How should the KS3 ICT National Curriculum be taught so that it delivers capability at KS4?

1 Introduction

The National Curriculum for ICT across all Key Stages is designed to deliver ICT capability (DfEE 1999). The Programmes of Study have undergone a series of revisions to attempt to ensure capability is the central focus of teaching and learning in ICT. However, despite this, many teachers remain focused on teaching and assessing ICT skills.

Various theories of what constitutes ICT capability are explored and examined critically to determine whether they are helpful in understanding what is a difficult concept for many schools.

In teaching KS4 courses, the author has observed that few students seem to understand the need to analyse, design, test and evaluate their systems. This ‘systems lifecycle’ is critical to success at KS4 and the lack of students’ understanding of it may be a critical factor in why ICT lags behind the other core subjects in KS4 achievement.

This paper proposes a definition of ICT capability that is closely aligned with the KS4 curriculum and suggests how the KS3 curriculum could be taught in order to prepare students for their examination courses in KS4. To do this, the author has drawn upon direct experience in teaching KS3 and KS4 courses in three schools, and the views of Year 9 students.

2 The nature of ICT capability?

2.1 What is ICT capability?

Until recently, educators used to talk about ICT literacy to define what was required by students. This has been replaced by the term 'ICT capability' but effectively, they mean the same thing. This section assesses various definitions of ICT capability/literacy and discusses their usefulness in helping teachers to understand how ICT should be taught and assessed.

There are many definitions of ICT capability, including:

> "The education system is exhorted to provide all students with the computer competence they need to be functional members of the expected new information society." (Magrass and Upchurch, in Selwyn, 1997).

> "It's not just about doing, but also about being able to use things effectively and knowing why. They key to all of this is the knowledge and understanding." ACITT (2002).

> "ICT capability involves information gathering, presentation and technical processing skills, underpinned by understanding of key concepts related to the nature of information and of technology. It includes, but is much broader than, a set of technical competencies in common software applications." DfES (2002).

> "ICT/IT literacy is the ability of a person to confidently use information technologies and apply previously acquired vocabulary, skills, knowledge and understanding to new tasks." Wheeler (1999)

> "Computer literacy also entails an ability to use the computer independently and creatively and crucially, to understand IT in its social context." Selwyn (1997)

One of the most useful definitions of ICT capability is proposed by Kennewell et al (2000). They suggest that it comprises five key components:

- Basic skills or routines such as how to use a mouse are learned by direct instruction and repetition. It would be impossible to attain a high degree of ICT capability without expertise in these basic skills and most students acquire them at an early age. It is likely that within a few years, most pupils will enter school already having mastered these skills. However, mastery of basic skills is of little value unless the student has a purpose in mind. The knowledge of how to use a mouse to click on icons on a screen is of little value unless one knows which icon to click to achieve the desired result.
- Techniques that require the student to think about how to achieve a specific outcome. They will normally be acquired by teacher demonstration or trial-and-error and can be application-specific. Increasingly, the majority of applications that students will encounter are converging in terms of their user interfaces and navigation techniques. For example, inserting and manipulating a picture in a DTP document requires similar techniques to a range of other applications.
- Processes where techniques are combined to produce deliverable outcomes. For example, to produce a poster, the student would have to be able to insert images and text, select appropriate fonts, sizes and colours and be able to move objects around to produce an appropriate outcome.
- Key concepts that students needs to know in order to interact effectively with ICT. They include basic terminology that will enable students to communicate effectively and to understand what is required of them.
- Higher order skills and knowledge where students demonstrate understanding of what they are doing. They select appropriate routines, techniques and processes to produce a specific outcome. This requires greater independence and is developed through

exploration and reflection on past experiences. Some higher order skills include:

- When to use ICT and what ICT to use;
- Planning what routines, techniques and processes will be required;
- Solving problems independently;
- Evaluating the use of ICT and the outcome of a task;
- Explaining and justifying choices and techniques; and
- Reflecting on learning and how the objectives might be met more effectively in the future.

Kennewell et al (2000) also propose that capability:

> "Implies a capacity or power to act in as yet undefined situations, defining itself through its potential for application."

Furthermore, that:

> "ICT capability therefore involves an interaction between technical facts and processes, strategic knowledge, meta-cognitive self-knowledge and effective aspects of mind including self-confidence and a disposition to use the technology."

It is clear from these definitions that capability implies transferability; that students should be able to apply knowledge learned in one situation to other, similar situations. This is not possible if they have only learned a narrow set of skills by copying a teacher's demonstration or completing sequential tasks on a worksheet. Students need to develop confidence and independence so that when faced with a new problem or software, they have the ability and willingness to explore in a purposeful manner rather than giving up and asking their teacher what to do next.

Capability requires a certain level of skills, but there is much more to it than simply knowing how to use a range of functions in computer applications.

Furthermore, it is not necessary to have high technical skills in ICT applications in order to have high capability in ICT. It is possible to design complex systems without having the skills to implement them. However, it is not possible to produce excellent, user-orientated systems just because one knows a lot of techniques unless one has the capability to know how and why these techniques can be used effectively. Therefore, when assessing capability, it is possible for a student to attain a high National Curriculum even if their implemented system contains flaws, so long as the student is able to identify those problems and explain what the system is supposed to do:

> "It is a feature of ICT that you do not have to learn techniques fully before they can be used." (Kennewell et al 2003).

