Teacher Perceptions of Key Competencies in ICT

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Abstract: Regardless of what is intended by government curriculum specifications and advised by educational experts, the competencies taught and learned in and out of classrooms can vary considerably. In this paper, we discuss in particular how we can investigate the perceptions that individual teachers have of competencies in ICT, and how these and other factors may influence students' learning. We report case study research which identifies contradictions within the teaching of ICT competencies as an activity system, highlighting issues concerning the object of the curriculum, the roles of the participants and the school cultures. In a particular case, contradictions in the learning objectives between higher order skills and the use of application tools have been resolved by a change in the teacher's perceptions which have not led to changes in other aspects of the activity system. We look forward to further investigation of the effects of these contradictions in other case studies and on forthcoming curriculum change.

Keywords: ICT competencies, Teacher perceptions, Activity Theory, Contradictions

1   Introduction

In England and Wales, the introduction of the National Curriculum in 1989 required all students between the ages of 5 and 16 to follow the same subject-based curriculum which was to be designed by government based committees and approved by the secretary of State.

Prior to this, there was no established curriculum for Informatics up to age 14; indeed there was little formal basis for the learning of Information and Communication Technology (ICT). The ICT curriculum of 1990 was

strongly influenced by the earlier document from the government inspectorate for Education (DES, 1985). The curriculum has been revised on a number of occasions, and since the devolution of Wales in 1998, there have been differences between the curriculum in England and Wales, with the latest revision in Wales coming into being in 2008 (DCELLS, 2009). However, what is taught and learned in different schools, and different classrooms in the same school, may vary considerably from what is intended by authors of curriculum specifications. It is the purpose of this paper to explore the key competencies or 'skills' which are inherent to ICT as it exists within the Welsh education system and to investigate teachers' individual constructs and perceptions of the subject and the methods they use in the classrooms to develop those skills.

In an attempt to identify the key competences within Informatics and ICT, it is important to define the subject area. According to a number of authors (e.g. Staggers, Gassert, Curran, 2001), Informatics can be defined as being related to the structure of information, that it is a "problem or purpose-oriented" discipline, further that it has particular reference to the structure and use of information within our environment, and as such has a social implication. However, more recently, authors have used the word Informatics as being synonymous with Computer Science (Sysło, Kwiatkowska, 2008). For the purposes of this paper, the focus will be on the earlier definition which is more clearly related to that of ICT as defined within the National Curriculum documents for England and Wales. The definitions include such aspects as "communicating, problem solving" (HMI, 1977); "transmitting information and interpreting information conveyed by table, diagrams and models" (ACCAC, 2008); "Aesthetic and creative; human and social; linguistic and literary; mathematical; moral; scientific; spiritual and technological" (DES, 1985). In further defining ICT, Kennewell, Tanner, Parkinson (2000: 1) suggest that

> *Information and communications technology refers to the set of tools used to process and communicate information; to be 'ICT capable' is to be competent in controlling the situations in which those tools are applied.*

This refers to the use of higher order skills as well as the tools provided by particular applications; ICT involves the use of those skills involved in deciding which tools to use and how to use them to bring about the optimum solution. This is supported by DCSF (2002), which states that students should have the ability and confidence to use ICT equipment and software with purpose to support their work. They should also be able to identify situations where

the use of ICT would be relevant. To enable this, students should be able to reflect and comment on the use of ICT, and to recognise that ICT affects the way in which people live and work (Gaskell, 2003). These ideas are similar to those of ICT literacy, which Markauskaite (2007) suggests is the use of digital technology, communication tools, and/or networks to access, manage, integrate, evaluate and create in order to function in a knowledge society.

In order to understand the nature of ICT and the key competencies within this subject area, it is not enough to analyse what is contained in curriculum specifications and schools' schemes of work. We need to ask how these competencies are developed in the classroom and, indeed, if learning these skills are particularly suited to the discrete subject of ICT/Informatics or are they better developed across the curriculum. An investigation of this development of competencies thus also needs to consider the perceptions and practices of the teacher involved, and it is that aspect on which this paper will focus.

