	None	None
19	0	None	None	None	None
20	0	None	None	None	None
21	0	None	None	None	None
22	*	Latch alarm	Circuit manufacture (copper on paper) Soldering	Thyristor theory	None

Figure 5: ECT curriculum content at Year 8

* Insufficient data to determine curriculum time spent on projects undertaken in these schools.

Year 9 saw a marked increase in ECT coverage with fourteen of the twenty-two schools undertaking some form of ECT project work within the design and technology curriculum. Project content was more varied than in Years 7 and 8. Over a third (five) of the projects

focused on control work and included pic chip technology, five projects utilised simple ICs such as the 555 timer and the final four projects were based on the use of discrete components including switches, transistors and thyristors (Figure 6).

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Sch	Hrs	Projects	Skills	Knowledge	Software
1	16	Toothbrush timer	Soldering	Pcb manufacture, 555 and component theory, pcb design, systems design	Quickroute pcb wizard croc clips
2	*	Electronic quiz	Soldering	Pcb manufacture Pcb design Component theory	None
3	*	Jitterbug	Soldering	Pic technology Systems design Component theory	Pic logicator
4	*	Musical money box	Pcb production Soldering	Thyristor latch Musical chips	Croc clips
5	16	Alarm (555 timer)	Pcb manufacture Soldering (chips)	Capacitor transistor theory, timers	Pcb wizard Croc clips
6	0	None	None	None	None
7	0	None	None	None	None
8	*	Interactive display	Pcb manufacture Soldering chips	Pcb design Systems design Component & 555 theory	Croc clips Logicator
9	16	Christmas decoration (Music chip, transistor)	Pcb manufacture Soldering	Component identification Conductors, insulators Transistor theory	None
10	*	Road safety	Pcb manufacture Soldering	555 timer, Lights	Quickroute Pcb wizard Croc clips Control studio
11	0	None	None	None	None
12	*	Steady hand game	Soldering	Continuity switch theory	None
13	13	Pic technology	Modelling solutions Programming Problem solving	Pic theory Systems design Programming	Pcb wizard Chip factory
14	*	Jitterbug	Soldering Pcb Manufacture	Pcb design Systems design Component theory	Croc clips
15	0	None	None	None	None
16	0	None	None	None	None
17	0	None	None	None	None
18	0	None	None	None	None
19	*	Jitterbug	Modelling solutions Programming Pcb manufacture	Pic programming	Quickroute Pic logicator
20	0	None	None	None	None
21	*	Moisture sensor	Pcb manufacture Soldering	Transistor theory Current flow	None
22	*	Traffic lights	Programming	Logic theory	Pic logicator

Figure 6: ECT curriculum content at Year 9

* Insufficient data to determine curriculum time spent on projects undertaken in these schools.

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With one exception, all schools offering ECT project work to pupils at Year 7 revisited this area of the curriculum at some point during Year 8 and/or Year 9. 32% of schools visited ECT in all three years (7, 8 and 9); these schools provided clear opportunity for progression through the Key Stage by enabling pupils to build on experience gained in previous years. All of these schools offered a curriculum that included both electronics and control focused project work at Key Stage 3.

On average, slightly less curriculum time was given to ECT activity during Year 7 (approximately twelve hours per week) than in Year 8 (just under sixteen hours) and Year 9 (just over fifteen hours). This is to be expected because more time per project is generally required as the skills and knowledge levels are raised and the complexity of project work undertaken increases.

Number of Teachers Teaching ECT at Key Stage 3

In fourteen of the sixteen schools providing an ECT curriculum at Key Stage 3, two or more teachers undertook the teaching for this part of the course and in several instances, the whole of the design and technology resistant materials/systems and control team were involved. This must be considered as a positive feature. In schools where a single teacher is responsible for delivery of ECT, there is a risk that if that teacher were to leave or was subjected to a prolonged period of absence, the department may no longer have the capability to continue delivering this aspect of the curriculum.

Use of Specific ECT Software at Key Stage 3

Access to software to support ECT activity appears variable (Figure 7). Five of the sixteen schools offering an ECT component in design and technology at Key Stage 3 used no computer software to support teaching and learning through Years 7 to 9. The other eleven schools employed a range of software packages, several using these virtual tools as a means of providing curriculum progression by introducing them at different points to support specific projects through the Key Stage.