Loveless and Ellis (2001) discuss the need to construct knowledge from information, requiring more than the ability to use ICT skills and techniques. They define information literacy as being the "ability to question, access, interpret, amend, construct and communicate meaning from information." For example, most secondary students know how to use the Internet. That is to say that they have the skills to use web browsers and search engines. However, they lack the capability to use the Internet effectively and tend to be poor at identifying reliable and useful information, content to use a single source without questioning its validity (Graham and Takis Metaxas, 2003).

Potter and Darbyshire (2005) have developed the work done by Kennewell at al (2000) to produce a practical approach of teaching the KS1 and KS2 Programmes of Study. They suggest that "it is the mix of techniques, routines, concepts, processes and higher order skills that, together, make for ICT capability." This is a useful contribution in that it proposes the notion that advancement in ICT capability takes place through parallel progression in all of Kennewell at al's criteria rather than a sequential progression through the key stages. Thus, students should be expected to attain some higher order skills as early as KS1 and that even at KS4, students will still be learning basic techniques.

2.2 Why are schools not teaching ICT capability?

There remains a debate between what constitutes true capability and what is simply the acquisition of specific skills in ICT packages. The National Curriculum is very clear that students should develop capability and "become increasingly independent users of ICT tools and information sources" (DfEE, 1999).

The National Curriculum orders state that:

> "Information Technology (IT) capability is characterised by an ability to use effectively IT tools and information sources to analyse, process and present information, and to model, measure and control external events." (DfE 1995)

However, as Potter and Darbyshire (2005) point out: "many teachers are uncertain about what the ICT National Curriculum Programmes of Study really mean."

To counter this problem, both the DfES and the QCA issued schemes of work and resources to support the teaching and learning of ICT from KS1 to KS3 that purport to provide teachers with the tools to teach ICT capability.

The framework for teaching ICT capability (DfES 2002) was introduced because schools were taking a skills-based approach to the teaching of ICT. In this document, the DfES provides a definition of capability:

> "ICT capability involves information gathering, presentation and technical processing skills, underpinned by understanding of key concepts related to the nature of information and of technology. It is includes, but is much broader than, a set of technical competencies in common software applications." (DfES 2002)

In their case study of the introduction of the framework materials into a school in Bolton, DfES (2003) stated that:

> "The schemes of work that existed in the school prior to the KS3 Strategy launch were primarily skills based. Not enough emphasis was placed on the design, refining and evaluation of their work."

Hammond and Mumtaz (2001) found that: "Many schools came to associate IT capability with acquiring experience and expertise in the major content-free programmes."

Despite these attempts at promoting capability, many teachers still concentrate on skills acquisition in ICT lessons. Webb and Wood (2002) suggest that:

> "Teachers didn't understand the teaching model probably because they didn't read anything except the units of work that they had to teach, and ended up going through the motions, not really knowing why they were teaching it."

It is easier to teach and assess specific skills than it is to judge the overall capability of a student. This is even more likely when non-specialist teachers are required to teach ICT.

> "People who are self-taught in ICT have usually acquired skills in using software packages for their own personal needs and are less likely to have studied the knowledge and processes required to develop more complex systems in a range of organisations." Webb (2002)

The material issued to assist teachers is, in the author's experience, exacerbating rather than ameliorating the problem. The KS3 strategy (DfES 2002) and the exemplar material to indicate levels of work (NCAction 2004) focus on skills rather than capability. For example, on the NC in Action website, a student's work in control and monitoring is considered to be level 6 mainly because the student has included a subroutine in her work. However, the subroutine is badly framed and inefficient and it is doubtful that the student understood its purpose and unlikely that she would know when and how to use this technique in a new situation (Appendix 1).

Webb (2002) suggests that even at level 8, the descriptors focus on the ability to use a skill or complete a process and that the underlying knowledge is not explicitly stated unlike in the descriptors for other subjects.

The KS3 Strategy makes frequent references to capability, but many of the activities in the lesson plans are short, skills-orientated tasks that do not support this objective. A good example of this is Unit 8.4 where students undertake a variety of tasks on different spreadsheets and spend the majority of their time inputting formulae and functions. The lessons in Unit 8.4 require considerable modification to deliver transferable capability, including why one should use spreadsheet models and how one should design and construct them with specific audiences and purposes in mind.

As Kennewell et al (2000) point out: “All too often, ICT activities in school focus on showing pupils how to do a particular task using a particular ICT tool.” But, capability “implies a capacity or power to act in as yet undefined situations, defining itself through its potential for application.”

2.3 Problems with assessing capability

Selwyn (1997) observes that the serious issue of measuring ICT literacy has been largely overlooked. In response to teachers’ difficulties in allocating secure levels to students, some LEAs have issued checklists to allow teachers to assess students’ progress. These generally list the skills that a student has to demonstrate to be assigned a level for each unit. The implication is that if the student has done all the tasks in the Level 5 column, then they are working at Level 5. But, as Potter and Darbyshire (2005) point out, “Processes cannot be assessed using a tick-box approach or by making judgements based on printouts”. Students may have completed the tasks in the lessons and produced the required printouts, but may not have gained the level of capability to carry out similar tasks at some stage in the future.

The main problem with using checklists is that they narrow the focus of assessment to a series of tightly defined tasks where the students' outputs are broadly similar. In assessing capability, teachers should be looking for increasing levels of independence and therefore, students' outputs can be very different and consequently more difficult to assess using a checklist.

There is considerable temptation to fall back on assessment checklists because:

- They provide demonstrable evidence to justify why a student has been given a particular level;
- It requires less justification and is easier than taking a general view of a pupil's capability.