1.1 Theoretical Framework for Pedagogical Research

Shulman (1987) designed a model for the processes involved in developing teaching and classroom practice, based on observing and interviewing a large number of teachers. The model is not a mechanistic process, but rather an underlying concept that drives best practice in pedagogy. In analysing the teachers' knowledge base, Shulman generated a number of categories to evaluate the knowledge base: Content Knowledge; General Pedagogical Knowledge; Curriculum Knowledge; Pedagogical Content Knowledge; Knowledge of learners and their characteristics; Knowledge of educational contexts; Knowledge of educational ends. One of the key points was the link between the content knowledge and the pedagogical knowledge, that the teaching of a subject will be improved if there is not only specialist knowledge of the subject but also knowledge of how best to teach the subjects and develop the skills inherent to that subject (Shulman, 1987).

More recent studies of teachers and teaching have recognised the importance of the context, including the school and the wider social and political environment. It is the work of Engestrom (2001) which has been examined in order to establish a possible analytical framework for this study. Cultural Historical Activity Theory or CHAT, allows the researcher to pay particular attention not only to the specific object of activity under research, but also the Vygotskian focus of 'mediation and discourse'. Activity theory is

a developing resource which has the flexibility to adapt to any given activity within the workplace (Daniels, Edwards, Engestrom, Gallagher, 2010).

The proposition of activity theory is that human activity consists of much more than mere action, but is a socially-situated phenomenon. It is a theory or framework that examines practice, but situates that practice within an environment, which also examines the process and the purpose of that practice (Daniels, et al., 2010). In doing this, it attempts to account for the complexity of real-time activity, investigating factors that influence the activity such as the beliefs and perceptions of those central to the activity (Engestrom, Meittinen, Punmaki, 1999). Webb (2005) suggests that our increasing understanding of cognition and meta-cognition has led to the need for researchers to develop more complex models of analysis, involving aspects of influence such as the environment in which learning is to take place. Within CHAT, the activity triangle (Figure 1) represents the relationships and networks within related activity systems, in which any change and alteration of an aspect of one system, whether it be part of the tools, rules, roles, individuals, or outcomes are likely to affect another part of the system or systems. The analysis works by examining the individual components of the activity system, and looks for contradictions, which are essentially disturbances within the system (Daniels, et al., 2010).
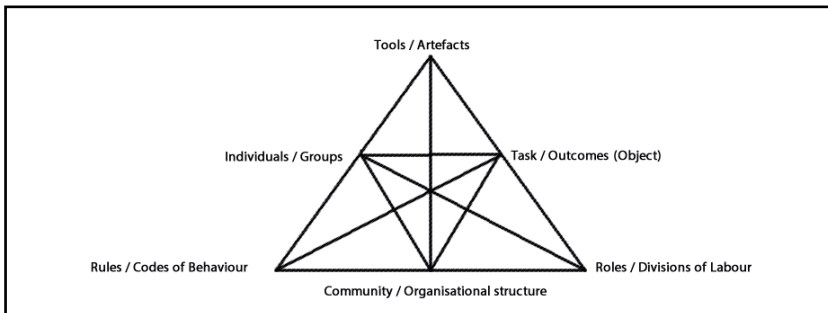

Figure 1: Activity Triangle adapted from Engestrom (1999)

This framework does not address the detail of classroom interactions which are so important in pedagogical practice, however. Kennewell (2010) suggest the use of a model based upon the analysis of the affordances (or potential for action within the setting) and constraints (the structure allowing that action to take place), which are related to the goals observed within the classroom. Consequently, this model was adopted as a framework for observing and recording classroom practice, details of which can later be extracted for analysis within the activity setting triangle.

2 Methods

This research is concerned with why the teachers teach in the way that they do, and how the development of key competencies matches with their own personal constructs. Case study is a preferred method when researchers are asking the how and why questions and it is particularly applicable when the researcher has little control over the events taking place in the macro environment (Yin, 2009). Consequently, it was decided to use three separate schools as the basis for independent case studies. The three schools represent different ways in which they develop ICT, ranging from teaching within a discrete subject based environment to one where the skills are developed through one week of intense study during the year and supported on a cross-curricular basis.

The data has been collected within each school using an initial interview, a lesson observation and subsequent reflective dialogue, then a repeat of the observation and reflection and finally another interview.