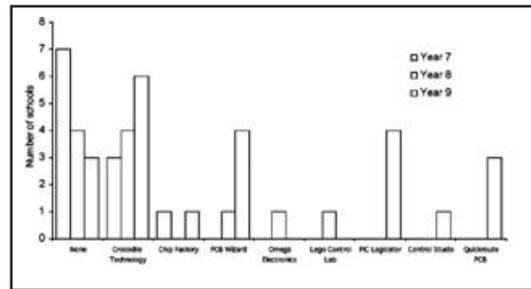


Figure 7: Software usage at Key Stage 3

The most widely used pieces of software included Pcb Wizard as a pcb design tool, Pic Logicator for pic programming, and Crocodile Technology as a circuit design and experimentation tool. The wide variety of software packages employed reflects market conditions and demonstrates the breadth of commercial school-based electronics and systems and control software currently available to schools.

Current ECT Provision in Schools at Key Stage 4

Number of schools offering discrete courses of study in ECT at Key Stage 4:

45% of schools involved in the study offered an external examination course in the field of ECT at Key Stage 4 (Figure 8). Of these schools, all but one were running courses in both Years 10 and 11; the other school had recently introduced an Electronics Products GCSE course of study in Year 10, with a view to rolling this out to Years 10 and 11 in the following year.

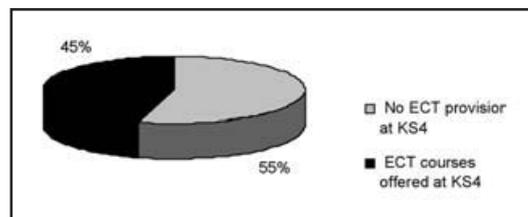


Figure 8: Number of schools offering ECT examination courses in Design and Technology at Key Stage 4

The percentage of schools offering no ECT provision showed a marked increase from 27% at Key Stage 3 to 55% at Key Stage 4 (Figure 9). All schools failing to deliver an ECT element within the Key Stage 3 curriculum also failed to provide GCSE examination courses of study in ECT at Key Stage 4.

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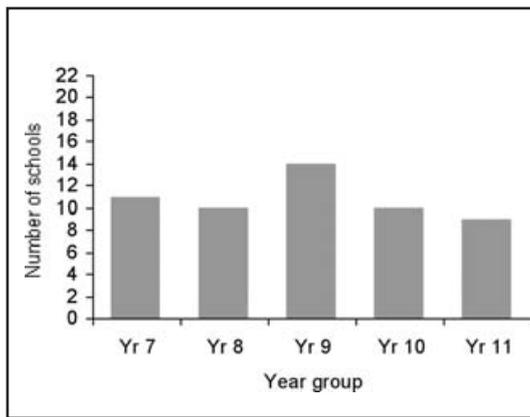


Figure 9: Number of schools delivering ECT curriculum (by year)

Numbers of Pupils and Nature of ECT courses at Key Stage 4

Within the twenty-two schools involved in this study, a total of approximately 7700 pupils were on roll in Years 10 and 11. Of these approximately 48% (3724 pupils) had the option to take some form of ECT course of study at GCSE level. The number of pupils who had actually taken up this option and were undertaking an ECT GCSE course of study totalled 693 or 9%. In Year 10, 389 pupils were reported to be studying on an ECT GCSE course, an increase of approximately 28% on the 304 pupils studying ECT in Year 11 (Figure 10).

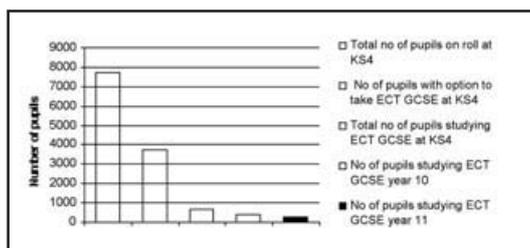


Figure 10: ECT course provision at Key Stage 4

Of the schools offering ECT courses at Key Stage 4, the average number of pupils per school undertaking a GCSE course of study in ECT also showed a substantial increase from 33.8 in Year 11 to 38.9 in Year 10.

Analysis of the study data obtained clearly shows that schools offering a broad and progressive approach to delivering ECT at Key Stage 3 have larger cohorts of pupils undertaking a GCSE course of study at Key Stage 4.