The situation in schools seems far removed from Kennewell et al's vision and the objective that the National Curriculum should promote capability rather than just skills. As Selwyn (1997) describes:

> "Educationalists have tended, therefore, to interpret 'computer literacy' solely in terms of specific skills gained. At the end of a course, pupils can be seen to be able to 'do' something; to have gained specific skills."

The problem with this is summed up by Birnbaum (1990):

> "A pupil can know a word processing package inside out, but be unable to apply it properly to real tasks because he or she has not grasped the concepts involved in doing so. The aim of valid IT assessment is to measure this conceptual understanding through the use of tasks which require the application of IT."

Students also tend to equate achievement with the completion of skills-based tasks. In the classroom research done for this paper, when asked what they had learned in Year 9, most students listed the skills they had acquired rather than their general improvement in ICT capability (Appendix 3).

Crawford (1999) suggests that a reason for the over-emphasis on skills is the pedagogical approach in many schools, where ICT is taught by non-specialists who have brought their 'behaviourist' pedagogy with them from their previous experience. Behaviourism concentrates on:

> "Only those outcomes which are overt, observable or otherwise measurable, disregarding descriptions of individuals' cognitive and meta-cognitive strategies and other internal processes as unreliable."

The situation will become even more confusing for teachers when the DfES introduces its on-screen test to assess each student's National Curriculum level at the end of KS3. The training material exhorts teachers to concentrate on critical thinking and problem solving using ICT. This is a laudable objective, supported by Neiderhauser (in Loveless and Longman 1998) who proposes a definition of an information society that requires problem-solving skills and critical thinking.

However, the test will assess sequences of key strokes to judge the level at which the student is working. For example, a student will gain more credit for using a shortcut key than selecting from a pull-down menu. This is hardly an assessment of capability and will further confuse teachers and encourage them to focus on teaching the skills required for the test rather than developing ICT capability in their students.

In the face of such conflicting information, it is unsurprising that teachers are confused about what is expected of them in terms of teaching and assessing capability. Perhaps the problem is that it appears relatively simple to define capability but much more difficult to define a teaching process that can achieve it.

3 How can KS3 deliver capability at KS4?

3.1 The nature of capability at KS4

The KS4 Programme of Study and GCSE course specifications require students to demonstrate high levels of capability. Students have to use ICT to meet specific user requirements (audience and purpose) and are required to document the full systems lifecycle. A student who produces an excellent application without providing evidence of the whole lifecycle process will only get a small proportion of the available marks (Webb 2002).

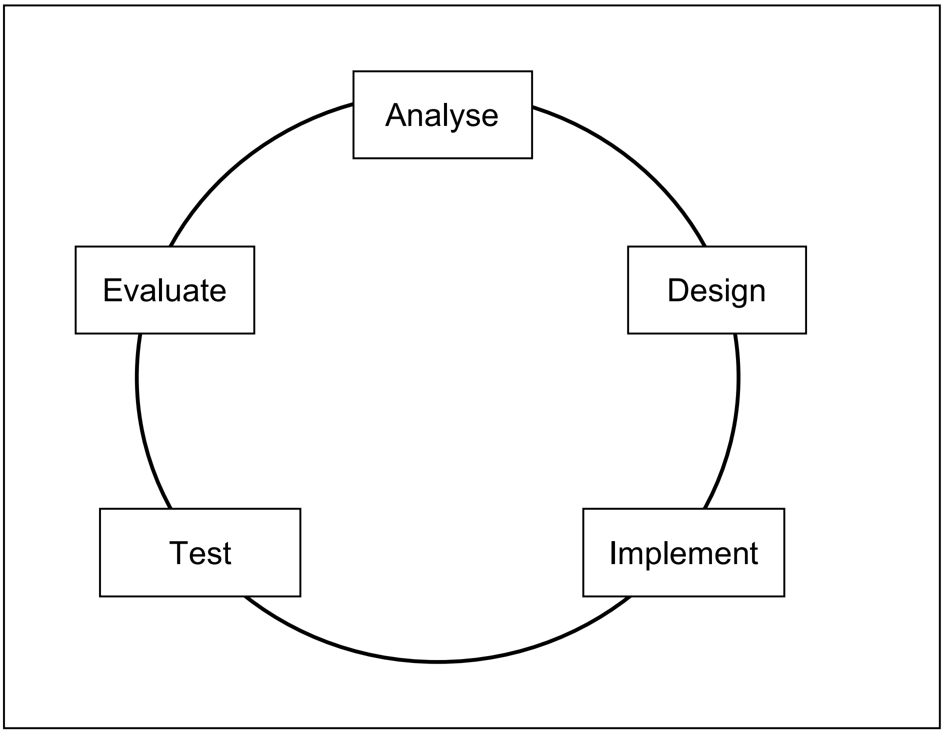

Figure 1 Systems Lifecycle (DfES 2002)

Implementation represents only 20% of the total process and yet students will spend the majority of their time on this phase if left to their own devices. This may be because KS3 focuses so much on using skills to produce ICT outputs and because most students equate ICT lessons with ‘working on a computer’.

"The 'systems lifecycle' is a key process underpinning the content of ICT syllabuses, so comprehension of its nature and application in a range of real-world contexts is crucial for ICT teachers." (Webb 2002).

OFSTED (2004) report that the attainment levels in ICT at KS4 continue to lag behind the other foundation subjects, as shown in Figure 2.