The interviews were conducted in order to gain an understanding of the teachers' perception of those skills which are definitive to the subject of ICT, whilst the observations were conducted to establish if the activity within the classrooms supported the development of the skills the teacher had identified. Because each teacher was also looking at their own practice in the development of these skills in their students there was also a post-observation dialogue, in which attempts were made to encourage the teacher to reflect on their own practice prior to a different observation and finally another interview to find out if any of the teachers' earlier perceptions had changed.

2.1 Data Analysis

Thematic analysis was used for identifying and analysing patterns of meaning in the data and ultimately to highlight the most salient meanings present. The coding has been carried out independently, in that each item of data, that is interviews, reflective dialogue and observations have been scanned for themes independently of each other, and then re-scanned in order to establish common themes prior to deeper analysis. The broad themes from Activity Theory were used across all the analysis, but the subthemes that emerged when coding the interview data differed from those found in the observational data (see Figures 2 and 3).

Using activity settings as an analytical tool makes it possible to detect contradictions, either between different activity settings or indeed within the same activity setting (Engestrom, 2001). These contradictions have been

identified as existing on a number of levels, primary, secondary, tertiary and quaternary contradictions, whereby the primary contradictions are those which exist within a single mediating artefact within the triangle; secondary are those which exist between two mediating artefacts of the same triangle. Tertiary and quaternary are those where there is a disturbance between the elements of differing triangles (Hu, Webb, 2009).

Analysis of activity systems is particularly helpful in characterising change and professional environments, and identifying contradictions is valuable in explaining change in activity systems (Engestrom, 2001, Roth and Lee, 2007).
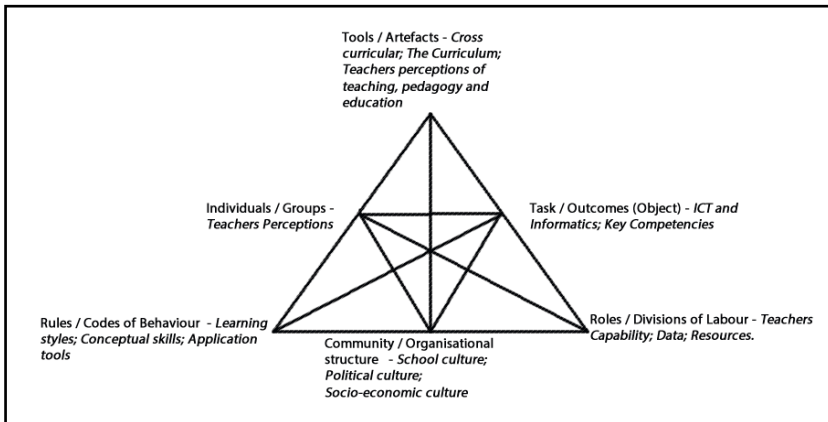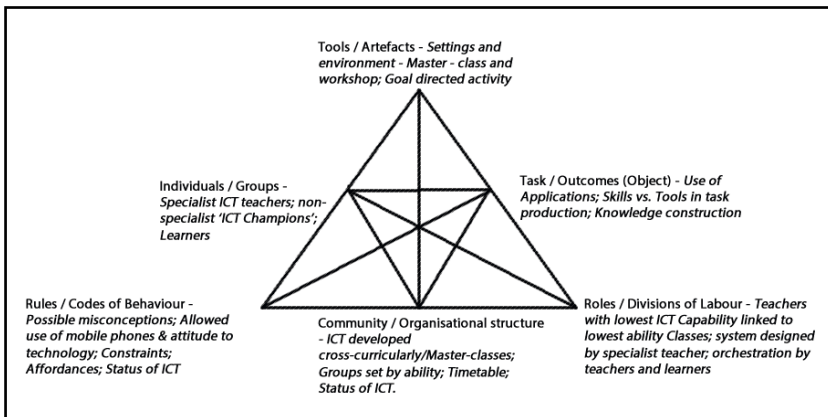
Figure 2: Interview analysis

Figure 3: Observation analysis

3 Results

The results are presented in terms of the elements or mediating factors of Engestrom's triangle, cross-referenced to the themes and examples emerging from the analysis of classroom observations together with both the initial and final interviews. This paper concerns one teacher/school, for which the activity setting involves ICT being taught to the whole year group (Year 9, aged 13–14) at once through a series of 'master-classes', lasting over an hour each morning throughout a week, followed up by workshops in ability groups for the rest of the school day. The masterclasses were given to the whole cohort as a lecture by the lead ICT specialist teacher and follow up workshops supervised by the lead teacher and a number of non-specialist teachers with an interest in technology.