Examinations Boards Used

All schools involved in this study undertaking GCSE courses in ECT at Year 11 were using the AQA examinations board. Four schools were working to the Electronics Products syllabus and five schools to the Systems and Control syllabus. Year 10 cohorts highlight a slight shift from Electronics Products towards the Systems and Control route and some movement from the AQA examinations board to EDEXCEL. The actual number of schools involved in these changes is small (two) and therefore cannot realistically be considered as a trend at this point.

Number of Teachers Delivering ECT at Key Stage 4

In six of the ten schools that were running GCSE Design and Technology courses in ECT at Key Stage 4, a single teacher was responsible for the delivery (Figure 11). In all cases this appeared to be due to a lack specialist knowledge and experience of other teachers within the department in this aspect of Design and Technology. The implications are potentially serious – if the teacher delivering the ECT component were to leave the school or succumb to a prolonged period of absence it is probable that there would be no other person in the department with the capability to take over delivery of the courses. Because of the timetabling constraints this scenario imposes, further development and expansion of ECT course provision in these schools could also be severely restricted.

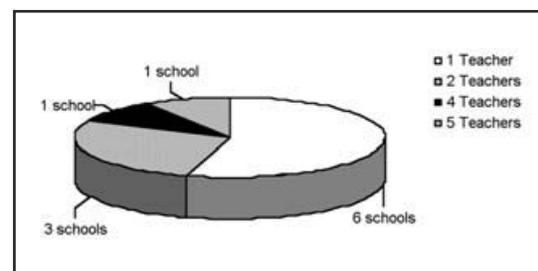


Figure 11: Number of teachers involved with ECT delivery at Key Stage 4

Worthy of particular note is the fact that only two of the schools in this study had more than two Design and Technology teachers participating in the delivery of ECT at Key Stage 4 (Figure 11). In one of these cases, all six resistant materials specialists were involved in the delivery of ECT projects at Key Stage 3, and

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five of the six were involved with GCSE course delivery at Key Stage 4. Of all the schools involved in the study, this one had the highest number of entries for ECT based GCSE courses.

Teacher Capability in ECT

The ECT capability of design and technology teachers in the schools participating in this study broadly reflected the extent to which the area of ECT was embraced within the curriculum. All of the schools offering ECT GCSE options had one or more members of staff with recent training within this area.

Conversely, all of the schools failing to offer a Design and Technology ECT strand to pupils at Key Stage 4 had a teaching team who have had at best minimal ECT training, and in the majority of cases, no training at all. Where training had been undertaken, it was invariably when teachers obtained their degrees or PGCE qualifications, the most recent having qualified in 1992!

Of the six schools that offered no ECT provision in Design and Technology at Key Stage 3 or Key Stage 4, only two teachers (teaching in different schools) felt that they had any level of knowledge or understanding within the field of ECT, both were self-taught.

Teacher Perceptions of ECT Training Needs

In all schools where there was no Design and Technology ECT provision in either of the Key Stages, staff failed to identify any ECT training requirements they may need. This is hardly surprising, as in order to identify development needs, some understanding of the nature and scope of the ECT work it is possible to carry out in the school situation is required. These staff are beginners in this field and appear to have little, and in the vast majority of cases, no prior knowledge and experience to build on.

Staff in schools offering an ECT component at Key Stage 3 only, again, in all but one case, failed to identify any training needs. The one teacher who did, suggested the need for 'basic electronics' INSET but provided no further details.

Teachers in schools delivering ECT in Design and Technology at Key Stages 3 and 4 were far more aware of their training needs in this area. The most popular request was for courses on the theory and application of pic chip technology (Figure 12). Staff in three of the ten

schools in this category failed to identify any training requirements.

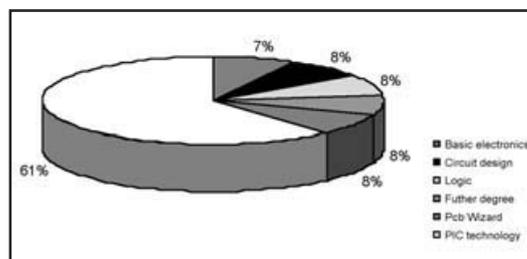


Figure 12: Future training needs as identified by teacher responses

Summary of Current Situation

The findings from this study support the notion that ECT provision within the design and technology subject area across Key Stages 3 and 4 varies considerably from school to school.