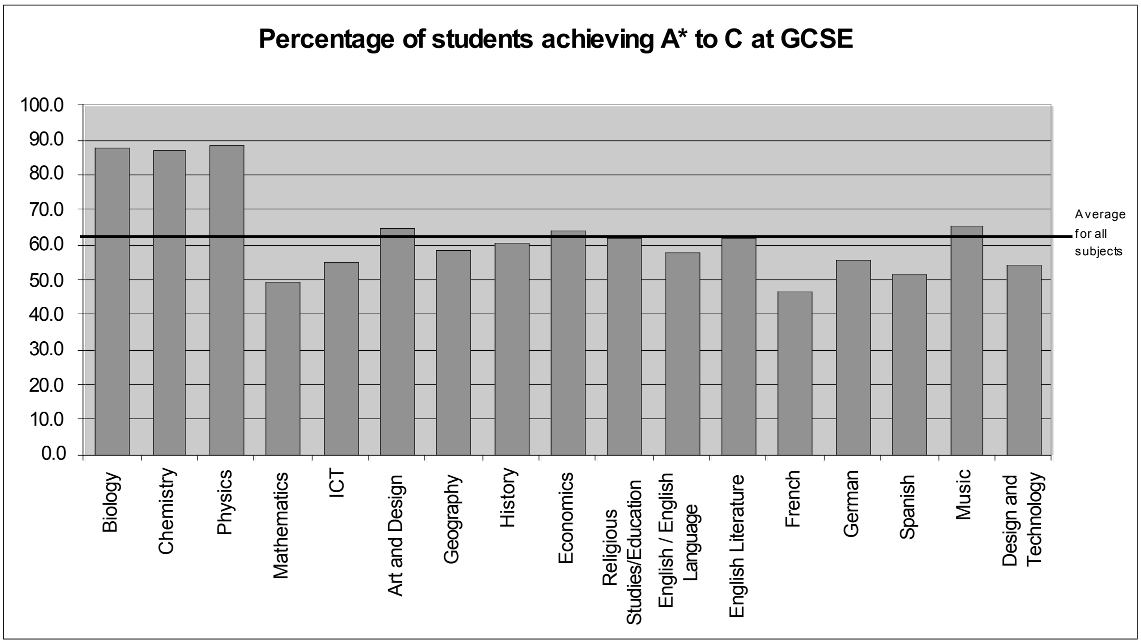

Figure 2 GCSE performance 2004 (from data supplied by OFSTED)

3.2 Implications for teaching ICT at Key Stage 3

Given that capability is so important at KS4, it would seem to be sensible for it to be a key focus for teaching and learning at KS3:

"Students need to develop their ability to analyse problems and design solutions so, that at GCSE level they are able to work independently to produce coursework based on an analysis and design of a system." (Webb 2002).

"The aim is to ensure that by the end of Key Stage 3 all pupils can use ICT securely, creatively and independently, are confident enough to

> keep their skills up-to-date and are able to generalise from their ICT experiences." DfES (2002).

However, in practice, this does not seem to be happening, perhaps because the KS3 units are so predominantly skills-orientated and teachers are encouraged by LEA consultants to assign levels based on demonstration of skills. But, as Kennewell et al (2000) stress:

> "Increased use of sophisticated software per se does not constitute progression in ICT capability. It may involve little more than the development of further techniques that the pupil finds hard to use in different contexts."

Skills acquisition in Year 9 and beyond should be through independent enquiry where students know what they want to do and simply need to look up the techniques for doing it. Webb and Wood (2002) describe this as: "the understanding of a general principle, in any subject area, enables the child to apply it in another context."

Year 9 students should be taught higher order skills, and given opportunities to apply them. Students should learn to:

- Analyse business problems and identify how ICT can be used to address them;
- Design systems from a user perspective, identifying system inputs, processes and outputs;
- Build systems in a structured way, including documentation;
- Test and amend their systems;
- Evaluate the system and the process used to produce it.

So why is this not happening? Hammond (2004) believes that one of the reasons is that:

> "ICT as it appeared on the school curriculum was comparatively slow to change, learning outcomes were prescribed and often assumed to be predictable, and learners' personal exploration was constrained."

This is supported by Wood (2001):

> "Expert ICT consultants will happily do little more than train children to use standard office tools, and the quicker and more proficient with them they are, the higher the skill."

Teachers are more comfortable with teaching skills via tasks with predictable outcomes as these are easy to understand, give students a sense of achievement and are straightforward to assess.

3.3 A teaching approach to deliver capability at KS3

The objective of the KS3 curriculum should be to build on the technical skills developed during KS1 and KS2 and develop the higher order skills required for success at KS4. To do this, the balance between skills and capability should change during Years 7, 8 and 9, so that by the end of Year 9 students are comfortable with all the phases of the systems lifecycle.

Jedeskog and Nissen (2004) developed a model to demonstrate the balance between teachers and learners that can be used to illustrate what is proposed for ICT teaching and learning in KS3.