Tasks/Outcomes In the case of this study, the object is the development of the key competencies inherent to ICT. These are generally referred to as 'skills' by teachers, a term which can cover a wide range of general competencies and tool-specific techniques. There was a change between the initial and final interviews in that during an initial discussion of skills, there was reference to *"higher order"* skills; *"Problem solving that goes with it"*, whereas in the later interview there was an indication that skills are synonymous with the tools used to operate the various applications.

The observations were of a master class and lesson which concentrated on the strand of the ICT curriculum 'Communicating Information', and the media for implementing this was the production and editing of a video. The observations showed that there was a strong emphasis on the use of the applications associated with the tasks. Both the masterclass and the subsequent workshop concentrated on what certain tools within the application were for and what the subsequent effects were. The product here was task based, with procedures and expected outcomes shared and reinforced with the group. During the masterclass and the class-based recap there was no reference to higher order skills and the sessions were focused on the use of the tools in the software, and thus the learning outcome was likely to be tool based. The product (video) could be quite polished depending on the individual skills and creativity of the student; however evaluation and reflection seemed to be absent. There was no difference between the two observations in the outcome or object of the activity setting in that both were concerned with the production of a piece of work, and the learning that took place was focused on the tools used in the two applications, that of video production in the first observation and that of a presentation in the second.

Tools and Artefacts These include the curriculum; interpretations of the curriculum (e.g. lesson plans); software and hardware; language and conceptual understanding.

The aim of this school's curriculum is to develop the competencies predominantly through a cross-curricular approach, but with one week each year during which there is an intensive course of ICT. *"The tools are built up in the specialist weeks and then the other subjects can use those skills in their subjects."* It was felt that the statutory ICT curriculum is currently not motivating enough for the students in itself and their approach to the curriculum is designed to overcome this: *"move away from the boring routine of regular classes and do cool stuff with ICT."*

There were two physical settings: the main hall where all students were seated and listening to the lead teacher, and a variety of classrooms with networked PCs. The class observed were situated in the ICT-equipped portion of the library for the workshop, using Serif Video Plus for the task.

Examination of the classroom activity settings indicated that this aspect remained constant; the two interviews provided evidence of a change in the teacher's perception. She recognised the need for a change in curriculum, influenced by the external environment, particularly changes in the political position existing within the community and organisational mediating artefact of the triangle. In particular, if there were change in the curriculum to include aspects of computer science imposed externally then there would be a need to teach the subject with a more conceptually orientated approach. *"There is going to be huge change, not only what is going to be implemented, but also how it is going to be implemented by WAG [the body governing education in Wales] ...";* "hopefully it will move away from the tools aspect and towards more of a concept driven aspect".*

Individuals and Groups This element appears as the 'subject' in more traditional activity theory triangles. When analysing the activity within the classroom there are at least two different perspectives, with corresponding activity systems taking place; that of the teacher, whose object is likely to be the learning that they wish to take place, and that of the students, who are less likely to recognise the development of the competencies as the objective, but are more likely to be concerned with the successful completion of the task: in this case, the production of a movie. For the purpose of this paper, the analysis of the observations will focus on that of the teacher as the Individual and it is their object that will lead the activity triangle. The individuals and groups consisted of the lead specialist ICT teacher (who designed the unique approach to developing ICT competencies used within the school), the non-specialist

ICT teachers (who were supporters of technology within the school, but apart from workshops during the masterclass weeks were only involved with the development of ICT competencies on a cross-curricular basis), and the groups of students. The observed group was perceived to have high ability in ICT. There were no differences in the activity settings of the two observations of classroom practice.

Rules and Codes of Behaviour This may include the attitude of the participants, for example the motivation of the students; it may also be linked to how the key competencies are perceived, for instance in cross-curricular development compared with discrete lessons; any use of specialist knowledge and also any perceptions of the students which may change the status of ICT to a societal role.

The motivation of the students was high when observed, and this may be due to the perception that this was not an ordinary week of lessons. The operational delivery of ICT within the system means that ICT may be perceived as a tool rather than a subject in its own right. This reflects students' use of ICT outside the classroom, as there is a culture within the school of students being allowed access to mobile phones with games or 'apps' within their lunch breaks and free time. This may reinforce the perception of ICT as a tool instead of a subject.