In under half of the schools involved in the study (45%), pupils are required to study ECT through Key Stage 3 and have the option to continue through to GCSE level at Key Stage 4 within the design and technology subject area. In these schools, contemporary approaches to ECT form a substantial part of the curriculum and there is wide use of a variety of software to support teaching and learning.

In ECT active departments, ECT teaching at Key Stage 3 is generally shared across several members of the teaching staff. This is not the case at Key Stage 4, where the norm is for a single teacher to undertake the delivery. In most cases, the reason for this appears to be that only one teacher has the expertise to deliver at this level.

Across secondary schools there is a lack of equality of opportunity for pupils with 55% of schools failing to provide a cohesive framework for ECT study within Design and Technology across Key Stages 3 and 4. In many cases no opportunity to study ECT is offered, in others some 'token' work, generally at a very basic level is undertaken at Key Stage 3, but there is no opportunity for pupils to undertake further courses of study at Key Stage 4.

27% of schools taking part in the study offer no ECT provision in either of the Key Stages and are therefore not fulfilling the statutory requirements of the Design and Technology National Curriculum at Key Stage 3.

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In all cases, schools that do not currently offer ECT provision within the design and technology curriculum do not have the hardware and software required to deliver such courses effectively.

Staff teaching Design and Technology in schools where there is no ECT provision in either of the Key Stages would currently find it difficult (if not impossible) to implement the necessary curriculum developments because of their lack of knowledge, understanding and practical expertise within the field of ECT. Teachers who have no background in ECT have great difficulty in identifying their own training needs.

Conclusions

This study set out to determine the breadth and depth of ECT opportunity currently on offer to pupils in the 11–16 age phase in secondary school Design and Technology departments within Yorkshire and the surrounding regions. The findings indicate that current provision varies considerably from school to school. In the best, an integrated, progressive programme of ECT activity is offered through Key Stages 3 and 4, while at the other end of the spectrum, many schools are failing to fulfil the minimum requirements of the National Curriculum at Key Stage 3 and offer no opportunity for progression through to Key Stage 4. If these issues are to be addressed, curriculum development within the field of ECT must be considered a priority. To this end, it is essential that appropriate funding is secured and effective systems developed to provide appropriate training for teachers who are new to this area and to offer opportunities for more experienced teachers of ECT to further extend their knowledge and understanding. In short, the Design and Technology fraternity must work together at all levels to develop teacher capability and increase the resource provision at their disposal so that in the future we can ensure that an exciting and dynamic ECT curriculum is available to all children in all of our secondary schools.

Outcomes

In response to the findings of this study, The Centre for Design and Technology Education at Sheffield Hallam University (SHU), has instigated the following curriculum initiatives:

- Introductory Level ECT Training Courses for Teachers – these two-day courses are intended for Design and Technology teachers

who have little or no previous experience of teaching ECT. They provide an introduction to the basic principles of electronics and offer participants the opportunity to experiment with software, components and pcb manufacturing methods.

- DATA Accredited ECT Training Courses for Teachers – these two x two-day courses are for more experienced teachers of ECT. The focus is on the development of subject knowledge and the consideration of pedagogic and management issues.
- Post Graduate Certificate and Masters Degree Courses for Prospective Heads of Department in Design and Technology – building on the highly successful MA course in ‘Managing D&T’ at Sheffield Hallam University, a new strand is under development for the first (Post Graduate Certificate) year. It will offer teachers who have successfully completed their DATA ECT accreditation the opportunity to continue their professional development and provides a gateway onto the full MA course.

References

Breckon, A. and Branson, P. (2001), *The Journal of Design and Technology Education* 6, 3.

Branson, P. (2001), unpublished data from ECT Training Course for Teacher Trainers.

Breckon, A. (2001), unpublished data from ECT Training Course for Teacher Trainers.

Marconi ECT website: www.marconiect.org

National Curriculum 2000 HMSO

With thanks to all of those SHU students who took the time and trouble to complete the questionnaires in their placement schools during an extremely busy time of the year, and to the schools and teachers involved who assisted them.