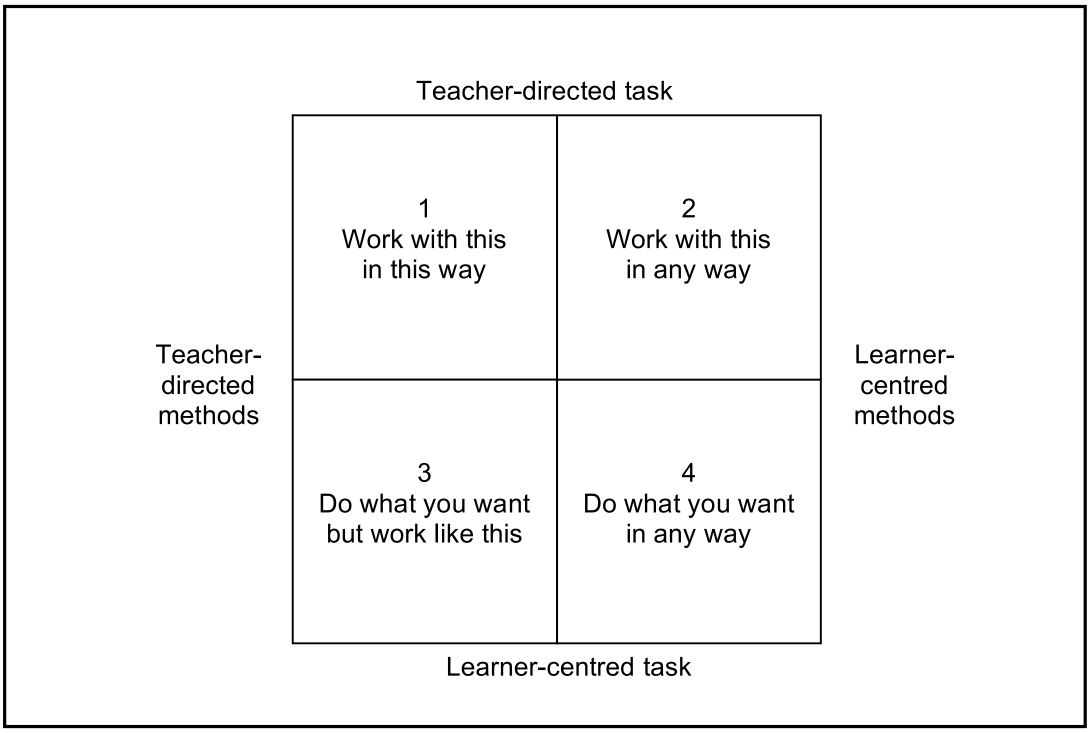

Figure 3 Teacher/Pupil Influence and Control (Jedeskog and Nissen 2004)

In terms of applying this model to KS3 ICT teaching and learning:

- Year 7 would be typified by approach 1 where students are given specific tasks to do using specific software and methods. Students will produce broadly similar outputs and the objectives will be for them to learn the processes needed to produce the required outcome. For example, students would be required to produce a school leaflet using DTP software. They would have choices in layout, images, colours and text, but would not be able to choose to do an interactive presentation rather than a leaflet.
- Year 8 moves towards approach 3 where students would be required to use a specific software package but have freedom to choose what they use it for. For example, students could be asked to produce a spreadsheet system that demonstrates the application of the Input-Process-Output model and uses data from an external source to produce information for an end-user. The students would select their

own end-user and the purpose of the system. This would begin to introduce them to the concept of analysis.

- Year 9 would be typified by approach 2 where students would be given a case study and choose their own way of addressing the problems using their own choice of software tools. For example, publicising a concert could be via TV advertising, a poster, a web site or a mailshot. They would have to use the full systems lifecycle to do this effectively.
- KS4 students would use approach 4, where they have to define their own project and software tools of sufficient complexity to satisfy the requirements of the GCSE specification.

The balance between skills and capability should change as students move through KS3 and KS4 as follows:

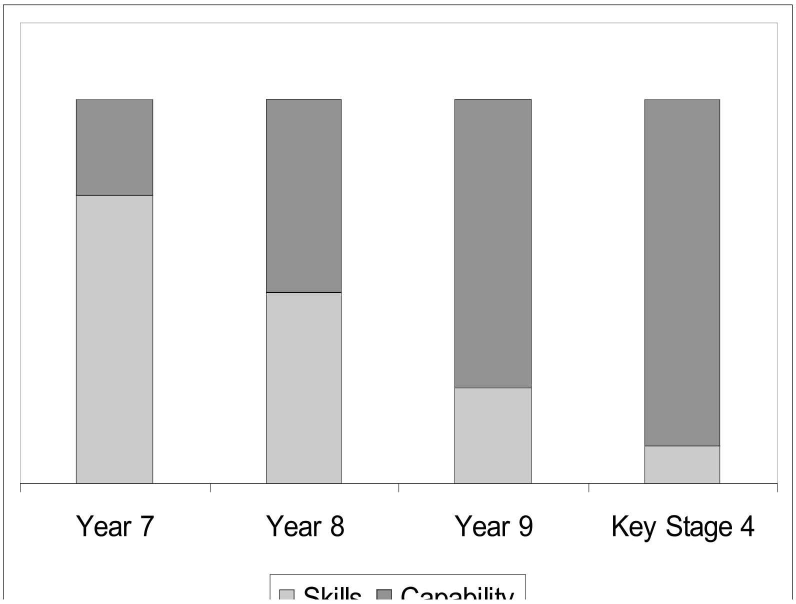

Figure 4 Balance of skills versus capability teaching at KS3 and KS4

Working on case studies is a very good way of helping students to relate their practical skills to the reality of systems use in the outside world (Kennewell et al 2003) and it is recommended that students should do at least three of them in Year 9. The scheme of work should be aimed at developing the skills and capability required to do each end-of-term project through a series of mini projects and increasingly independent exploration of software skills.

Teachers should set tasks that enable students to:

- Engage in higher order cognitive processes.
- Reflect on their learning.
- Explore on their own rather than be pushed through a predetermined agenda, thus allowing for problem-solving and experimentation (Somekh and Davies 1991).