There was no change in the attitude of the teacher interviewed, but there was a difference in the constraints and affordances supplied by the teacher in the second observation of classroom practice, in that the students were informed of "success criteria" in order to judge the actions they needed for successful completion of the task. This also enabled the students to orchestrate their own affordances in the construction of their knowledge. There was a status quo in the pedagogical process in that the specialist teacher still interacted with the top ability set.

Community and Organisational Structures The environment of both the school and the wider community influence this area of the activity. There is a political drive to change the ICT curriculum, which is already taking place in England and is currently under review with recommendations to Welsh government under consultation. This has influenced the perception of the key competencies within this study; in the beginning there was a clear focus on skills and tools with an acknowledgement of higher order skills but subsequently there was more emphasis on the skills needed for socio-economic success with allusions to industry and the world of work. *"Greater programming so we get better industry"; "Need to look at what skills they need in the wider world to know what they will need at schools".*

During the course of this study there has been increasing impetus in the external educational arena for the need to change the curriculum and this has had an effect on the perception of ICT and informatics in the school, as noted in other sections of the results.

Roles and Divisions of Labour The key roles are that of the teacher under interview and her team of non-ICT-specialist teachers who help facilitate the workshops within this system. Two of the key themes that emerged here were resources and differentiation. The specialist ICT teacher holds the responsibility for the design of the system, the mode of delivery and the design of the teaching material, any differentiation and the assessment of the work produced. Whilst she designs any differentiated resources these resources are taught by non-specialist 'ICT Champions': *"We use teachers who have a particular interest in the use of ICT, all of them are masters at using ICT within their own subject area."* Higher ability students were supported by the teachers with more specialist ICT knowledge. The ICT specialist also has responsibility for placing the students in classes according to ability: *"Their capabilities you see very quickly. You have to differentiate very carefully, and we will set the classes by achievement"*. However she is the teacher who has least knowledge of students individually, and is reliant on general cognitive ability data which may not be the best indicator of ICT potential. Whilst the interviewee had expressed a belief that this method suited her students – *"The tools are built up in the specialist weeks and then the other subjects can use those skills in their subjects"* – its place in the curriculum implies that the subject is not held in the same esteem as other subjects afforded an hourly lesson a week: *"In secondary schools generally it would need more money, for example to have specialist teachers, I mean at the moment I am a department of one"*.

Participation of the different individuals and groups varied, in that during the master-class portion of the teaching and learning experience the action was in the hands of the specialist ICT teacher, there was no opportunity for interaction other than in a superficial checking of the recall of the instructions given. There was also no participation from the non-ICT-specialist teachers at this point. However, in the workshop setting, there was opportunity for greater questioning regarding the workings of the software under investigation. There was also opportunity for the students to interact with their own learning, as the learners in the group had a greater control over how they organised the learning of the software, and there was evidence of exploration as a strategy. If the effect of an action was perceived as successful, students discussed this with those sitting close by. In this way the learning was shared. The degree of autonomy of learning was dependent on the overall ability of the group and

the confidence that this ability brings. Therefore this autonomy is likely to be reduced in the less able groups as the difficulties of the learner are greater; the group observed had the confidence to explore the tools of the software independently and had developed clear ideas about how they wished their finished product to appear.

4   Discussion and Conclusions

When discussing the nature of ICT and trying to establish the key competencies within ICT with teachers, the key themes that emerge appear to exist on two levels: those which are concerned with the operation of a specific application *"this Microsoft application process that we're going down in our current curriculum"* and those competencies which are concerned with the use of higher order skills and concepts, e.g. *"increase capability by working at higher order skills and teaching not just skills but the content behind it"*. There was also an allusion to the need for metacognition within the desired competencies.

There is a primary contradiction in the object – the intended learning – between the tool-based teaching observed in lessons and the goals stated in the initial interview which refer to 'problem solving', 'higher order skills' and concepts: *"Communicating information often is posters and PowerPoint. The kids have the skills – they get those skills in primary school – we don't need to spend the time developing that skill, we need to be looking at the concepts behind it"*. However, there are apparent differences in the goals between the two interviews, which warrant further investigation. In the final interview, there is no reference to higher order thinking and the discussion of skills focuses on tools: *"for example in spreadsheets ... we are looking at the tools within the application"* and at one point the teacher expressed the view that the term 'skills' was synonymous with the term 'tools', indicating that the key competencies within ICT were perceived to be of lower order.