Teaching and learning in KS3 must have a strong degree of 'purpose' as defined by Hammond and Mumtaz (2001). They suggest that purposeful lessons place a strong emphasis on:

- Higher order skills such as analysis and interpretation;
- Problem-solving;
- Opportunities to develop specific, relevant skills;
- The transformation of data into useful information; and
- A high degree of student choice leading to different finished products.

Having completed a project, the students should reflect critically on their learning and be able to show how the capability they have developed is transferable to other situations. This 'meta-cognition' is key to developing capability (Brown 2004).

OFSTED (2003) observes that this is happening in some schools and that it does deliver the desired results:

> "In some schools key tasks are used to provide overall assessments of pupils' ICT capability. In the best practice pupils are made aware of the importance of these and have an understanding of the National Curriculum level descriptions."

3.4 Pedagogical requirements

The approach proposed in the previous section fits well with a constructivist pedagogy (Crawford 1999):

> "Learners create their own knowledge and understanding through active engagement with realistic tasks in authentic contexts using actual tools."

The teacher's role is to suggest approaches that encourage experimentation and self-discovery, as Crawford (1999) suggests:

> "Teachers cannot transfer meanings or concepts direct to passive learners but can only orientate their conceptual construction process. There is an emphasis on process rather than specified outcomes and…it is likely that learning outcomes will be less predictable and may vary from learner to learner."

However, it is much more difficult to assess pupils' attainment as their projects will be different, hence marking them will not be a straightforward process and it is understandable that teachers have not, in the main, adopted this approach. It is not an easy approach to implement, but the rewards should be worth the effort.

> "We will have done very well indeed, if by Year 9, they [students] can be set real world problems and come up with appropriate IT solutions by applying skills they have learnt efficiently." (ACITT 2003).

4 Findings from Year 9 survey

The author conducted a survey of 52 Year 9 students in two classes taught by different teachers in a secondary school in NW England. The results of the survey are documented in Appendix 3. This section summarises the key messages from the survey in students' attitudes towards the case study project they had been working on in Year 9.

The key questions that the survey addressed include:

- What do they think they have learned in Year 9?
- Do they understand the systems lifecycle?
- Do they perceive the differences between the style of learning in Year 9 compared to Years 7 and 8?
- Do they believe that what they've done in Year 9 will help them in KS4?

The main findings from the survey include:

- Students were reasonably successful in identifying the design, implementation and evaluation stages of the systems lifecycle, probably because they had done some design and evaluation in Year 8 and were familiar with these activities.
- About half the students recognised the purpose of analysis, but only 40% described the need to test their systems. Many students do not perceive testing as a separate activity, but tend to do it naturally as they are building a system.
- The majority of the students were clear that higher order skills are important to achieving Levels 6/7.
- Nearly 60% of the students recognised that their learning in Year 9 concentrated more on capability than in Year 8 and the same percentage recognised that it was these skills that would be important to them in KS4.

- However, when asked to list what they had learned in Year 9, nearly three-quarters of the students described technical skills, for example:
    - Database queries;
    - Hyperlinks;
    - Mail-merge; and
    - Flowcharts.

The fact that students mainly identify technical skills when asked what they had learned is probably linked to their sense of achievement in creating something that works. Students show a sense of pride when a previously unknown spreadsheet function delivers the right answer, a hyperlink displays the correct page, or a flowchart turns lights on and off in the correct sequence.

5 Conclusions

There is little dispute that ICT capability is preferable to simply acquiring ICT skills. The problem is that although the definitions of capability are broadly similar, there is little consensus on how capability should be taught and teachers are confused about what should they teach and how should they assess students' capability (Watson 2001).

There appears to be a major gap in the research into teaching and learning ICT that is worthy of exploration, particularly if the KS4 results are to be improved. "Very little work has been done on the teaching of ICT and the development of the subject is proceeding on an uncertain knowledge base." Hammond (2004). The Year 9 questionnaire highlighted some interesting issues that unfortunately cannot pursued in this paper, but are worthy of further investigation.

This paper has looked at the causes of the problem and found that they lie in the failure of the National Curriculum to describe adequately how teachers should teach and assess ICT capability. To address this situation, the author proposes an approach to teaching that should deliver the increasing levels of capability required for success at KS4. However, it will require the DfES, LEAs and teachers to take a consistent approach to teaching and learning and be clear about the desired outcomes. "The content of the ICT curriculum needs to be specified more precisely, particularly…at Key Stage 3" (Webb 2002). So long as schemes of work continue to emphasis the acquisition of skills and the assessment methods continue to measure those skills, it is unlikely that the holy grail of delivering high levels of ICT capability will be achieved.

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Appendices

Appendix 1 Sample flowchart work from NC in Action

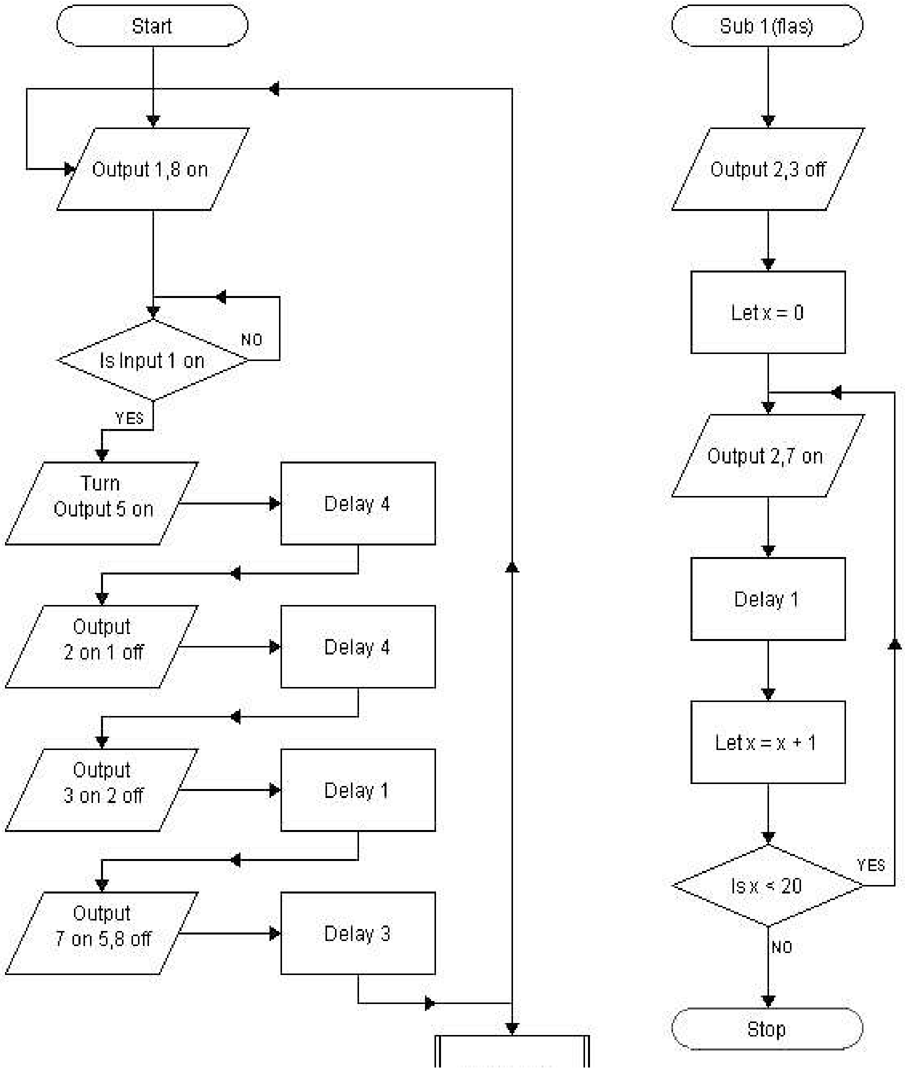
On the NC in Action website (NCAction 2004), there is an example of a Key Stage 3 student's work on producing a control program for a pelican crossing.

This work has been assessed at Level 6 on the National Curriculum levels for the following reasons:

> *In this example, Anita has successfully created a flowchart that implements the appropriate sequence of events. She initially created a sequence of instructions to monitor an input (used to indicate when a pedestrian wished to use the crossing), control the sequence of the traffic lights and reset back to the monitoring phase. Anita realised that she had missed out part of the sequence for a standard pedestrian crossing: the flashing of the amber lights to warn of the imminent change of the lights. She researched, using books, how to add a flashing signal, and, in her final version, used a sub−routine with a counter to achieve this. This shows that she can develop and refine her work to enhance its quality.*
>
> *By revising her flowcharts before assembling her pedestrian crossing Anita showed she can try out and refine sequences of instructions to control events. She has shown efficiency in framing these instructions through the use of a sub−routine with a counter. She has used a sensor to monitor an external event and control the system.*
>
> *This example illustrates aspects of work at level 6.*

The following diagram shows the student's final version of her flowchart. Whilst it is true that she has included a subroutine, it does not make her flowchart more efficient as the summary claims. In fact, she has used more instructions than if she had included the routine in the main program. The problems with this student's subroutine include:

- She has included a count-loop in the subroutine to tell the system how many times to flash the amber light. This means that the subroutine cannot be used in another part of the program to flash the light a different number of times. A key attribute of a subroutine is that it can be called any number of times from the main program and it is the main program instruction that determines how many times to subroutine is executed.
- Outputs 2 and 7 (the amber light and the green man) are turned on, but there is no instruction to turn them off, therefore the desired repeated flashing will not take place. The outputs will simply come on and then stay on for a count of 20 seconds. Control will then pass back to the main program without outputs 2 and 7 being turned off. Therefore, at the start of the second pass through the sequence, the green and amber lights and the red and green men will all be on.



The problem with this work being assessed as Level 6 is that it suggests to teachers that refining the work and including a subroutine automatically means level 6. In this example, the student does not appear to have tested her control program as she shows no awareness (in the material provided) that the system does not work. Her subroutine does not produce the desired outcome and there is no annotation to indicate this. From the evidence provided, it is impossible to agree that she has gained the capability of understanding how to use subroutines to improve the efficiency of a control program. It is highly questionable that she would be able to transfer her learning to another similar situation where a subroutine is required.