This change in the object of the activity may resolve the primary contradiction, but leaves a secondary contradiction between the tools/artefacts and the object of the teachers perceptions, in that the teacher's perceptions tend to focus on the lower order tools used to operate a variety of applications and less on the higher metacognitive skills which are discussed within the National Curriculum in Wales (ACCAC, 2008), where ICT capability is described for example as having the ability to use ICT in problem solving. Examination of the scheme of work also supports the need for evaluation: *"state ways in which you can improve your work"*. However, in reality, this was superficial with an absence of any real metacognition.

Thus a change in the perception of the key competencies is emerging, in that the teacher's perception is moving from one incorporating higher levels of metacognition to a merely tool-based definition, which matches the practice observed. The contradiction within the object – between the espoused goals and the practical objectives – has been resolved but the conflict is now between the object (learning to use tools) and the artefacts (the scheme of work and the National Curriculum). Furthermore, examining the rules, community and roles, all point to a lesser status for ICT within the school compared with other subjects, which is at variance with the lead teacher's initial perceptions of having a subject which in itself develops higher order key competencies such as problem solving and metacognition.

Another contradiction lies within between the individuals/groups and the roles/division of labour in the use of non-specialist staff in the development of ICT competencies, and furthermore the assignment of those staff with lesser ICT competencies themselves to the lower ability groups. Currently it is the specialist ICT teacher who is responsible for the formation of the scheme of work, the system of teaching and the differentiation taking place to enable both the less able and the more able student. However, because this teacher does not teach at this age group apart from isolated periods throughout the school year, she does not know the students but is reliant on general data concerning cognitive ability. The non-specialist teachers know students as they teach them in other subjects. Furthermore the rationale driving this is that the higher ability group needs the specialist teacher so that she can 'push' them, however her object is tools based and given that the very students she is 'pushing' have the ability to explore tools, to orchestrate their own learning, to build their own constraints and affordances to bring about the knowledge construction, whereas the lower ability would need the constraints and affordances as implemented by the specialist teacher. Shulman's (1987) work suggests that the development of learning within a subject is dependent on the pedagogical content knowledge of the teacher rather than just subject knowledge and knowledge of learners, and it may be that those classes with the least ability would gain most from a specialist ICT teacher whereas students with good higher order skills would gain most from being challenged to apply ICT in learning other subjects.

This study has demonstrated change, predominantly the change in teacher perceptions of the key competencies of ICT. The realisation that the teacher's object is really the learning of ICT tools rather than higher-order skills may have been brought about by the study itself, or indeed by external influences such as the present political and educational arena within England and Wales. In order to resolve the contradictions and implement the current curriculum, a

number of changes to the activity system will need to be adopted. There will need to be changes to the curriculum as it is perceived within the school, in that there will need to be more expectation and support for the students to use the metacognitive skills. At present, the scheme of work and mode of teaching limits the students to a tool-based construction of knowledge. Furthermore, in order to effectively achieve this, there may be a need to re-assess the scheduling of the subject to allow for the students to reflect on their learning and explore the use of the applications in differing situations. As the political environment drives change in the subject towards a more conceptual nature the impact on the mediating factors of community and organisational structure within the school environment may take the form of greater status afforded to the subject. Any subsequent increased teaching time is likely to have cost implications as there may be the need to employ further specialist teachers.

Finally, there may be a need to further evaluate the pedagogical knowledge which is fundamental to this scheme of work and use specialism where there is greater need, with those less able students. By facilitating the more able students to orchestrate their own learning and construction of knowledge, using self-created affordances and con-straints, especially those which may be prevalent in problem solving scenarios, whilst correcting any misconceptions which may occur, then those higher order metacognitive competencies which are being highlighted within the subject area are likely to be better developed.

The analysis of one case study is not sufficient to fully identify contradictions in the systems for developing key competencies in ICT. The use of CHAT in the analysis has proved valuable, however, and promises to help reveal further insights in subsequent case studies and cross-case analysis. Furthermore, the work has provided a baseline from which to explore the effects of changes to the activity systems as the statutory curriculum experiences a more fundamental shift towards computer science.

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