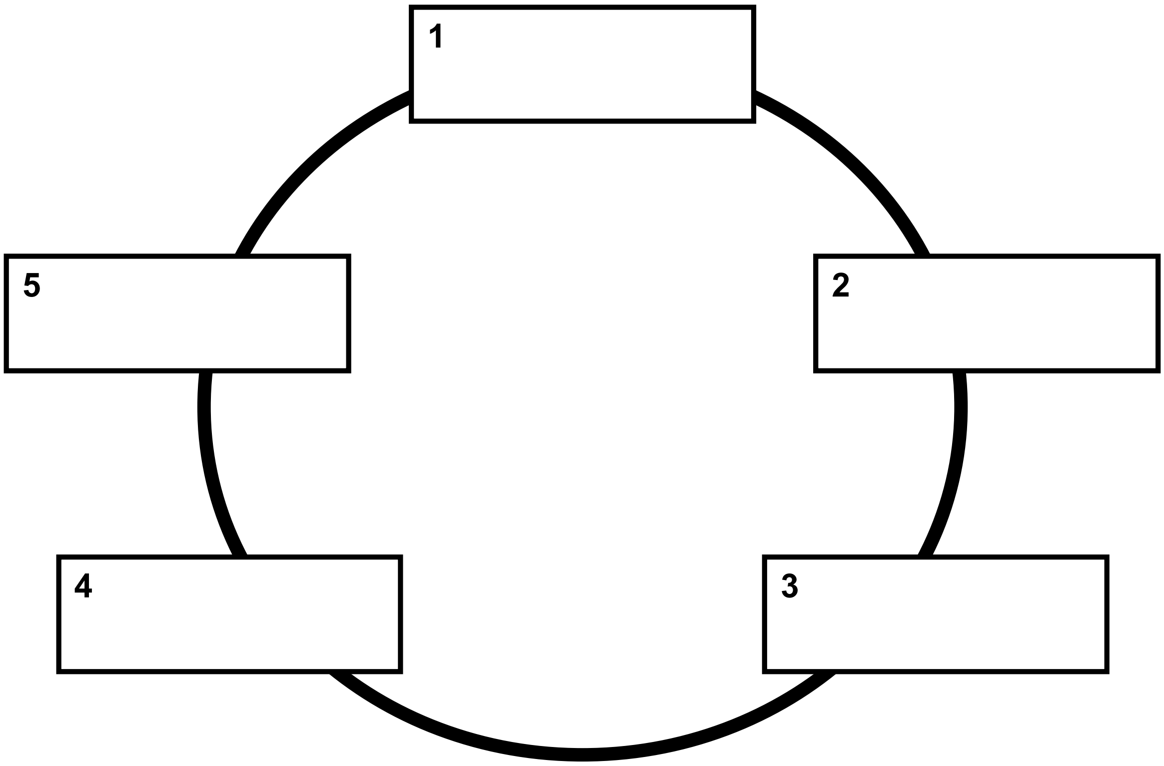
A level 6 student should be able to construct an efficient subroutine and then describe what it is doing, why it is necessary and how it makes the control program more efficient and more like a real pelican crossing.

Appendix 2 Year 9 questionnaire

Answer all questions as fully as you can.

Question 1. The systems Lifecycle

Label all the stages in the systems lifecycle on the diagram below:



Question 2. Describe what you do in each stage of the systems lifecycle

Stage 1

Description:

Stage 2

Description:

Stage 3

Description:

Stage 4

Description:

Stage 5

Description:

Question 3. Describe why you think it is important to design ICT systems before you create them on the computer.

Question 4. Describe what you think you need to do to achieve Level 6 or 7 for your ICT work.

Question 5. Describe what you think are the three main differences between the way you worked in Year 8 and the way you need to work now in Year 9.

Question 6. Describe what ICT skills you think you have learned this year.

Question 7. Next year you will be doing VGCSE or GNVQ ICT. Your grade on these courses is based on your descriptions of the ICT systems you make, not the systems themselves. Describe how you think the skills you have learned this year will help you in Years 10 and 11.

Appendix 3 Summary of responses to the Year 9 questionnaire.

Fifty-two students completed the questionnaire (23 boys and 29 girls). All the students were in the top sets for ICT and the girls and boys are in separate classes. The questionnaire was set as a test at the end of the spring term.

Some students did not answer all questions. Some answers mentioned neither skills nor capability and have not been included in the results. Some students described both skills and capability in their answers and so have been included in both categories. As a result of these factors, the totals for responses are sometimes less than the total number of students and in one case more than the total number. In all cases where skills and capability are being assessed, the percentage figures are based on the total number of valid responses rather then the total number of students who completed the questionnaire.

Some direct quotes from the questionnaire include:

- "I have learned how to evaluate my work and also how design because the last 2 years I have just begun implementing straightaway."
- In Year 8 we only did implementation and sometimes a design. Now we have to design much more often and also do analysis, testing and evaluation."
- "I have found that implementation is the smallest part of the whole cycle."
- "In Year 9 you do more project work."
- "Using the skills of analysing to find out the best way to create a working system and then to critically look at the system to see how it worked/didn't work."

Results from Year 9 Questionnaire Survey

Stages of the systems lifecycle (Correctly identified and described)

	Boys	Girls	Total correct	% correct
Analyse	10	18	28	54%
Design	15	22	37	71%
Implement	20	11	31	60%
Test	18	3	21	40%
Evaluate	17	21	38	73%

Awareness of requirements for Level 6/7

	Boys	Girls	Total	Percent
Capability	16	19	35	73%
Skills	3	10	13	27%

Perception of differences between Year 9 and Years 7 & 8

	Boys	Girls	Total	Percent
Capability	14	16	30	57%
Skills	9	14	23	43%

Perception of their learning in Year 9

	Boys	Girls	Total	Percent
Capability	8	4	12	26%
Skills	25	9	34	74%

Perception of what Year 9 learning will be important in KS4

	Boys	Girls	Total	Percent
Capability	14	10	24	60%
Skills	7	9	16	40%